Towards better speech perception and beyond

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Abstract Book

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APSCI 2023

November 9 (Thu), 2023

Abstract Book

Plenary Lecture 01

PL 01

Hearing loss, cognition, and brain health – Results from the ACHIEVE randomized trial

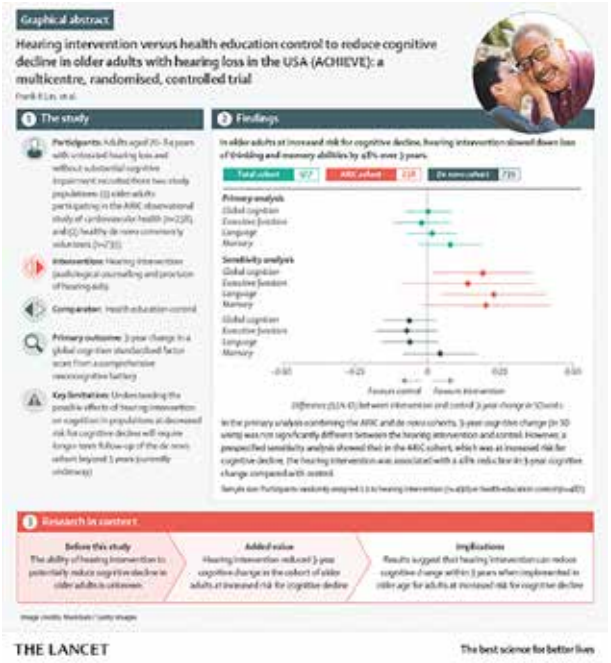
Frank LIN

Otolaryngology, Johns Hopkins University, USA

Background: Hearing loss is associated with increased cognitive decline and incident dementia in older adults. We aimed to investigate whether a hearing intervention could reduce cognitive decline in cognitively healthy older adults with hearing loss.

Methods: The ACHIEVE study is a multicentre, parallel-group, unmasked, randomised controlled trial of adults aged 70–84 years with untreated hearing loss and without substantial cognitive impairment that took place at four community study sites across the USA. Participants were recruited from two study populations at each site: (1) older adults participating in a long-standing observational study of cardiovascular health (Atherosclerosis Risk in Communities [ARIC] study), and (2) healthy de novo community volunteers. Participants were randomly assigned (1:1) to a hearing intervention (audiological counselling and provision of hearing aids) or a control intervention of health education (individual sessions with a health educator covering topics on chronic disease prevention) and followed up every 6 months. The primary endpoint was 3-year change in a global cognition standardised factor score from a comprehensive neurocognitive battery. Analysis was by intention to treat. This trial was registered at ClinicalTrials.gov, NCT03243422.

Findings: From Nov 9, 2017, to Oct 25, 2019, we screened 3004 participants for eligibility and randomly assigned 977 (32·5%; 238 [24%] from ARIC and 739 [76%] de novo). We randomly assigned 490 (50%) to the hearing intervention and 487 (50%) to the health education control. The cohort had a mean age of 76·8 years (SD 4·0), 523 (54%) were female, 454 (46%) were male, and most were White (n=858 [88%]). Participants from ARIC wereolder, had more risk factors for cognitive decline, and had lower baseline cognitive scores than those in the de novo cohort. In the primary analysis combining the ARIC and de novo cohorts, 3-year cognitive change (in SD units) was not significantly different between the hearing intervention and health education control groups (–0·200 [95% CI –0·256 to –0·144] in the hearing intervention group and –0·202 [–0·258 to –0·145] in the control group; difference 0·002 [–0·077 to 0·081]; p=0·96). However, a prespecified sensitivity analysis showed a significant difference in the effect of the hearing intervention on 3-year cognitive change between the ARIC and de novo cohorts (pinteraction=0·010). Other prespecified sensitivity analyses that varied analytical parameters used in the total cohort did not change the observed results. No significant adverse events attributed to the study were reported with either the hearing intervention or health education control.



Figure

Interpretation: The hearing intervention did not reduce 3-year cognitive decline in the primary analysis of the total cohort. However, a prespecified sensitivity analysis showed that the effect differed between the two study populations that comprised the cohort. These findings suggest that a hearing intervention might reduce cognitive change over 3 years in populations of older adults at increased risk for cognitive decline but not in populations at decreased risk for cognitive decline.

Featured Talk 01

FT 01

Genetic study in Chinese CI candidate

Pu DAI

College of Otolaryngology Head Neck Surg, Chinese PLA General Hospital, China

In China, a nationwide molecular epidemiology had been performed since 2003, which covering 31 provinces, 21 ethnic group. Till now, more than 20000 cases mostly with severe to profound hearing loss were collected. 21.8% of them suffered from EVAS with the pathogenic variants of SLC26A4 found. 20.5% of them were found to have causative variants in GJB2 gene. 4.4% of them were found to carry mitochondrial C1494T or A1555G variants, suggesting aminoglycoside antibiotics might be the cause of hearing loss. In this population, syndromic hearing loss like Waardenburg, Pendred, Charge, Noonan, account for 0.1-1% of whole population respectively. Their genetic etiology can be reviewed by routine genetic testing or WES, even WGS strategy. The new testing method based on second generation sequencing can explore genetic etiology of relative rare deaf genes for more 12.6-15.0% of patients. In some deaf family without positive genetic testing result, new causative genes like ATP6V1B1, INFLR1 and so on were identified by WESWGSLinkage analysisThird generation sequencing. Among the deaf cases with cochlear malformation, 75% were mondini malformation which mostly caused by mutant SLC26A4 gene, 2% were incomplete partition deformity III (IP-III) which mostly caused by mutant POU3F4 gene. SNHL patients associated with TMPRSS3OTOFmtDNA mutations are good candidates of residual hearing preservation for cochlear. Also Auditory Neuropathy caused by pathogenic variants in OTOF gene indicates very good outcome after CI intervention. According to our research, 60% of cochlear implant candidates may have a positive genetic test result, while 95% of patients with definite hereditary deafness have good outcome after cochlear implant, so genetic diagnosis is a predictive tool for the effectiveness of cochlear implant. Genetic diagnosis of deafness also has important role for genetic counseling, deafness prevention and fertility guidance in cochlear implant recipient's families. Meanwhile, preimplantation genetic diagnosis may be the most effective and direct way to prevent deafness in offspring in families with high risk of genetic deafness.

Featured Talk 02

FT 02

Surgical treatment of single sided deafness

Wolf-Dieter BAUMGARTNER

Department of Otorhinolaryngology, Head and Neck Surgery, Medical University of Vienna, Austria

Featured Talk 03

FT 03

Intraoperative ECochG as a predictor of speech perception

Stephen O'LEARY

The Department of Surgery – Otolaryngology, University of Melbourne, Australia

Aims: Electrocochleography (ECochG) appears to offer the most accurate prediction of post-CI hearing outcomes. This may be related to its capacity to interrogate the health of underlying cochlear tissue. The four major components of ECochG (cochlear microphonic (CM), summating potential (SP), compound action potential (CAP) and auditory nerve neurophonic (ANN)) are generated by different cochlear tissue components. Analysing characteristics of these components can reveal the state of hair and neural cell in a cochlea. The present study aimed to examine the relationship between ECochG components recorded from an intracochlear approach can explain postoperative speech perception or audiometric thresholds.
Design: In 113 human subjects, responses to 500Hz tone bursts were recorded at 11 intracochlear (IC) electrodes across a 22-electrode CI array immediately following insertion. Responses to condensation and rarefaction stimuli were then subtracted from one another to emphasise the CM and added to one another to emphasise the SP, ANN and CAP. Maximum amplitudes and EC electrode locations were recorded for each of these ECochG components. These were added stepwise to a multi-factor generalised additive model (GAM) to develop a best-fit model predictive model for pure tone audiometric thresholds (PTA) and speech perception scores (Speech Reception Threshold – SRT, and Consonant Vowel Consonant-Phonemes CVC-P) at 3 -and 12- month postoperative timepoints. This best-fit model was tested against a GAM using clinical factors alone (preoperative score, age and gender) as a null model proxy.
Results: ECochG-factor models were superior to clinical factor models in predicting postoperative PTA, CVC-P and SRT outcomes at both timepoints. Clinical factor models explained a moderate amount of PTA variance (r^2 = 45.9% at 3mo, 31.8%at 12mo, both $p < .001$) and smaller variances of CVC-P and SRT (r^2 range = 6 to 13.7%, p = .008 to .113) but age was not a significant predictive factor. ECochG models explained more variance at the 12-month timepoint (r^2 for PTA = 52.9%, CVC-P = 39.6%, SRT= 36.4%) compared to the 3-month one timepoint (r^2 for PTA = 49.4%, CVC-P = 26.5%, SRT= 22.3%). The ECochG model was based on three factors: maximum SP deflection amplitude, and electrode position of CM and SP peaks. Adding neural (ANN and/or CAP) factors to the model did not improve variance explanation. Large negative SP deflection was associated with poorer outcomes and a large positive SP deflection with better postoperative outcomes. Mid-array peaks of SP and CM were both associated with poorer outcomes.
Conclusions: Post-insertion IC ECochG recordings across the array can explain a moderate amount of postoperative speech perception and audiometric thresholds. Maximum SP deflection and its location across the array appears to have a significant predictive value which may reflect the underlying state of cochlear health.

Featured Talk 04

FT 04

Drug delivery to the inner ear in combination with cochlear implants

Stefan K. PLONTKE

Dept. of Otorhinolaryngology, Head and Neck Surgery, Martin Luther University Halle-Wittenberg, Germany

Local drug delivery to the inner ear offers several advantages over systemic delivery. Local drug, gene, and stem cell therapy for peripheral hearing and vestibular disorders currently encompasses extracochlear (i.e., through intratympanic injection) and intracochlear/intralabyrinthe administration, with or without combination with cochlear implants (CI).

To improve the efficacy and safety of rehabilitation with cochlear implants, one focus is the development of drug-releasing electrode carriers, e.g., for delivery of glucocorticosteroids, antiapoptotic substances, neurotrophines to the inner ear. The performance of cochlear implants may thus be improved by protecting neuronal structures from insertion trauma, reducing fibrosis in the inner ear, and by stimulating growth of neuronal structures in the direction of the electrodes.

Controlled drug release after extracochlear or intracochlear/intralabyrinthine application in conjunction with a CI can also be achieved by use of a biocompatible, resorbable controlled-release drug delivery system.

This featured talk focuses on basic principles including pharmacokinetic, pharmaceutical technologic and drug delivery device aspects as well as current developments and future challenges related to drug delivery to the inner ear in combination with cochlear implants.

Featured Talk 05

FT 05

Hearing preservation – Cochlear implantation using the concept of partial insertion

Thomas LENARZ

Otolaryngology, Hannover Medical School, Germany

An increasing number of cochlear implant recipients have usable residual hearing which should be preserved during cochlea implantation in order to allow for electric acoustic stimulation. This has shown to be superior in terms of speech understanding in noise and music listening over electric stimulation. Therefore it is utmost important to preserve the residual hearing during cochlea implantation. The insertion of electrodes shall cover the high frequency range which is needed for electric stimulation while low frequencies are preserved for acoustic stimulation. In order to reduce the risk caused by a deeper electrode insertion which is correlated with an increased risk of hearing loss and to achieve an adequate insertion depth for electric stimulation, the electrode insertion depth should be pre-calculated using a specific cochlea model based on anatomic factors such as length and shape of the cochlea as well as the audiogram. There is a tradeoff between hearing preservation on one side using short insertion versus sufficient cochlea coverage in cases of loss of residual hearing for electric stimulation only. In order to overcome this tradeoff a concept of partial insertion has been developed. At time of first surgery the implant electrode is only inserted up to the pre calculated insertion depths while several electrode contacts are positioned outside the cochlea. This minimizes the risk of electrode insertion trauma and provides enough reserve in case of loss of residual hearing with after loading of the electrode to its full length for electric stimulation only.
Clinical results will be presented which shows that hearing in those patients with partial insertion, using electric-acoustic hearing, outperforms results of patients with electric stimulation only. Results of afterloading will also be presented. It shows that afterloading is possible and leads to an increased improved hearing in cases if residual hearing is lost after surgery or over time.

Featured Talk 06

FT 06

Indications and long term outcome of pediatric ABI

Levent SENNAROGLU

Department of Otolaryngology, Hacettepe University, Türkiye

Featured Talk 07

FT 07

What Does Music Sound Like to a Cochlear Implant User?

Charles LIMB

Otolaryngology-Head and Neck Surgery, UC San Francisco Medical Center, USA

Despite remarkable advances in speech perception for cochlear implant users, music remains a significant challenge and the most challenging stimulus for cochlear implant users to hear well. This difficulty is due to a number of acoustic, biological, and technological constraints. Beyond entertainment, music can be used as a tool to probe the limits of cochlear implant-mediated perception of complex sound. In terms of musical elements, cochlear implant users demonstrate important limitations in pitch and timbre processing, as well as impaired perception of sound quality. In this presentation, I will discuss research into the various limitations of music processing by cochlear implant users. Using psychophysical data, neuroimaging methods, and patient self-reporting, I will demonstrate some of the strategies that have been used to overcome the limitations of cochlear implant-mediated listening for music.

Featured Talk 08

FT 08

Towards optogenetic hearing restoration

Tobias MOSER

Institute for Auditory Neuroscience, University Medical Center Goettingen, Germany

When hearing fails, cochlear implants (CIs) provide open speech perception to most of the currently half a million CI users. CIs bypass the defective sensory organ and stimulate the auditory nerve electrically. The major bottleneck of current CIs is the poor coding of spectral information, which results from wide current spread from each electrode contact. As light can be more conveniently confined, optical stimulation of the auditory nerve presents a promising perspective for a fundamental advance of CIs. Developing optogenetic stimulation for auditory research and future CIs requires efforts toward design and characterization of appropriate optogenetic actuators, viral gene transfer to the neurons, as well as engineering of multichannel optical CIs. The presentations will summarize the current state of optogenetic stimulation of the auditory pathway and report on recent breakthroughs on achieving high temporal fidelity and frequency resolution and establishing multichannel optical CIs.

Keynote Lecture 01

KL 01

Impact of Cochlear Implantation on Brain Cortical Activity and Auditory Function in Single-Sided Deafness: A PET Study.

Seung Ha OH

Department of Otorhinolaryngology, Seoul National University College of Medicine, Seoul National University Hospital, Korea

Patients with single-sided deafness (SSD) face challenges in discriminating sounds in noise environments and in determining the sound localization. SSD modifies the contralateral hemispheric dominance during monaural stimulation, shifting it towards the hemisphere ipsilateral to the ear with better hearing. This study aimed to investigate whether cochlear implantation (CI) could restore the functional patterns of brain cortical activity and whether this restoration correlates with improved audiological functions. We prospectively included a total of 8 patients with post-lingual SSD. The period of deafness was 4.7 years. The mean hearing threshold and speech discrimination score in the SSD ear were 87.8 dB and 8.7% respectively. All patients underwent audiological tests, including the Hearing in Noise Test (HINT) for sentence recognition and a sound localization test. Changes in brain cortical activity were assessed using H215O-positron emission tomography (PET) in 6 patients with right-ear SSD. During PET scanning, the patients underwent the auditory speech recognition test, determining odd numbers, while listening either with their worse ear or with both ears. After CI, significant improvements were observed in Signal to Noise Ratio (SNR) in HINT (Noise front: -1.5 to -2.7, Signal on worse ear: 0.8 to -2.1) and root mean square error (RMSE) for localization error (4.8 to 3.3). Moreover, Speech, Spatial, and Qualities of Hearing Scale (SSSQ) improved after CI (14.9 to 18.4). During the both-ears condition, increased activation in the contralateral (left) auditory cortex was found in post-CI compared with pre-CI. During the deaf-ear condition, increased activation of the ipsilateral (right) auditory cortex, frontal and cingulate regions in pre-CI compared with post-CI. In conclusion, the changes of activation in the auditory cortex after CI align with improved audiological functions. Additionally, the decreased activation in frontal and cingulate regions may be associated with reduced cognitive attentional efforts required for auditory speech recognition following CI.

Keynote Lecture 02

KL 02

Cochlear implantation surgery in challenging cases

Luis LASSALETTA

Otolaryngology, La Paz University Hospital, Spain

Cochlear implantation is generally considered a straightforward surgical procedure in most cases. A mastoidectomy with a facial recess approach can result in a smooth and complete insertion of the electrode array in approximately two-thirds of cases. However, anatomical variations and surgical conditions can transform this seemingly straightforward procedure into a highly challenging one, demanding exceptional surgical expertise and sometimes necessitating modifications to the standard surgical technique. This lecture will present a spectrum of complex conditions, including narrow mastoidectomies due to vascular malposition, challenging cases involving the revision surgery of misplaced electrode arrays, cochlear implantation in chronic otitis media, middle and inner ear malformations, cochlear fibrosis or ossification due to otosclerosis of meningitis, and various scenarios of cochlear implantation in patients with vestibular schwannoma. The role of subtotal petrosectomy as an alternative surgical approach in specific cases, and the utility of certain specialized tools such as insertion probes will also be discussed."

Keynote Lecture 03

KL 03

Developmental hearing experience shapes auditory top-down processing

Andrej KRAL[1,2]

[1]*Institute of AudioNeuroTechnology & Dept. of Experimental Otology, ENT Clinics, Hannover Medical School, Hannover, Germany*
[2]*Australian Hearing Hub, School of Medicine and Health Sciences, Macquarie University, Sydney, Australia*

A popular model of prelingual deafness are congenitally deaf cats, where plasticity with chronic electrostimulation through cochlear implants have been studied (Kral et al., 2019, Ann Rev Neurosci). Congenital deafness had extensive influence on the organization of the auditory system, with predominant consequences in the cerebral cortex (Kral et al., 2016, Lancet Neurol). In recent years, mathematical tools exploiting analysis of oscillatory cortical activity allowed to decipher specific effects of deafness on cortical processing. So-called induced responses, indicative of corticocortical interactions, were most prominently reduced in the auditory cortex of congenitally deaf cats (Yusuf et al., 2017, Brain). In adult hearing cats (HC) and congenitally deaf cats (CDCs), cortical responses to acoustic and electric stimulation (through a cochlear implant) were compared in the primary auditory field (A1) and the higher order posterior auditory field (PAF). Recordings were performed using multielectrode arrays and the penetrations were histologically reconstructed. For effective connectivity pairwise phase consistency, weighted phase-lag index and nonparametric Granger causality were used as connectivity measures. CDCs demonstrated a substantially reduced stimulus-related corticocortical coupling in the connectivity measures used. Largest deficits were observed in sensory-related top-down interactions, in the alpha and beta band. The data document that corticocortical interactions are dependent on developmental hearing experience. The result suggest that the congenitally deaf brain cannot incorporate top-down prediction information into auditory processing and thus have a deficient mechanism of predictive coding.

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Keynote Lecture 04

KL 04

Difficult surgical issues in CI and heads-up CI surgery (surgery without microscope)

Prepageran NARAYANAN

Department of Otolaryngology Head & Neck Surgery, University of Malaya, Malaysia

Symposium 01

Functional Neuroimaging
SP 01-1

Prediction of cochlear implant outcome using brain imaging

Doug Edward Hugh HARTLEY[1,2]

[1]Hearing theme of the NIHR Nottingham Hearing Biomedical Research Centre, Nottingham University, UK
[2]Nottingham Auditory Implant Programme, Nottingham University Hospitals NHS Trust, UK

Whilst many cochlear implant (CI) recipients achieve good speech understanding, some people receive less benefit from their implant than others, and large variability still exists in how well individuals can understand speech through their CI. While some influential factors have been identified, including age at onset of hearing loss and the duration of deafness, currently there is no accurate predictor of how well an individual will perform with a CI. However, a better understanding of the mechanisms underlying the variability in CI may inform clinicians in counselling patients prior to implantation about their likely prognosis and help shape the rehabilitation that they receive post-implantation, to ensure that limited healthcare resources are directed effectively.
Evidence suggests that 'cross-modal' reorganisation of auditory brain regions could be an important factor in understanding and predicting how much benefit an individual will receive from their CI. Following deafness, cortical areas that would usually process auditory information can reorganise and become more sensitive to the intact senses, such as vision. Indeed, it has been shown that individuals with a CI rely on a heightened synergy between audition and vision. Such findings highlight the importance of exploring and understanding how the brain responds to auditory and visual speech information before and after cochlear implantation. However, the time course and nature of these changes in cortical responsiveness, and their relationship with an individual CI user's ability to make use of auditory and visual speech information has, until recently, been challenging to study.
Specifically, the established methods for non-invasive brain imaging in humans are generally not well suited to research involving CI users due to the electric and magnetic artefacts generated by the operation of the CI. In this talk I will review our work using functional near-infrared spectroscopy (fNIRS), a flexible and non-invasive imaging technique which, owing to its optical nature, is fully compatible with CIs and is essentially silent. Our work indicates that fNIRS provides a powerful tool to explore cortical reorganisation during deafness and following cochlear implantation. By developing fNIRS as a tool to study how the brain responds to multisensory stimulation before and after cochlear implantation, we can provide valuable insights into the reasons for variable CI outcomes.

Symposium 01

Functional Neuroimaging
SP 01-2

Functional imaging and electrophysiology for the diagnostics and prognostics of CI

Chen-Chi WU

Otolaryngology, National Taiwan University College of Medicine, Taiwan

Sensorineural hearing impairment (SNHI) is a common and etiologically heterogeneous clinical entity in children. For children with severe to profound SNHI, cochlear implantation (CI) is currently the best treatment option. However, the performance of CI recipients is highly variable. Although several factors have been identified that influence CI outcome, accurate objective assessment tools are still lacking in clinical practice. In recent years, several new auditory physiological and neuroimaging tools have been developed that may provide a solution to this unmet clinical need.
In recent years, our team has been dedicated to the assessment, diagnosis, counseling, treatment, and rehabilitation of pediatric SNHI and has actively introduced novel auditory physiology and neuroimaging tools, including cortical auditory evoked potentials (CAEPs), mismatch negativity (MMN), and functional near-infrared spectroscopy (fNIRS). In this presentation, I will discuss the value of these new tools in the diagnosis and prognosis of pediatric CI recipients.

Symposium 01

Functional Neuroimaging
SP 01-3

Brain glucose metabolism in the profoundly deafened elderly: A comparison between ineffective hearing aid users and effective cochlear implant users

Yasushi NAITO

Department of Otolaryngology, Comprehensive Ear and Hearing Center, Kobe city medical center general hospital, Japan

Background and Purpose of the Study:
Many studies have shown that hearing loss can cause dementia, but its specific mechanisms remain unclear. Research using fMRI is revealing that multiple regions of the brain are synchronously active even at rest, serving as the basis for various neural activities. However, since fMRI uses a strong magnetic field, it is not suitable for testing patients with profound hearing loss who use implanted medical devices such as cochlear implants. Thus, in this study, we observed resting-state brain activity in profoundly deafened elderly patients by measuring regional cerebral glucose metabolism with FDG-PET, which does not use a strong magnetic field, and evaluated the effect of profound hearing loss on brain activity.

Subjects and Methods:
Regional glucose metabolism in the brain was measured using FDG-PET at rest without specific tasks in elderly patients with severe hearing loss (aged 65 or older and under 85) who met the criteria for cochlear implantation and (1) who had not yet undergone cochlear implantation despite inadequate hearing aid effectiveness and (2) who had recovered speech and language communication more than one year after cochlear implantation. The data were analyzed using 3D-SSP (Three-Dimensional Stereotactic Surface Projections) and SSE (Stereotactic Extraction Estimation) to calculate the percentage of regions in each brain region where FDG uptake was reduced or increased by more than two standard deviations from the mean value in healthy subjects (using basic data from our Molecular Imaging Research Department).

Results:
Regional cerebral glucose metabolism differed between the elderly with profound hearing loss and normal subjects, with a general tendency for a decrease in the temporal and parietal lobes in those with profound hearing loss. When the regions of interest were further divided, a greater reduction in glucose metabolism was observed in the anterior and posterior cingulate cortex and parahippocampal gyrus in the group of elderly patients with profound hearing loss for whom hearing aids did not provide sufficient benefit than in those with profound hearing loss who had regained spoken language communication with cochlear implants.

Discussion:
In older patients with profound hearing loss, glucose metabolism is altered in several brain regions. When hearing aids fail to compensate for hearing loss, there may be reduced activity in the cingulate cortex, which plays an important role in the resting-state brain activity network (default mode network), suggesting a link between severe hearing loss and dementia. On the other hand, in the group that regularly wears cochlear implants, there is less decrease in glucose metabolism in these regions, suggesting that effective auditory compensation may improve glucose metabolism in the brain. However, these findings need to be validated in a larger number of cases.

Acknowledgements: This study was conducted in collaboration with the Department of Molecular Imaging Research, Kobe City Medical Center Central Municipal Hospital: Michio Senda, Senior Advisor; Shigehiko Yamane, Director; Department of Otolaryngology: Norio Yamamoto, Keizo Fujiwara, Naoko Fujii, Rinko Tamaya, Tomoko Yamazaki, Saburo Moroto; Department of Otolaryngology, Kyoto University: Hiroshi Yamazaki.

Symposium 01

Functional Neuroimaging
SP 01-4

Cortical reorganization following auditory deprivation predicts cochlear implant performance in postlingually deaf adults

Hong Ju PARK

Department of Otorhinolaryngology-Head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Objectives: We aimed to predict cochlear implantation outcomes by evaluating imaging features and quantifying cortical structural changes.
Materials and Methods: We studied 94 postlingually deaf patients who underwent cochlear implantation and 37 recent sudden hearing loss patients who were expected to show no brain structural changes. We performed voxel-based morphometry to compare the brain gray matter probability between postlingually deaf patients and sudden hearing loss subjects.
Results: Compared to those with sudden hearing loss, we found decreased gray matter probabilities in bilateral superior, middle, and inferior temporal cortices; pre-/post-central cortices; as well as the thalamus in the postlingually deaf group, most of which are regions related to auditory and language processing functions. As the deafness progresses, however, the aforementioned brain areas except the middle temporal cortex displayed gradually reverse increases in gray matter probability, whereas the middle temporal cortex showed constant gradual decreases. Gray matter clusters in the left superior temporal cortex, left middle temporal cortex, and bilateral thalami showed the most accurate prediction of post-cochlear implantation word recognition scores (mean absolute error = 10.1%, r = 0.82), which was significantly better than when clinical variables used (12.1%, $p<0.05$). The prediction was slightly improved when the gray matter features were combined with clinical variables like deafness duration and age at cochlear implantation (8.5%, r = 0.9).
Conclusions: Our findings suggest that early hearing deprivation induces initial gray matter volume loss in the superior temporal cortex and thalamus, while the cross-modal plasticity that enables these regions to process other modal sensory inputs reverses the volume decrease trend when deafness becomes persistent for years. However, volumes of the middle temporal cortex, which processes higher-level language comprehension, persistently decrease over time, suggesting this area's association with the degradation of speech comprehension in patients with long-term postlingual deafness. These imaging features of the cross-modality and progressive atrophy of language processing areas might play a key role in predicting outcomes of cochlear implantation.

Symposium 01

Functional Neuroimaging
SP 01-5

Neural correlates of speech-in-noise performance in cochlear implant users: PET and EEG studies

Phillip GANDER

Radiology, Otolaryngology - Head and Neck Surgery, Neurosurgery, Psychological and Brain Sciences, Communication Sciences and Disorders, University of Iowa, USA

Cochlear implants (CIs) have been the most successful intervention for severe sensorineural hearing loss. However, speech-in-noise (SiN) performance of CI users varies, which poses a barrier to positive clinical outcomes. In addition to good peripheral encoding, speech-in-noise understanding requires multiple central processes. Using neuroimaging techniques, we seek to characterize the central auditory cognitive mechanisms that contribute to CI users' SiN performance.
We developed electroencephalography (EEG) and positron emission tomography (PET) paradigms in which we disambiguate responses to noise and speech based on precise timing to derive metrics that predict SiN ability. In our study with normal listeners, listeners heard a brief noise followed by a target word. We found that the amplitude ratio of auditory cortical evoked responses triggered by the noise and the same triggered by the speech – the internal signal-to-noise ratio – predicts SiN accuracy. This supports early auditory cortical mechanisms to separate signal from noise to support SiN. We extended this to CI users and demonstrated that the auditory cortical evoked response to speech predicts their SiN performance in 114 CI listeners.
A follow-up PET study recruited 33 CI users. In the PET scanner, subjects performed a SiN listening task. The neural activity was compared to a non-verbal control task. The contrast between these conditions showed auditory cortex activation during the SiN task across all CI subjects. Left auditory cortex showed a significant positive correlation between the speech-in-noise contrast and performance on the speech-in-noise task. The correlation was negative and significant in left and right inferior frontal cortex, consistent with the idea that activity in these regions reflects listening effort.
The outcome of this work establishes new EEG measures of CI listening success operating over different timescales and different frequency ranges and examine with PET the auditory cognitive brain basis for speech-in-noise listening in CI users.

Symposium 02

BCI & MEI in SSD & AHL
SP 02-1

Benefits of active middle ear implants in mixed hearing loss: Stapes versus round window

Jae Young CHOI

Otorhinolaryngology, Yonsei University, Korea

We compared the audiologic benefits of active middle ear implants with those of passive middle ear implants with hearing aids in mixed hearing loss, and also compared the outcomes of stapes vibroplasty with those of round window vibroplasty. Thirty-four patients with mixed hearing loss due to chronic otitis media were treated with a middle ear implant. Of these, 15 were treated with a passive middle ear implant (conventional ossiculoplasty with a partial ossicular replacement prosthesis), nine with an active middle ear implant coupling to the stapes, and 10 with an active middle ear implant coupling to the round window. Patients underwent pure-tone/free-field audiograms and speech discrimination tests before surgery and 6 months after surgery, and the results of these tests were compared. The active middle ear implant resulted in better outcomes than the passive middle ear implant with hearing aids at mid to high frequencies ($P < .05$). Patients who received either a stapes vibroplasty or a round window vibroplasty showed comparable hearing gain except at 8,000 Hz (48.9 dB vs. 31.0 dB, $P < .05$). Patients who received a stapes vibroplasty showed an improvement even in bone conduction at 1,000 Hz and 2,000 Hz (both $P < .05$). Active middle ear implantation could be a better option than treatment with passive middle ear implants with hearing aids for achieving rehabilitation in patients with mixed hearing loss. Vibroplasty via either oval window or round window stimulation shares similar good results

Symposium 02

BCI & MEI in SSD & AHL
SP 02-2

BAHA Attract and OSIA 2 in Single Sided Deafness

Robert James BRIGGS[1,2]

[1]*Surgery, Otolaryngology, The University of Melbourne, Australia*
[2]*Cochlear Implant Programme, The Royal Victorian Eye and Ear Hospital, Australia*

Bone conduction implants can provide very useful rehabilitation in patients with single sided deafness (SSD), particularly when bone conduction thresholds are good in the contralateral ear. In Melbourne transcutaneous systems have now largely replaced the traditional percutaneous – direct connect – system, providing improved cosmesis and avoiding infection issues. The OSIA 2 system has now effectively replaced the BAHA Attract as the device of choice both for conventional BAHA indications and for SSD candidates.
This paper reviews our experience with both systems in the initial clinical trials and also uses intra-subject comparisons to demonstrate the superiority of the OSIA 2.

Symposium 02

BCI & MEI in SSD & AHL
SP 02-3

Efficacy of Bonebridge on single sided deafness; A prospective multicenter study

Yun-Hoon CHOUNG

Otolaryngology, Ajou University School of Medicine, Korea

Bone conduction implant (BCI) is one of treatment options for single sided deafness (SSD). The purpose of the study was to investigate the safety and efficacy of a novel active transcutaneous BCI device for patients with SSD. This study was conducted at 15 institutions in Korea. Thirty SSD patients (aged ≥ 19 years) were recruited and took the implantation of an active transcutaneous BCI device (Bonebridge BCI602). Objective outcomes included aided pure-tone thresholds, aided speech discrimination scores (SDSs), and the Hearing in Noise Test (HINT) and sound localization test results. The Bern Benefit in Single-Sided Deafness (BBSS) questionnaire, the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire, and the Tinnitus Handicap Inventory (THI) were used to measure subjective benefits. The mean aided pure-tone threshold was 34.2 (11.3), mean (SD), dB HL at 500–4,000 Hz and the gain was most significant at 1,000 Hz [aided threshold = 23.7 (9.6) dB HL]. The mean total BBSS score was 27.5 (13.8). All APHAB questionnaire domain scores showed statistically significant improvements between baseline and post-intervention: ease of communication, reverberation, background noise, and aversiveness. Moreover, the THI scores were significantly reduced after implantation of the BCI602 device [47.4 (30.1) vs. 34.4 (29.1), P = .042]. The use of lifts and type of anesthesia had no impact on device performance or user satisfaction. The aided sound field threshold at 4,000 Hz was a significant predictor of the aided SDS (estimate = -.309; 95% CI: -.575 to .042) and congenital SSD was a significant factor of subjective benefit (-11.643; 95% CI: -21.946 to -1.340). In conclusion, The BCI602 active transcutaneous BCI device can provide functional hearing gain without any adverse effects and may be the best surgical option for acquired SSD patients with long-term deafness.

Symposium 02

BCI & MEI in SSD & AHL
SP 02-4

Bonebridge in Children with Pinna Abnormalities and Canal Atresia

Ing Ping TANG[1,2]

[1]ORLHNS, UNIVERSITI MALAYSIA SARAWAK, Malaysia
[2]ORLHNS, SARAWAK GENERAL HOSPITAL, Malaysia

Abstract:

Introduction: Children with pinna abnormalities and canal atresia, either bilateral or unilateral, always present with conductive or mixed hearing loss and this is one of the indications of Bonebridge, an active osseo-integrated transcutaneous bone conduction implant.

Methods: This was a prospective, single-subject repeated measures designed study in which each subject serves as his/her own control from 2013 to 2022. The subjects' audiometric thresholds (air conduction, bone conduction and sound field at frequencies 250Hz to 8kHz) were assessed preoperatively, then subsequently at 6 months postoperatively. Subjective satisfaction with the device was evaluated by means of the Hearing Device Satisfaction Scale (HDSS) questionnaire.

Results: 20 patients were included in the study. Their age ranged from 7 to 18 years old. Computed tomography (CT) scans of temporal bone were performed in all the patients preoperatively to assess the suitability of implant placement. The Bone Conduction Floating Mass Transducers (BC-FMT) were placed at sinodural angle in 16 patients and at presigmoid area in four patients. There were no major complications intraoperatively. Audiometric thresholds for air and bone conduction showed no significant change with respect to time (P>0.05), for any of the tested frequencies until 6 months of follow-up. This confirmed that the patients' residual unaided hearing did not deteriorate with treatment. Meanwhile, sound field testing with aided thresholds showed significant improvement over time (p<0.05) at all tested frequencies until 6 months of follow up postoperatively. The aided hearing thresholds for frequencies from 500Hz to 4kHz at 6 months of follow-up postoperatively were between 21 to 30 dB. All the patients were very satisfied with the implant in terms of improvement of the aided hearing thresholds (91% to 98%) and acceptable cosmetic appearance of the sound processor.

Conclusion: Bonebridge is a transcutaneous bone conduction hearing implant that has been demonstrated to be safe and effective in improving patients' hearing thresholds from the age of 5 years old and above in children with pinna abnormalities and canal atresia. It provides another alternative treatment for patients with hearing loss who fail conventional hearing aids.

Symposium 02

BCI & MEI in SSD & AHL
SP 02-5

Active Middle Ear Implants in Chronic Otitis Media Cases

Levent OLGUN

Baskent university ENT Clinic, Zubeyde hanim Research Center, Türkiye

Active middle ear implants may be a good choice in hearing rehabilitation of patients with chronic otitis media.In this study technical details and outcome of the Active Middle ear implants used in 27 chronic otitis media cases will be presented.All cases had had several operations for chronic otitis media and hearing losses were not adequately corrected with these interventions.In all but two there was a mixed type hearing loss and all were not be able to wear conventional hearing aids either because of medical problems and /or dissatisfaction.In 25 of the cases MED_El Vibrant Sound Bridge and in 2 cases Otologics carina device were used.In all but two floating mass transducer of the MED -EL Vibrant sound bridge applied to round window.In 20 cases any coupler did not used and in 3 cases a transducer used with a round window coupler.In In two case transducer useed was applied onto stapes with a coupler.Both two Otologics Carina devices transducers were apllied to round window with special coupler.

In all cases bone conduction levels did not change. A considerable hearing gain could be obtained in all cases.In 3 MED EL and one Otologics cases a revision surgery necessitated.Also in the revised Otologics case device was explanted because of infection.

Symposium 03

Electrically Evoked Potential
SP 03-1

Predicting preservation of residual hearing from cochlear-implant derived measurements

Stephen O'LEARY

Dept Otolaryngology, University of Melbourne, Royal Victorian Eye and Ear Hospital, Melbourne, Australia

Objectives: To determine the cochlear-implant related measurements that predict the preservation of residual hearing following cochlear implantation.

Background: Patients with cochlear implants (CI) struggle to hear in the presence of background noise. Preserving residual hearing can ease this burden. Our aim is to determine whether measurements, derived directly from the cochlear implant, can predict preservation of residual hearing.

Design: Here we test whether two candidate measurements, the electrophysiological response of the cochlea to acoustic stimulation (ECochG) and electrical impedance, relate to hearing preservation. Thirty-nine subjects with residual low-frequency hearing were implanted with a slim-straight cochlear implant electrode array. ECochG and four-point impedance measurements were made along the 22 electrodes of the array immediately after implantation and 3 months after surgery. Hearing preservation was assessed after 3 months.

Results: 22 subjects (56%) exhibited the largest amplitude ECochG response at the tip of the electrode array (apical-peak, AP), whereas 17 subjects (44%) exhibited a maximum amplitude in more basal regions (mid-peak, MP). At 3 months, 6 subjects with an AP pattern peri-operatively exhibited a MP (apical-to-mid-peak, AP-MP).

The latency of the ECochG response increased with insertion depth in AP recordings (n=38). In MP recordings (n=30), the maximum latency shift was detectable more basally (median EL12, p<.001).

Four-point impedance measurements were available at both time points in 90% (n=35) of all subjects. At 3-months, four-point impedances were lower in the AP group (n=15, mean=222W, standard deviation (SD)=63) than in the MP (n=14, mean=295W, SD=76) and AP-MP groups (n=6, mean=234W, SD=129; AP vs. MP p=.026, AP vs. AP-MP p=.023, MP vs. AP-MP p>.999).

The mean post-operative hearing loss in the AP group was 13dB (n=16, SD=9). A significantly larger hearing loss was detectable in the MP and in the AP-MP group with 28 (n=17, SD=10) and 35dB (n=6, SD=13), respectively (AP vs. MP p=.002, AP vs. AP-MP p=.002, MP vs. AP-MP p=.926).

Discussion: MP and AP-MP ECochG patterns were correlated poorer residual hearing, and higher four-point impedances. The AP ECochG pattern is consistent with normal cochlear mechanics, and the MP pattern with contact between the electrode and the basilar membrane. The higher impedances suggest that MP and AP-MP patterns are associated with increased intracochlear fibrosis. The transition from AP to MP patterns suggests that cochlear fibrosis has restricted vibration of the basilar membrane.

Conclusion: Four point impedance appears to be a biomarker for fibrosis, as suggested in previous experimental studies. this supports the role of impedance in providing insights into the biology of hearing loss after cochlear implantation.

Symposium 03

Electrically Evoked Potential
SP 03-2

The limitations of using eCAPs for fitting - Results from a meta-analysis

Johan FRIJNS

Otorhinolaryngology and Head and Neck Surgery, Leiden University Medical Centre, The Netherlands

Objectives:
The electrically evoked compound action potential (eCAP) is widely used in the clinic as an objective measure to assess cochlear implant functionality. During the past decade, there has been increasing interest in applying eCAPs for fitting of cochlear implants. Several studies have shown that eCAP-based fitting can potentially replace timeconsuming behavioral fitting procedures, especially in young children. However, a closer look to all available literature revealed that there is no clear consensus on the validity of this fitting procedure. This study evaluated the validity of eCAP-based fitting of cochlear implant recipients based on a systematic review of the recent literature.

Design:
The Preferred Reporting Items for Systematic Reviews and Meta-Analyses were used to search the PubMed, Web of Science, and Cochrane Library databases. The term "eCAP" was combined with "cochlear implants," "thresholds," and "levels," in addition to a range of related terms. Finally, 32 studies met the inclusion criteria. These studies were evaluated on the risk of bias and, when possible, compared by meta-analysis.

Results:
Almost all assessed studies suffered from some form of risk of bias. Twenty-nine of the studies based their conclusion on a group correlation instead of individual subject correlations (analytical bias); 14 studies were unclear about randomization or blinding (outcome assessment bias); 9 studies provided no clear description of the populations used, for example, prelingually or postlingually implanted subjects (selection bias); and 4 studies had a high rate of loss (>10%) for patients or electrodes (attrition bias). Meta-analysis of these studies revealed a weak pooled correlation between eCAP thresholds and both behavioral T- and C-levels ($r = 0.58$ and $r = 0.61$, respectively).

Conclusions:
This review shows that the majority of the assessed studies suffered from substantial shortcomings in study design and statistical analysis. Meta-analysis showed that there is only weak evidence to support the use of eCAP data for cochlear implant fitting purposes; eCAP thresholds are an equally weak predictor for both T- and C-levels. Based on this review, it can be concluded that research on eCAP-based fitting needs a profound reflection on study design and analysis to draw well-grounded conclusions about the validity of eCAP-based fitting of cochlear implant recipients.

Symposium 03

Electrically Evoked Potential
SP 03-3

The feasibility of electrically evoked compound action potential (ECAP) metrics to objectively characterize the functional status of the auditory nerve in CI users

Jeong-Seo KIM

Hearing Research Laboratory, Samsung Medical Center, Korea

Introduction: Electrically evoked compound action potential (ECAP) is a direct measurement of neural responses generated by auditory nerve fibers. Current cochlear implant (CI) devices incorporate a reverse telemetry capability that allows near-field recordings of the ECAP using intracochlear electrodes. The proximity of the recording electrode to the auditory nerve fibers results in an excellent signal-to-noise ratio that was not affected by the patient's arousal status. Compared to other electrophysiological measures, ECAP yields several advantages, including robust response amplitude and ease of recording that does not require extra equipment or special software, or an external recording electrode other than the standard equipment for clinical CI programming. Clinical applications of ECAP have been mainly focused on assessing the responsiveness of the auditory nerve during the CI surgery and determining stimulus levels for individual electrodes to provide audibility for hard-to-test populations. Along with these conventional uses of ECAP, new clinical implications of ECAP measures will be discussed based on recent research on the feasibility of ECAP metrics to objectively characterize the electrode-neuron interface by the changes in the intracochlear electrode design and the functional status of the auditory nerve in CI users.

Methods: ECAP was recorded via neural response telemetry across varied stimulation levels from fifty-two ears that were implanted either with perimodiolar electrodes (i.e., Nucleus CI522/622) or lateral wall straight electrodes (i.e., Nucleus CI532/632). An amplitude growth function was generated to measure the ECAP threshold, amplitude, and slope. The spread of excitation (SOE) function was obtained by varying the masker electrodes, and the width at half amplitude of the SOE function (half width) was measured to quantify channel interaction. Also, ECAP responses were recorded by varying the interphase gap (IPG) of the electrical pulse to test the IPG effect on ECAP response to characterize the functional status of the auditory nerve. Threshold, slope of the ECAP amplitude growth function and half width of ECAP SOE function were compared to investigate the influence of the intracochlear design on the spread of neural excitation. Threshold, maximum amplitude, and slope of the ECAP amplitude growth function varied with IPG were compared among CI users who had shorter or longer deaf duration.

Results: ECAP threshold and slope were not significantly different among CI users who were implanted with perimodiolar electrodes and lateral wall straight electrodes. Half widths of ECAP SOE function were significantly larger in subjects implanted with the lateral wall straight electrodes, indicating a wider spread of excitation and more channel interaction compared to those with perimodiolar electrodes. The IPG effects on maximum ECAP amplitude and slope were significantly larger in subjects with shorter deaf duration than those with longer deaf duration.

Conclusion: Results suggest that several metrics of ECAP amplitude growth function and ECAP SOE function may serve as sensitive metrics to characterize neuronal excitation patterns at the peripheral level and the functional status of the cochlear nerve. These findings indicate that ECAP may promote evidence-based decision making in the selection of the optimal electrode array suitable for individual CI recipients and expand our understanding of large individual variabilities in CI outcomes based on the functional status of the auditory nerve of CI users.

Symposium 03

Electrically Evoked Potential
SP 03-4

ECAP-based positioning of electrode in cochlear implantation

Byung Yoon CHOI

Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

Symposium 03

Electrically Evoked Potential
SP 03-5

Access resistance and polarization impedance measurements in cochlear implant patients with fluctuating electrode impedances

Aniket Arvind SAOJI

Otolaryngology Head and Neck Surgery, Mayo Clinic, USA

Introduction: Cochlear implant (CI) electrode impedance is a measure of the resistance to the flow of current between the stimulating and return electrodes. It is composed of two components: access resistance and polarization impedance. Access resistance is the resistance of the tissue and fluid surrounding the electrode, while polarization impedance is the resistance caused by electrochemical reactions at the electrode-tissue interface.
A small subset of cochlear implant (CI) patients exhibit fluctuating or rising electrode impedance patterns. The mechanisms underlying changes in electrode impedances are not fully understood.
Methods: In this study, transimpedance matrix (TIM) measurements were used to perform impedance subcomponent analysis to determine the mechanism for fluctuating or rising electrode impedances in CIs. TIM measurements are a non-invasive method that can be used to measure the impedance of each individual electrode in a CI.
Results: The results of this study showed that fluctuating or rising electrode impedances were associated with corresponding changes in near field resistance, decrease in Warburg capacitance, and increase in Faraday resistance. This indicates that a change in the double layer capacitance and mechanism for transfer of current from the electrode surface to the cochlear fluid may be responsible for fluctuating or rising electrode impedances. The study also found that device rest lead to a decrease in resistance and an increase in Warburg capacitance. This suggests that the use of electrical stimulation plays a vital role in the increase in electrode impedances.
Conclusions: The findings of this study have implications for the management of CI patients with fluctuating or rising electrode impedances. Future studies are needed to determine the effect of changes in pulse duration, stimulation levels, and rate of electrical stimulation in patients with rising or fluctuating electrode impedances.

Symposium 03

Electrically Evoked Potential
SP 03-6

Using Cochlear Implant Transimpedance/ Electric Field Imaging Measurements to Identify Extracochlear Electrodes in Clinical Practice

Patrick AXON

Dept Otolaryngology, Cambridge University Hospitals, UK

Introduction
Our laboratory has developed a novel method for identifying extra-cochlear electrodes in patients who perform poorly early in their implant activation and mapping. The technique called Stimulation-Current-Induced Non-Stimulating Electrode Voltage recordings (SCINSEVs) are obtained by stimulating each electrode in turn and recording the voltage that is passively induced on non-stimulated electrodes, with reference to the ground electrode. We present the validation of this recording technique.
Methods
Thirty patients were recruited based on a power analysis. All patients met pre-operative implantation criteria and consented to intra-operative testing. Each patient underwent SCINSEVs to 7 intraoperative electrode conditions based on variable depth of electrode insertion and middle ear environment. Each patient was randomly assigned 3 different numbers of extracochlear electrodes before full insertion was performed. At each insertion depth, SCINSEVs were performed when extracochlear electrodes were either surrounded by blood or fascia.
Results
A third of the outcome data was used to train 3 clinicians to interpret results using our algorithm described by de Rijk et al. These clinicians were then blinded to subsequent data and scored for accuracy in predicting the presence and number of extracochlear electrodes.
Conclusion
This study aims to validate the de Rijk technique for measuring the presence and number of extracochlear electrodes and therefore its use as a tool for clinicians to identify incomplete insertion early in the activation and mapping process if patients are not performing as expected.

Symposium 03

Electrically Evoked Potential
SP 03-7

Pre and Post- Operative Electrocochleography in Cochlear Implant Cases

Rohit MEHROTRA

otorhinolaryngology, mehrotra Ent Hospital, Kanpur, India

Electrocochleography (ECochG) is an electrophysiological technique that records electrical potentials generated by different components of the inner ear and peripheral cochlear nerve in response to acoustic stimulation. Electrical evoked potential has been long used in cochlear implant to record the neural responses during intra or post-surgery. During cochlear implant E-CAP or NRT test used to measure the neural responses. Historically, ECochG found its main application in the diagnostic evaluation of Meniere's disease. However, in the last decade, the focus has shifted towards cochlear implantation (CI). Less traumatic CI electrode array design and the use of "soft surgery" techniques allow for the preservation of residual low-frequency acoustic hearing. In patients with residual hearing after CI, combined electric and acoustic stimulation has resulted in improved hearing and speech outcomes. Preservation of acoustic hearing allows individuals with CIs to take advantage of periodicity, commonly referred to as voice pitch, and temporal fine structure, offering improved spectral resolution and supports in speech intelligibility better understanding in CI users. Pre implant and Post implant electrocochleography results were compared and evaluated. Comparison was made by comparing of pre and post implant peak and wave morphology, Summation Potential (SP) / Action Potential(AP) Area ratio and SP/AP Amplitude ratio.

Keywords : Meniere's disease, Soft surgery, Residual hearing

Symposium 04

Mapping Technology
SP 04-1

Image-guided cochlear implant programming in adults and children to minimize channel interaction and frequency-to-place mismatch

René Headrick GIFFORD[1,2]

[1]*Hearing and Speech Sciences, Vanderbilt University Medical Center, USA*
[2]*Department of Electrical and Computer Engineering, Vanderbilt University, USA*

Although children with cochlear implants (CIs) have significantly improved outcomes relative to previous generation CI recipients, too many children still display persistent auditory, speech, and language difficulties despite early intervention and implantation. Though persistent delays can be attributed in part to a period of auditory deprivation prior to implantation, increasing evidence suggests that a degraded CI signal is also implicated which is known to result in considerable spread of intracochlear electrical excitation (channel interaction) and poorer resultant spectral resolution for CI recipients across the lifespan. The primary goal of image-guided CI programming (IGCIP) is to improve electrode spatial selectivity—via selective electrode deactivation—with the goal of improving spectral resolution. To date we have applied IGCIP to nearly 100 children and 300 adults with CIs. At the group level, we have observed significant improvement on various tasks of auditory perception including behavioral spectral resolution, speech recognition in quiet and noise, and even speech production. However, responsivity to IGCIP is variable, particularly for our adult CI population. That is, all children have exhibited either equivocal or improved outcomes on all tested measures following IGCIP application; however, about 1/3 of adult CI recipients trying IGCIP have exhibited no benefit, and in some cases, objective and qualitative decrement. Though we have demonstrated recovery of performance and sound quality following restoration of original CI programming parameters in our group of adults who are not responsive, we are investigating numerous variables to help identify those best suited for IGCIP benefit. In this presentation we will describe IGCIP outcomes for all enrolled adults and children and will provide details regarding patient, demographic, and device variables influencing IGCIP success.

Symposium 04

Mapping Technology
SP 04-2

Clinical significance of the impedance and neural response telemetric thresholds in Mandarin-speaking cochlear implant patients

Chung-Feng HWANG

Otolaryngology, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College Of Medicine, Taiwan

We explored changes in impedance and neural response telemetry (NRT) data in terms of postoperative speech and tone performance in cochlear implant (CI) patients. We analyzed medical records, NRT thresholds, and impedance telemetry data of all electrode modes evaluated. Mandarin speech and tone identification were measured in CI patients for at least 1 year postoperatively. A total of 92 patients of average age 15.2 years underwent CI. The initial impedance data were significantly higher than the intraoperative data. However, the NRT threshold was lower on initial mapping. Initial mapping impedance was significantly lower when such initial mapping was performed <7 days postoperatively, and when curved electrode arrays were placed. Upon initial mapping of both the impedance level and the NRT threshold, straight electrodes (Cochlear Ltd. model CI422) exhibited significantly higher postoperative impedances at all mid-to-apical recording sites (except E16) than curved electrodes (Cochlear Ltd. models CI24RE and CI512). No intraoperative differences were noted. A lower initial NRT threshold was associated with better clinical tone and speech outcomes. We found that both impedance and NRT were significantly lower when curved electrode arrays were placed. Straight electrode arrays were associated with less intraoperative cochlear invasion. A lower postoperative NRT threshold might predict better performance in terms of Mandarin-Speaking cochlear implant patients.

Symposium 04

Mapping Technology
SP 04-3

Pediatric Cochlear Implant Wear Time and Early Language Development

Erika GAGNON

Otolaryngology, The University of North Carolina at Chapel Hill, USA

The aim of this presentation is to define the Hearing Hour Percentage (HHP) as a cochlear implant wear time metric and discuss the impact of device use on pediatric spoken language outcomes by highlighting results from Age at Full Time Use Predicts Language Outcomes Better Than Age at Surgery in Children Who Use Cochlear Implants by Park et al (2019) and The Impact of Cumulative Cochlear Implant Wear Time on Spoken Language Outcomes at Age 3 Years by Gagnon et al (2021).
The HHP was first introduced in Age at Full Time Use Predicts Language Outcomes Better Than Age at Surgery in Children Who Use Cochlear Implants by Park et al in 2019. Age at full time use was found to be a better predictor of spoken language outcomes at age 3 years old than age at implantation. Park et al found that HHP was a key variable in language outcomes but did not make a recommendation for minimum device use for age-appropriate spoken language outcomes. The Impact of Cumulative Cochlear Implant Wear Time on Spoken Language Outcomes at Age 3 Years by Gagnon et al, sought to analyze pediatric wear time and make a wear time recommendation based on spoken language outcomes. For age-appropriate spoken language outcomes at age 3 years, the minimum device use needed is 80% HHP with the goal of 100% HHP or comparable access to sound as age-matched normal hearing peers.

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Symposium 04

Mapping Technology
SP 04-4

Activation on sound processor: Never been too early

Abdulrahman HAGR

President of Saudi ORL Society, President of Arab Academy of Otology and Cochlear Implant, Professor King Saud University, Saudi Arabia

We started early activation of sound processor more than 10 years and since then it is our routine practice. This evolution of the timing of early activation after CI has been remarkable in the past few years in many centers.

We reported the feasibility same day activation of CI surgery in many publications. We are going to present our experience and show the audience the future of this practice.

Symposium 04

Mapping Technology
SP 04-5

Early activation after cochlear implantation: CHGH experiences and literature review

Lieber Po-Hung LI[1,2,3]

[1]*Department of Otolaryngology, Cheng Hsin General Hospital, Taiwan*
[2]*Faculty of Medicine, National Yang-Ming Chiao-Tung University, Taiwan*
[3]*Department of Medical Research, China Medical University Hospital, China Medical University,, Taiwan*

Cochlear implantation (CI) has become the standard treatment for patients with severe-to-profound hearing loss. To date, an estimated 750,000 individuals spanning the entire lifecycle have benefited from this life-changing technology. Traditionally, the device is not "activated" for 3 to 4 weeks after surgery. However, an increasing number of centers have recently begun to question the conventional wisdom that several weeks are necessary and are activating their patients' device sooner after CI. This review aimed to provide a comprehensive insight to better understand the feasibility, outcomes, benefits, and limitations of very early cochlear implant activation. Data sources from published medical literature were reviewed. A detailed examination and summary were provided. History and safety were also emphasized. Experiences form CI project of Cheng Hsin General Hospital (CHGH) was also provided. It was observed that approximately 20 studies have reported their experience with very early cochlear implant activation, ranging from the day of surgery to 1 week. Outcome measures are disparate, although there is general agreement that early activation is not only feasible but also provides some real-life benefits to patients and caregivers. The surgical, electrophysiological, audiological, and other outcomes were also reviewed. Very early activation is safe and beneficial in patients with cochlear implants. Many CI centers believe that such a process can lead to improvements in both patient-centered and fiscally responsible care. Although not ideal for all patients, cochlear implant programs may consider this option for their patients.

Symposium 04

Mapping Technology
SP 04-6

Minimum Speech Test Battery 3 (MSTB-3) for Adult Cochlear Implant Candidacy and Follow-up Care

Camille C DUNN

Otolaryngology, University of Iowa, USA

In 1996/2011, separate committees identified sets of materials to assess candidacy and the performance of adults with cochlear implants. Due to recent changes in candidacy criteria, a new committee formed consisting of co-chairs and selected content experts, to develop test batteries for pre-operative adult candidacy determination and postoperative assessment for groups of diverse candidates.
Content experts performed rigorous literature reviews to develop protocol recommendations for traditional, single/asymmetrical deafness, electro-acoustic stimulation, and bimodal candidates. Consensus through Likert statements via e-survey was conducted for recommendations including test materials, listening conditions, presentation level, and calibration. The outcomes of this process are described.

Symposium 04

Mapping Technology
SP 04-7

Timing of Acoustic Hearing Changes After Cochlear Implantation

Camille C DUNN

Otolaryngology, University of Iowa, USA

One of the risks of a cochlear implant in patients with significant residual hearing is loss of that hearing. Some patients lose their hearing immediately following surgical implantation while other lose their hearing at some point following surgery. This hearing loss is sometimes gradual, but often it is acutely lost. While the exact etiology of the hearing loss is unknown, we do know that one of the most important predictors of the loss of residual hearing is the depth of insertion; the farther an electrode is advanced into the cochlea, the greater the risk to residual acoustic hearing. However, it also appears that hearing loss might be related to intra-cochlear changes. Recently, a long-term research participant continued his commitment to research postmortem by donating his temporal bone for histopathologic evaluation. This subject had used a shorter electrode device for 108 months but had lost residual acoustic hearing between one- and four-months following device activation. The temporal bone evaluation revealed extensive fibrotic changes and bone debris associated with creating a cochleostomy within the scala tympani. These changes suggest that dampening of the acoustic traveling wave by intra cochlear fibrosis represents a potential mechanism contributing to the low-frequency hearing loss. This talk will discuss timing of the loss of residual hearing and the use of impedance measures as a predictor of intra acoustic fibrosis.

Symposium 05

Speech Perception
SP 05-1

Importance of place-pitch fidelity for binaural hearing in cochlear implant recipients with preserved low frequency hearing.

Kevin David BROWN

Univeristy of North Carolina, Department of Otolaryngology and Neurosurgery, USA

Objective: Investigate the incidence of electrode contacts within the functional acoustic hearing region in cochlear implant (CI) recipients and assess its influence on speech recognition for electric-acoustic stimulation (EAS) users.
Study Design: Retrospective review.
Subjects: 105 CI recipients with functional acoustic hearing preservation (≤80 dB HL at 250 Hz)
Interventions: Cochlear implantation with a 24-, 28-, or 31.5-mm lateral wall electrode array.
Main Outcome Measures: Angular insertion depth (AID) of individual contacts was determined from imaging. Unaided acoustic thresholds and AID was used to calculate the proximity of contacts to the functional acoustic hearing region. The effect of increasing distance from the acoustic hearing region or alternatively, overlap of contacts within the acoustic hearing region were determined. The influence of this on speech recognition in quiet and noise for EAS users at 6 months post-activation was reviewed.
Results: 60% of cases had one or more contacts within the functional acoustic hearing region. Proximity was not significantly associated with speech recognition in quiet. Better performance in noise was observed for cases with close correspondence between the most apical contact and the upper edge of residual hearing. Poorer results were seen when the most apical electrode was further from the acoustic hearing region (ie greater gap between electrically simulated and acoustic hearing region) and for increasing depth of the apical electrode into the acoustic hearing region (increasing electrode overlap into acoustic hearing region)($r(14)=.48$, $p=0.043$; $r(18)=-.41$, $p=0.045$, respectively).
Conclusion: There was a high incidence of electrode contacts within the functional acoustic hearing region, which is not accounted for with default mapping procedures. The variability in outcomes across EAS users with default maps may be due in part to electric-on-acoustic interference, electric frequency-to-place mismatch, and/or failure to stimulate regions intermediate between the most apical electrode contact and functional acoustic hearing region.

Symposium 05

Speech Perception
SP 05-2

Binaural benefit after sequential bilateral implantation in children

Artur LORENS

World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland

For many years, unilateral cochlear implantation (cochlear implant only in one ear) has become standard care in children with profound bilateral sensorineural hearing. This solution provides critical stimulation to the child's auditory system and brain, thus allowing auditory development and, in this way, improving its chances of developing spoken language. It lacks, however, the advantages of binaural hearing, that is, sound localization and effective verbal communication in a noisy environment, or with multiple talkers (i.e., classrooms, playgrounds, etc.), or situations where there are multiple moving acoustic objects. Moreover, unilateral cochlear implantation leaves the auditory pathways on the side opposite to the CI deprived of input and susceptible to degeneration and reorganization (Gordon, Wong, and Papsin 2013; Kral 2013; O'Neil et al. 2010).

Results from animal studies have demonstrated large effects on brain organization due to auditory deprivation on one side (Kral et al. 2007). Evidence shows increased excitation from the hearing ear and decreased inhibition from the deprived ear (Kral, Hubka, and Tillein 2015). Such changes manifested as an aural preference for a first hearing ear persist in many children with a long duration of monaural hearing (Kral et al. 2013). This asymmetry in hearing might not be reversible, as has been suggested by Vasama et al. (1994), Kral et al. (2007), and Propst, Greinwald, and Schmithorst (2010). Findings also suggest that asymmetry of hearing leads to a fundamental breakdown in the integration of bilateral input along the auditory pathways, hampering the binaural benefit.

In our recent study 46 bilaterally sequentially implanted children was assessed. Their mean age at first CI was 1.6 years old and mean age at second CI was 7.5 years. The mean interimplant delay was 5.9 years. Speech discrimination ability was assessed with Adaptive Auditory Speech Test. The test was performed in quiet and in noise for each implant separately and in bilateral condition. The test was conducted in anechoic chamber, speech and noise were presented in front of patient (azimuth 0). Children were tested at 4, 8 and 14 months of bilateral CI use.

The significant improvement of speech discrimination in bilateral condition over time was observed in quiet as well as in noise. Strong asymmetry in speech perception between the ears was observed at 4 months of bilateral CI use. Although the asymmetry greatly decreased over 14 months of bilateral stimulation, the differences in performance between the ears remain significant. Our results confirmed the preference toward first implanted ear, nevertheless the bilateral benefit was observed.

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Symposium 05

Speech Perception
SP 05-3

Importance of temporal fine structure in CI users

Hyunjoon SHIM

Otorhinolaryngology-Head And Neck Surgery, Nowon Eulji Medical Center, Eulji University School Of Medicine, Korea

Today, clinically available cochlear implant (CI) systems primarily deliver amplitude-modulation (AM) cues, also known as acoustic "temporal envelope" cues. However, a significant limitation of this design is that AM cues are highly susceptible to noise, leading to a rapid decline in speech identification performance as background noise levels increase. An alternative approach to conveying speech information is the use of frequency modulation (FM), often referred to as "acoustic temporal fine structure." FM is appealing because it is less affected by background noise and is crucial for music perception. While it's commonly stated that current CI systems cannot transmit FM information, our study demonstrated that CI speech processors can generate AM cues from speech FM through band-pass filtering. For the currently available implant processing, this FM-to-AM conversion is the sole mechanism for transmitting FM information to CIs. We aimed to determine the importance of the FM-to-AM conversion mechanism for CI users when original speech cues are severely degraded.

Original speech cues were degraded through various means, including manipulating acoustic signals (introducing background noise and simulating reverberation) or adjusting the sound processor (changing input dynamic range and the number of channels). We tested multiple levels of speech degradation under each condition. Speech perception was assessed in CI users and compared for stimuli containing both AM and FM information (intact condition) or FM information alone (FM condition). As the original speech cues were further degraded, speech perception performance decreased for both intact and FM conditions, but it consistently remained better than chance. Performance for intact and FM conditions became similar with severe degradation, suggesting that the use of the FM-to-AM conversion mechanism could determine speech perception for CI users in challenging acoustic environments. This is supported by significant correlations between speech perception for intact and FM stimuli, as well as electrode output measurements.

In everyday listening situations, CI users encounter various sources of envelope distortions. For example, CI users often find themselves in highly reverberant acoustic environments with multiple people present. The temporal-envelope cues derived from speech FM convey essential phonetic information to CI users when communicating in environments that degrade the original speech cues. Therefore, there is an urgent need for the development of CI devices capable of processing acoustic temporal fine structure to improve speech perception in degraded conditions and enhance music listening for CI users in the future.

Symposium 05

Speech Perception
SP 05-4

Neurofeedback training of auditory selective attention for improving speech-in-noise perception

Inyong CHOI

Department of Communication Sciences and Disorders, University of Iowa, USA

Understanding speech in noisy situations is essential for everyday communications. However, many listeners with hearing loss struggle speech communications in adverse conditions. Conventional hearing remediations do not improve speech-in-noise ability. Instead, perceptual training is one of the very few options currently available for such speech-in-noise problems. Here, we aimed to validate the feasibility of a novel auditory training protocol to improve speech-in-noise performance in human listeners. We also studied what biological changes such a training protocol induced. Two concurrent speech streams – a female voice repeating "Up" five times and a male voice repeating "Down" four times – were played concurrently. A visual neurofeedback (i.e., if the "up" stream was attended, a visual object on the computer screen would move upward, and vice versa) was determined based on the decoding of attention from single EEG trials measured concurrently while listeners listen to the sound mixture. Over the course of four weeks, subjects repeated this neurofeedback training four times while each time repeated 100 trials. After four weeks, participants exhibited improved speech-in-noise perception as well as strengthened attentional modulation on cortical evoked responses to the attended sound. Additionally, subjects showed strengthened alpha oscillation in the right parietal cortex during the after-cue-before-sound period, showing that spatial inhibitory processing to suppress sound inputs was improved. The temporal cortex showed increased attentional modulation of beta oscillation, indicating enhanced neural activity to forecast the target. These findings demonstrate how neurofeedback training effectively enhanced the top-down processing in executive cortical processing network for auditory selective attention. These findings are expected to deliver a clinically-applicable, immersive, and evidence-based rehabilitation paradigm for improving speech-in-noise performance. A long-term outcome will provide scientific foundations for individualized therapeutic options to address communication disorders that individuals face in their everyday lives.

Symposium 06

Biomedical & Cell Therapy
SP 06-1

Animal study on the hearing preservation using electrode-coupled microstructure for drug delivery

Jeong Hun JANG

Department of Otorhinolaryngology, Ajou University School of Medicine, Korea

In cochlear implants, the trauma caused by electrode insertion during surgery may damage residual hearing. Among the methods used to preserve residual hearing is the localised administrations of drugs, including steroids, but their application remains challenging. Here we describe an in vivo study using and electrode-coupled microstructure for steroid delivery.

The scaffold was coated steroid (dexamethasone)-encapsulated in poly lactic-co-glycolic acid and the continuous release of the steroid into artificial perilymph during 6 weeks was monitored. The steroid-containing scaffolds were then implanted into guinea pigs and threshold shifts were analysed for 4 weeks by measuring the acoustically evoked auditory brainstem response. Some of candidate drugs for hearing preservation was used for hearing preservation experiment in vivo.

The threshold shifts tended to be lower in the group implanted with the steroid-containing microstructure.

Our study demonstrates the feasibility of a 3D-printed microstructure the development of next-generation cochlear electrodes with improved dynamics of cochlear steroid release.

Symposium 06

Biomedical & Cell Therapy
SP 06-2

How to increase inner ear drug delivery less invasively - An experimental study

Yong-Ho PARK

Otolaryngology-Head And Neck Surgery, Chungnam National University, Korea

The application of steroids for the treatment of hearing loss, including cochlear implant surgery and such as sudden hearing loss is very diverse. We observed the expression of glucocorticoid receptor in the murine cochlea and conducted animal experiments in which dexamethaone, a prpresentative steroid, was administrated in various ways. In this presentation, we would like to talk about some strategies and attempts to increase the drug concentration in the cochlea with functional recovery in noise induced hearing loss animal model.

Symposium 06

Biomedical & Cell Therapy
SP 06-3

Perilymph sampling to identify potential poor performers

Hinrich STAECKER

Department of Otolaryngology-Head and Neck Surgery, University of Kansas School of Medicine, USA

Symposium 06

Biomedical & Cell Therapy
SP 06-4

Transplantation of human ES cells to the ablated mouse cochlea

Hiroki TAKEDA

Otolaryngology, Head and Neck Surgery, Kumamoto University, Japan

Sensorineural hearing loss is caused by the irreversible degeneration or loss of cochlear hair cells in most cases. Stem cell based approaches represent one potential therapeutic option for cochlear hair cell regeneration. The development of this therapy will require a detailed understanding of the process of differentiation from pluripotent stem cells to cochlear hair cells in vitro, as well as the conditions that will allow for engraftment and terminal differentiation to functional cells in vivo upon transplantation. Here we report on the in vitro differentiation of human embryonic stem cells and cochlear transplantation of these cells to the neonatal transgenic mouse cochlea. First, we differentiated human embryonic stem cells (hESCs) to the preplacodal ectoderm (PPE)-like cells using a previously reported method (Leung, et al. 2013). We then transplanted these differentiated cells into the selectively-ablated neonatal mice cochlea through the round window membrane. Finally we evaluated the localization of transplanted ESC-derived progenitors within the cochlea at several time points after transplantation. We found that hESCs differentiated into PPE-like progenitors as identified by immunocytochemistry and qPCR for up to 14 days in vitro. Furthermore, some of the transplanted cells at day 7 of differentiation engrafted in the organ of Corti and some, albeit limited, engrafted cells expressed supporting and/or hair cell markers at 29-30 postnatal days.

Symposium 06

Biomedical & Cell Therapy
SP 06-5

Three trials: COACH, Rincell-1 and IMPACT

Doug Edward Hugh HARTLEY[1,2,3]

[1]Ent Department, Nottingham University Hospitals Nhs Trust, UK
[2]Nihr Nottingham Brc in Hearing, Nottingham University, UK
[3]Clinical, Rinri Therapeutics, UK

Background:
1) Benefits of CIs vs HAs in adults who fall just outside UK CI candidacy is unknown.
2) Rincell-1 is a novel stem-cell therapy for neural hearing loss.
3) Benefits of parent-implemented therapy on language development in deaf children with CIs, and the mechanisms by which this therapy exerts its effects, is uncertain.

Methods:
1) COACH is an ongoing UK multicentre randomized control trial that compares the efficacy of CIs with HAs to improve speech understanding in adults who fall outside current UK candidacy for cochlear implantation.
2) The first-in-human trial of Rincell-1 will be conducted as an adjunct to cochlear implantation in two groups of patients: those over 60 years old with presbycusis and adults with auditory neuropathy.
3) The IMPACT trial is a multicentre randomised control trial to evaluate the effects of parent implemented therapy on speech understanding in children with cochlear implants.

Results:
Updates will be presented for all three groundbreaking trials.

Conclusions:
All three trials have the potential to provide evidence to change clinical practice in the UK and abroad.

Symposium 07

Imaging and Radiology
SP 07-1

The efficacy of intraoperative mobile cone-beam computed tomography during cochlear implantation

Norio YAMAMOTO

Department of Otolaryngology, Kobe City Medical Cener General Hospital, Japan

Although cochlear implantation has become a popular surgical treatment, we still face several issues regarding electrode insertion. One of them is cochlear malformation. Especially the cochlear anomaly lacking modiolus, including common cavity deformity (CCD), requires precise placement of electrodes and sometimes causes their displacement into an internal auditory canal. Although intraoperative plain X-ray (X-P) images are usually used to evaluate the status of cochlear implant electrodes, they are not suitable in cases of cochlear malformation. The other issue is tip fold-over, where the electrode tip bends inside the cochlea during insertion. The complication rate is higher for a slim modiolar electrode, a thin modiolar-hugging electrode, than for other types of electrodes, reaching 4 to 12%. Correcting the tip fold-over by detecting it and performing an electrode re-insertion during the operation is essential because the tip fold-over adversely affects the cochlear implant (CI) outcome. However, ordinary functional tests do not detect tip fold-over, including electrically evoked compound action potential (ECAP). Even intraoperative X-P images sometimes cannot detect it.

Computed tomography (CT) images, the most popular modalities for temporal bone, are possible options for evaluating CI electrodes. However, conventional multi-detector CT (MDCT) requires huge space to place its machine, and intraoperative image acquisition is impossible. Moreover, MDCT causes artifacts if its target contains metal, such as CI electrodes, and the precise evaluation of CI electrodes is challenging with its images. Recently, the improvement of a flat panel to detect radiation signals enabled the development of a small CT scanner called a cone-beam CT (CBCT). Its scan head rotates around the head of a patient sitting on a chair and obtains images. A CBCT scanner fits a small office-based clinic and provides precise CT images. To use a CBCT scanner for patients on bed in an operating room, a mobile CBCT (mCBCT) scanner with a light but firm scan head, whose rotating axis is parallel to the ground, is developed. It can be used in any operating room and at any time during surgery. Moreover, its low contrast resolution contributes to the low metal artifact of images. Thus, mCBCT is a suitable tool for intraoperative evaluation of CI electrodes1).

In this talk, we will present how we use mCBCT in cases with the difficulty of electrode insertion. In CCD cases, CI electrodes need to be inserted in the antero-inferior side of the cavity along its wall 2). However, it is hard to precisely evaluate the placement of the electrodes during surgery. mCBCT images clearly show the position of electrodes so that we can adjust the electrode placement based on the images. In cases of tip fold-over, mCBCT images help detect it because the images show the electrode status precisely (Figure) 3). For the middle ear and inner ear anomaly, including CHARGE syndrome cases, an image-guided surgery (IGS) system is helpful. However, it should be more precise in an otological surgery than in cases of endoscopic sinus surgery or other surgeries. mCBCT enables accurate but easy registration for image-guided surgeries intraoperatively.

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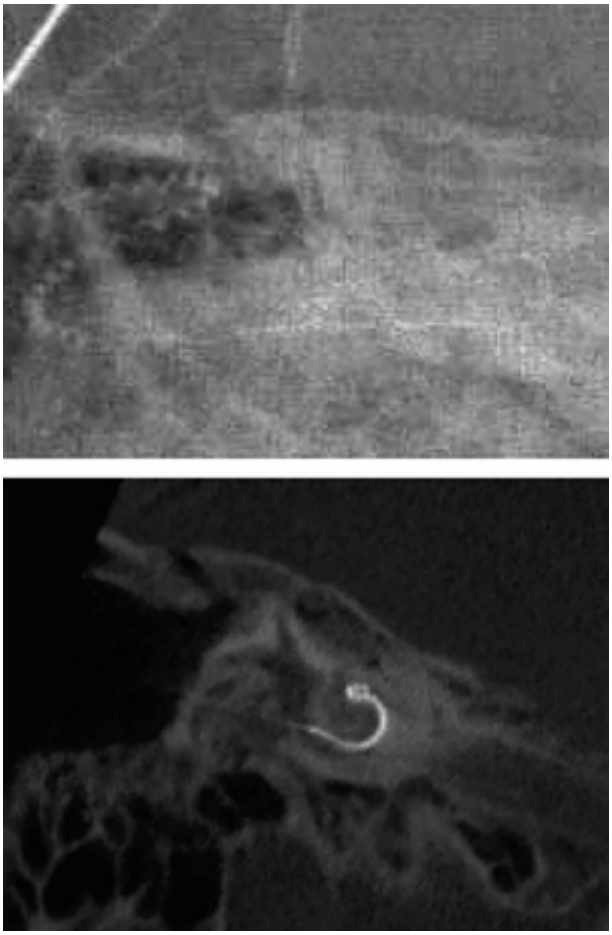

Figure Intraoperative X-P and mCBCT images of tip fold-over

Symposium 07

Imaging and Radiology
SP 07-2

Intraoperative and Postoperative Radiology

Ashima SAXENA[1,2,3]

[1]*Otorhinolaryngology, Maulana Azad Medical College, New Delhi, India*
[2]*Otorhinolaryngology, Shri Ashwini Saxena Hospital , Haryana, India*
[3]*Neuro-otology, University of California, San Diego (UCSD), USA*

From a surgical perspective, the most important factor determining a good outcome in CI surgery, is the correct placement of electrode array into the cochlea. An insertion which is in the scala tympani, close to the modiolus and atraumatic offers preservation of residual hearing and optimum audiological and speech outcomes. For this crucial part- intraoperative radiology serves as an important tool in the surgeons' armamentarium, allowing to prevent potential failures and poor outcomes.

Intraoperative radiology allows for peri-operative diagnosis of incomplete insertions, extracochlear insertions, kinking of electrodes , tip roll-overs . It is the single most definitive indicator of the need to reposition or revise a case, over and above impedance testing and ECAP's.

Although rare, but there have been case reports of extracochlear insertions into the vestibule, eustachian tube, internal auditory meatus, superior semi circular canal, internal carotid artery canal- mandating a revision surgery.
There are emerging reports of tip rollover and electrode kinking which are being identified on the operating table with the help of radiology and company provided softwares. This is being seen more so with the pre curled peri modiolar electrode arrays as compared to the straight electrode arrays. It poses a challenge for the surgeon and is one of the most important applications of intraoperative radiology. . Clinically, it results in tinnitus and pitch confusion for the patient if not corrected during surgery or deactivated later, leading to suboptimal results.

As the surgery for CI is advancing and indications for CI surgery are expanding to include anomalous cochleas, advanced otosclerosis, ossified cochleas post -meningitis - better and newer techniques for imaging are being used. The application of radiology is vast - ranging from a simple flat panel Modified Stenver's view radiograph to image guided minimally invasive CI surgery with real time monitoring while threading the electrodes into the cochlea.

Overcoming the drawback of 2-D image in a radiograph with limited information, CBCT scanning is being shown to be helpful in determining the angle of insertion, depth of insertion , distance from the modiolus, and detecting scalar deviation. However it comes at an increased cost, with challenges of equipment availability in the OR and radiation exposure and still has limited world wide application.

Postoperative radiological studies, both radiographs and CT scans, not only serve for baseline documentation and quality control tool, but also form the mainstay for future research on electrode designs that would overcome the present day challenges of tip foldover and scalar deviation.

Symposium 07

Imaging and Radiology
SP 07-3

3D-reconstruction image of computed tomography for cochlear implantation

Beomcho JUN

Departments of Otorhinolaryngology, Catholic University of Seoul, Korea, Uijeongbu St.Mary's Hospital, Korea

The temporal bone is one of the most complicated structures in the human body. Cochlear implantation, used to rehabilitate patients with severe sensorineural hearing loss, involves electrode insertion. Generally, three anatomical entrances (or 'gates') must be created during implantation. The surgical procedures required include cortical mastoidectomy, posterior tympanotomy and cochleostomy (or the round window approach). Here, we describe these gate-creating surgical procedures, and emphasize that preoperative temporal bone three-dimensional (3D) computed tomography (CT) is invaluable for ensuring patient safety by identifying surgical landmarks.
We also analyzed the length and shape of the cochlea using three-dimensional (3D) reconstructions of the temporal bone (TB) based on computed tomography (CT) scans. These results might be helpful to improve the selection of CIs and the mapping strategy, by measuring the cochlear canal preoperatively.

Symposium 07

Imaging and Radiology
SP 07-4

Identification of Partial Cochlear Implant Insertion with Intraoperative Electrical Field Imaging-Transimpedance Matrix Analysis.

Neil DONNELLY

Cambridge Hearing Implant Centre, Cambridge University Hospitals, UK

Background and Aims

Traditionally, whether a cochlear implant (CI) has been fully inserted has been determined by surgeon judgement and intraoperative impedance testing. However, the reliability of these methods is poor. Therefore, intraoperative electrical field imaging-transimpedance matrix analysis (EFI-TIM) has been proposed as a more reliable substitute.

Method
During EFI-TIM, electrodes on the CI electrode array are stimulated one at a time. Voltage is measured for each of the unstimulated electrodes. The process is repeated until each electrode has been stimulated, and thus producing a matrix.
Data from 217 CI surgeries over one year were collected and analysed retrospectively. This included surgeon notes on degree of CI insertion; intraoperative impedance testing; intraoperative EFI-TIM; postoperative EFI-TIM; and postoperative x-ray. The number of extracochlear electrodes estimated using different methods were compared to ascertain the effectiveness of intraoperative EFI-TIM as an assessment for the degree of CI insertion.

Results
Of the 217 CI surgeries, 122 had intraoperative EFI-TIM analysis. Postoperative x-ray data showed 0.94% vestibular and 22.64% partial insertion, but surgeons only labelled 8% of these as 'partial insertions'. Intraoperative EFI-TIM data also suggests under-reporting of partial insertions by surgeons. Postoperative CI extrusion is possible but uncommon, since there is little variation between intraoperative and postoperative EFI-TIM results.
The number of extruded electrodes identified on x-ray was in many cases higher than the number identified on EFI-TIM. Since x-ray films and EFI-TIM require subjective interpretation, this could result in overestimation of extruded electrodes in x-rays or underestimation in EFI-TIM.

Conclusion
Compared to surgeon judgement and conventional impedance testing, EFI-TIM was more reliable at identifying partially inserted CI. However, further research is required to ascertain the accuracy of using EFI-TIM to estimate the number of extruded electrodes.

Symposium 08

Vestibular Function
SP 08-1

Vestibular status of pre and post-lingual profound hearing loss adults with no complaint of dizziness

Myung-Whan SUH

Department of Otorhinolaryngology-Head & Neck Surgery, Seoul National University, Korea

Background and ObjectivesZZCochlear system and vestibular system have close relationship anatomically and developmentally. According to previous literatures, there are high incidences of vestibular dysfunction in subjects with severe hearing loss. The aim of this study is to validate the status of vestibular function in adults with profound hearing loss, and to compare the status of vestibular function between pre-lingual and post-lingual deaf. Subjects and MethodZZVestibular function of 59 patients who had profound hearing loss was reviewed retrospectively. Patient's information and audiometry, Korean version Central Institute for the Deaf (KCID) scores, caloric test, rotation chair test and vestibular evoked myogenic potential (VEMP) were analyzed. The subjects were divided into two groups, prelingual deaf (pre-LD, n=12) and postlingual deaf (post-LD, n=47). We analyzed the difference between two groups. ResultsZZFifty nine point six percent of patients showed hypo-function in caloric test. In the rotational chair test, abnormality of step velocity gain (43.1%), time constant (51.8%), sinusoidal harmonic acceleration (SHA)-gain (53.4%), SHA-phase lead (29.1%) and SHA-asymmetry (23.6%) were found. There was unilateral (20.0%) and bilateral (37.5%) hypo-function when VEMP was tested. Between pre-LD and post-LD groups, VEMP test revealed statistically significant difference between two groups (p=0.020). Post-LD groups had more patients of unilateral or bilateral hypofunction in VEMP test. The KCID score showed no significant correlation with vestibular functions. ConclusionZZThe patients of bilateral profound hearing loss showed unilateral or bilateral vestibular functional abnormality despite of no dizziness. Prevalence of lateral canal dysfunction does not seem to be different between pre-LD group and post-LD group. And post-LD groups have higher probability of saccular dysfunction than pre-LD.

Symposium 08

Vestibular Function
SP 08-2

Vestibular phenotype in hereditary hearing loss

Sung Huhn KIM

Otorhinolaryngology, Yonsei University College of Medicine, Korea

Objectives: As compared to genetic hearing loss, little is known about the genetic predisposition of vestibular disorders. Here, we performed this study to elucidate the vestibular phenotypes in patients with genetic hearing loss and identify the associated genetic factors.
Study Design: Retrospective cross-sectional study
Setting: A Single tertiary center
Methods: Patients who reported dizziness-related symptoms were selected from our hereditary hearing loss cohort of which individuals underwent genetic evaluation. Vestibular phenotypes such as feature, recurrence, and duration of dizziness were evaluated. Vestibular functions were evaluated using the bithermal caloric test, video head impulse test (vHIT), and cervical/ocular vestibular evoked myogenic potential (c/oVEMP).
Results: Among 627 patients, 143 (22.8%) had vestibular symptoms. The majority of inheritance pattern was autosomal dominant (AD) (n = 77, 53.8%). Genetic variations were confirmed in 45 out of 143 patients (31.5%); familial Meniere's disease had been clinically diagnosed in 10 out of 45 patients (22.2%). Nineteen genes were identified to be linked to vestibular symptoms; the most frequently identified gene was COCH in AD and SLC26A4 in autosomal recessive (AR). Vestibular symptoms were mostly vertigo type, recurrent and persisted for hours in both genetically confirmed and unconfirmed groups. Decreased vestibular function in caloric test, vHIT, cVEMP, and oVEMP was observed in 42.0%, 16.3%, 57.8%, and 85.0% patients, respectively. Particularly, the caloric test showed a significantly higher incidence of abnormal results in AR than AD individuals (p = 0.011) indicating unilateral canalopathy is prominent in AR individuals. The genes including SLC26A4, COCH, KCNQ4, MYH9, NLRP3, EYA4, MYO7A, MYO15A, and MYH9 were heterogeneously related with abnormality in vestibular function test.
Conclusions: Diverse vestibular symptoms are commonly concomitant with genetic hearing loss, but easily overlooked. Vestibular evaluation is indispensable and should be performed in every patient with inherited hearing loss.

Symposium 08

Vestibular Function
SP 08-3

Evaluation of balance capacities in children

Angelica PÉREZ FORNOS[1,2]

[1]Western Switzerland University Cochlear Implants Center, Geneva University Hospitals, Switzerland
[2]Department of Clinical Neurosciences, Faculty of Medicine, University of Geneva, Switzerland

Chronic vestibular dysfunction impacts the normal psychomotor development of children. Early identification is needed to allow for clinical management, ensuring better global development. To this purpose, our research group has developed the Geneva Balance Test (GBT) aiming to quantify objectively the balance capacity of children over a broad age range, to screen for bilateral vestibulopathy (BV) and to quantify the improvement of balance abilities in children.

We conducted an observational prospective study with three populations: 11 children with BV, and two age-matched control groups composed of (1) 15 healthy subjects without vestibular or auditory disorder (HS) and (2) 11 pediatric cochlear implant recipients (CI) without vestibular disorders. Results of the three populations have been compared in 3 different age sub-groups (3-5 years, 6-9 years, ≥10 years), and with results of a short, modified version of the Bruininks-Oseretsky test of Motor deficiency Ed. 2 (mBOT-2).

Statistical analyses demonstrated significant differences in the scores of the GBT between children aged 3-5, 6-9 and ≥10 years with BV and in both control populations (HS and CI). BV scores reflected poorer balance capacities at all ages. Children in the youngest CI sub-group (3-5 years) showed intermediate GBT scores (between HS and BV), but reached HS scores at 6-9 years, reflecting improvement of their balance capacities. All the results of the GBT were significantly correlated with mBOT-2 results, although only few BV achieved the mBOT-2 completely.

The GBT allowed to quantify balance deficits in children with BV. The GBT seems to be better tolerated in all age and group populations than the mBOT-2. Furthermore, mBOT-2 results saturated, reaching maximum values by 6-9 years whereas the GBT did not, suggesting the GBT could be a useful tool for monitoring the development of balance capacities with age, and could be used in the follow-up of children with severe vestibular disorders. Interestingly, we observed a significant difference in balance capacities in very young CI children which normalized by 6-9 years, potentially due to hearing rehabilitation with the CI. A study with a larger population is necessary to confirm these results.

Symposium 08

Vestibular Function
SP 08-4

Vertigo and nystagmus associated with sudden hearing loss

Chang-Hee KIM

Department of Otorhinolaryngology-Head and Neck Surgery, Konkuk University Medical Center, Korea

This presentation will cover the results of our recent clinical studies on 'vertigo and nystagmus associated with sudden hearing loss'. Firstly, we will present about "patterns of nystagmus conversion in sudden hearing loss with vertigo". In this study, we aimed to investigate the characteristic changes in type of nystagmus and clinical features in patients with sudden hearing loss with vertigo who experienced a change in their nystagmus pattern during follow-up. Initial nystagmus was classified into 5 subgroups: paretic type, irritative type, persistent geotropic direction-changing positional nystagmus (PG-DCPN), persistent apogeotropic direction changing positional nystagmus (PA-DCPN), and posterior semicircular canal benign paroxysmal positional vertigo. The most common pattern of initial nystagmus was PG-DCPN (n=7). The change of initial nystagmus pattern occurred on day 2 to 75 from symptom onset, and 2 (of 15) patients showed further conversion. The most common pattern of final nystagmus was PA-DCPN (n=9). Hearingimprovement after treatment was not significantly different (p=0.59) between patients with nystagmus change (25±17dB, n=15) and those without nystagmus change (28±18dB, n=35).

Secondly, we will present about "sudden hearing loss with positional vertigo: initial findings of positional nystagmus and hearing outcomes". In this study, we aimed to investigate the initial findings of positional nystagmus in patients with sudden hearing loss and positional vertigo, and to compare hearing improvement among patients with different types of positional nystagmus. Results showed that positional nystagmus was classified into five subgroups; PG-DCPN in head-roll test (HRT) and negative Dix-Hallpike test (DHT), PA-DCPN in HRT and negative DHT, positive DHT and negative HRT, PG-DCPN in HRT and positive DHT, and PA-DCPN in HRT and positive DHT. Pure tone threshold improvement was significantly greater in patients with negative DHT than with positive DHT ($p = 0.027$).

Finally, we will present about "nystagmus findings and hearing recovery in idiopathic sudden sensorineural hearing loss without dizziness". In this study, we aimed to investigate the incidence of nystagmus in patients with sudden hearing loss without dizziness, and to evaluate the correlation of the presence of nystagmus with hearing recovery in those patients. Results showed that of 33 sudden hearing loss without dizziness, nystagmus was observed in 22 patients (67%), of which 14 patients exhibited direction-fixed nystagmus, and 8 patients exhibited DCPN. Among the 14 patients with direction-fixed nystagmus, 9 displayed the paretic type, and 5 displayed the irritative type. The mean initial pure tone threshold was 58.2 ± 28.1 dB and 57.3 ± 20.0 dB in patients with and without nystagmus, respectively, which was not significantly different ($p = 0.925$). When hearing improvement was compared according to the presence of nystagmus, 39% (8 of 21) of patients with nystagmus were found to belong in the good prognosis group, and 72% (8 of 11) of patients without nystagmus were found to belong in the good prognosis group, which showed marginal statistical significance ($p = 0.063$).

Symposium 08

Vestibular Function
SP 08-5

Electrical stimulation of cochlear implant on vestibular function

Ja-Won KOO

Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

We investigated if electrical stimulation of cochlear implant (CI) influences on the VOR gain and posture. Eighteen subjects who had rehabilitated using CI over 1 year were enrolled prospectively. Video head impulse test (vHIT), bithermal caloric test, and computerized dynamic posturography were performed repetitively on condition of switch-on and switch-off. Gain of vHIT was significantly higher when the CI was switched on (0.78±0.37) than switched off (0.74±0.37) during impulse stimulation to the CI side (P=.005). The SPV of caloric response was significantly higher when the CI was switched on than switched off at CI side (switch-on, 16.6±22.7; switch-off, 14.1±20.3; P=.005) and non-CI side (switch-on, 18.9±24.5; switch-off, 14.5±17.4; P=0.001). The electrical stimulation of CI may influence on the VOR gain with a significant significance though the amount of difference is small.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-1

Benefits & challenges of combined electric & acoustic hearing in adults and children

René Headrick GIFFORD

Hearing and Speech Sciences, Vanderbilt University Medical Center, USA

Cochlear implantation with minimally traumatic surgical techniques and atraumatic electrode arrays has led to an increasing prevalence of adult and pediatric cochlear implant (CI) recipients with the potential for combined Electric and binaural Acoustic Stimulation (EAS). Many studies have demonstrated that adult EAS users consistently exhibit significant benefits for speech understanding in noise and spatial hearing tasks as compared to a CI paired only with a contralateral HA. We have also demonstrated that sensitivity to interaural time difference (ITD) and interaural level difference (ILD) cues is correlated with EAS benefit for postlingually deafened adult listeners. Despite this active phase of discovery, there is still a striking paucity of research on EAS outcomes in children, the expected trajectory of benefit following EAS fitting, as well as underlying mechanisms driving EAS benefit (or lack thereof) in all populations. There is a disconnect between EAS availability and EAS utilization in all CI users and current audiological management of EAS candidates is not data driven. This is problematic given the protracted maturation of the binaural system and the fact that we do not understand what additional effects sensorineural hearing loss and combined EAS may have on the developing binaural system. In this presentation, we will cover the current peer-reviewed literature on adult and pediatric EAS users and will present pilot data from our lab on binaural cue sensitivity and EAS benefit for speech in complex noise and minimum audible angle (MAA) for adults and children both pre- and post-operatively.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-2

Preimplant Hearing Threshold: An Important Predictor of Hearing Preservation in Cochlear Implantation With Lateral Wall Electrodes

Jin Woong CHOI

Department Of Otolaryngology-Head And Neck Surgery, Chungnam National University, College Of Medicine, Korea

OBJECTIVE: To evaluate the outcomes and association factors of long-term hearing preservation (HP) in cochlear implantation with lateral wall (LW) electrode arrays. STUDY DESIGN: Retrospective case review. SETTING: Tertiary academic center. PATIENTS: Thirty-four consecutive ears from 32 patients with a ≤ 80dB HL preoperative low-frequency pure-tone average of 250 to 500Hz were included. INTERVENTION: Cochlear implantation with LW electrode arrays and the intention of achieving HP. MAIN OUTCOME MEASURES: HP classifications according to the HEARRING group and functional HP methods (≤ 85dB HL of pure-tone threshold at 250Hz) at 1 year postoperatively. RESULTS: Based on the HEARRING classification, complete, partial, and minimal HP was achieved in 7 ears (21%), 12 ears (35%), and 4 ears (12%), respectively. Under functional classification, 14 ears (41%) exhibited functional hearing after surgery. The average threshold shift was 17.1 dB HL (SD=16.9 dB HL). Among various clinical features, a ≤ 60dB HL preimplant pure-tone threshold of 250Hz was associated with HP outcome in both classifications (OR=12.95, 95% CI=1.29-130.01, p=0.029 in HEARRING classification; OR=14.36, 95% CI=1.07-191.40, p=0.044 in functional classification). The following parameters were not associated with HP (p>0.05): patient demographics, surgical aspects (insertion route and depth), electrode array size, scalar electrode position, and presence of comorbidity. CONCLUSION: With LW electrode arrays, HP was achieved in 68% of HEARRRING group patients and 41% of functional classification patients. A ≤ 60dB HL preimplant pure-tone threshold of 250Hz was significantly associated with an increased rate of long-term HP.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-3

Electrocochleography for hearing preservation in CI

Oliver F ADUNKA

Otolaryngology, Head & Neck Surgery, Ohio State University, USA

Hearing preservation during cochlear implantation has evolved into a commonly practiced solution for cochlear implant candidates with low frequency residual hearing. Optimizing preservation rates has mostly been accomplished via flexible and less traumatic electrode arrays, limited insertion depths, and soft surgical techniques. More recently, electrophysiologic monitoring methods have been suggested. Of these electrocochleography (ECochG) has been successfully used to optimize hearing preservation rates. This presentation will review the clinical utility of ECochG for hearing preservation cochlear implantation.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-4

Intraoperative electrocochleography, electrode scan and immediate postoperative bone conduction threshold measurement to understand residual hearing loss following cochlear implantation.

Aniket Arvind SAOJI

Otolaryngology Head and Neck Surgery, Mayo Clinic, USA

Introduction: Intraoperative electrocochleography (ECochG) is a technique used to measure cochlear microphonics (CM) and monitor hair cell function during cochlear implant (CI) electrode placement. A decrease in CM amplitude during CI electrode placement is typically interpreted as a sign of cochlear trauma, and can lead to the pause, retraction, or alteration of electrode placement. However, other factors, such as advancement of the recording electrode beyond the multiple sites of CM generation, can also lead to a decrease in CM amplitude and can be misinterpreted as cochlear trauma.
Generally, intraoperative ECochG tracings are compared with air-conduction thresholds or preserved residual hearing that is measured a few weeks or months after CI surgery. However, during this postoperative period, factors such as inflammatory foreign body response can influence hearing preservation.

Methods: This study reports two separate studies that address the above issues.
Study 1: In the first study, multifrequency ECochG was used to monitor hair cell function during electrode insertion. The tracings were compared with electrode scan measurements to differentiate between electrode insertion trauma and advancement of the recording electrode through the cochlear space.
Study 2: In the second study, ECochG tracings were compared with immediate postoperative bone conduction (BC) thresholds (measured within a few hours after surgery) to determine the relationship between a decrease in CM and residual hearing loss immediately following cochlear implantation.

Results: The results of the first study showed that a strong correlation existed between the peak CM amplitude measured during electrode placement and electrode scan. This indicates that the decrease in CM amplitude in some patients was due to the advancement of the recording electrode beyond the multiple sites of CM generation along the basilar membrane.
The results of the second study showed that a significant decrease in immediate postoperative BC thresholds was observed in CI patients with a greater than 30% decrease in CM amplitude during CI electrode placement.

Conclusion: The results of this study suggest that real-time implementation of electrode scan can differentiate between cochlear trauma and advancement of the recording electrode through the cochlear space. This can prevent unnecessary alterations during CI electrode placement, which can reduce the risk of losing residual hearing. Immediate postoperative BC thresholds can be used to differentiate between immediate and delayed hearing loss following cochlear implantation. Postoperative BC thresholds can also be used to study the impact of drug-eluting technologies on residual hearing preservation following cochlear implantation.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-5

Intraoperative and postoperative intracochlear electrocochleography measured from EAS users

Jeong-Seo KIM[1,2]

[1]*Hearing Research Laboratory, Samsung Medical Center, Korea*
[2]*Department of Communication Sciences and Disorders, University of Iowa, USA*

Introduction: Less traumatic electrode design and the introduction of the "soft surgery" technique allow for the preservation of residual acoustic hearing in many cochlear implant (CI) users. A new intracochlear electrocochleography (ECoG) technique was developed that allows acoustically evoked peripheral responses to be measured in vivo from an intracochlear electrode. This method enables the recording of responses from hair cells (i.e., cochlear microphonics, CM) and responses generated from the auditory nerve (i.e., auditory nerve neurophonic, ANN). These recordings provide clues to the status of peripheral auditory structures. Recently, there has been growing interest in recording intracochlear ECoG from CI users with electro-acoustic stimulation (EAS) intraoperatively and postoperatively. Clinical applications of intracochlear ECoG measures will be discussed in this talk with more emphasis on postoperative data, such as providing information about the survival of functional cochlear elements and the underlying pathophysiology related to changes in the peripheral auditory system over time.

Methods: Acoustically-evoked ECoG responses were recorded from hybrid CI users with residual acoustic hearing. Various acoustic stimuli (i.e., low-frequency tone bursts, clicks, chirps) were presented via an insert earphone, and evoked ECoG responses were recorded from the most apical electrode in the intracochlear array. CM and ANN responses were correlated with audiometric thresholds to determine whether loss of residual hearing is reflected in changes in electrophysiologic measures. The feasibility of compound action potential (CAP) as an alternative metric was also investigated to overcome the limitation of ANN (much smaller amplitude than CM) and improve the accuracy of assessing the status of the auditory nerve.

Results: CM and ANN thresholds were significantly correlated with audiometric thresholds in CI users with residual acoustic hearing. When we monitored postoperative ECoG longitudinally, CM and ANN thresholds and amplitudes were stable in EAS CI users with preserved acoustic hearing. CM and ANN thresholds increased while ECoG amplitudes decreased for those with delayed hearing loss. However, ANN was much smaller in amplitude compared to CM which makes interpretation harder in some cases. As an alternative metric, CAP responses were reliably measurable to clicks and chirp stimuli compared to low frequency tone bursts in EAS CI users.

Conclusion: Results provide a new clinical application of intraoperative and postoperative ECoG as an objective tool to monitor peripheral auditory function and understand the pathophysiology of delayed hearing loss. Where the status of the auditory nerve is of primary interest, CAP may be an attractive alternative to ANN in terms of response amplitude and morphology. While CI manufacturers are designing and implementing hardware and software adaptations to conduct ECoG recordings, intracochlear ECoG can potentially be integrated into clinical practice as an objective method of monitoring residual hearing over the course of EAS CI use.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-6

Mechanical factors affecting intracochlear pressure variation in In-Vitro Cochlear implantation

William CROHAN

Otorhinolaryngology, University of Western Australia, Australia

Aim: To investigate factors significant for intracochlear pressure variation during implantation.
Methodology: In this study, changes in intracochlear pressure were measured against: varying speeds, depths; and level versus underwater insertions, of a dummy electrode array into an artificial cochlea.
Results: A deeper insertion was associated with greater pressure variation (0.059+/-0.007kPa versus 0.04+/-0.011kPa). The study also found that performing insertions underwater was associated with increased pressure variation (0.069+/-0.022kPa versus 0.03+/-0.003kPa).
Conclusion: This study did not demonstrate a relationship between the speed of insertion and pressure variation. This study is currently the largest in-vitro study looking at intracochlear pressures. We hope it develops an understanding of key variables associated with soft surgical techniques.

Symposium 09

Residual Hearing Preservation Ⅰ
SP 09-7

Preoperative evaluation of electrode trajectory to preserve residual hearing in CI

Yun-Hoon CHOUNG

Otolaryngology, Ajou University School of Medicne, Korea

Preserving residual hearing in cochlear implantation (CI) is very important to enhance the quality of sound enabling to use electric acoustic stimulation (EAS) system. In addition, this high-quality technique is also useful to maintain the fine functions of hearing and balance in all cochlear implantation patients, even if they don't have any residual hearing.
For preserving residual hearing in CI, electrodes have been developed rapidly as they became softer and thinner. And surgical techniques have also stabilized a lot using round window approach and steroid. Therefore, it is now necessary to consider the variable characteristics of the size and angle of patient's cochlea. Most of trauma in CI may occur in the process of inserting electrodes into round window membrane.
In this study, I will predict how the electrode insertion axis varies from patient to patient and suggest about how to prevent this insertion trauma. I think it's time for personalized precise operation to preserve more residual hearing in CI.

Symposium 10

Music Perception and Sound Localization
SP 10-2

Music perception in children and adults following cochlear implantation Luis Lassaletta, Miryam Calvino, Alejandro Zuazua, Isabel Sanchez-Cuadrado, Marta Mancheño, Helena Arroyo, Javier Gavilán

Luis LASSALETTA

Otolaryngology, La Paz University Hospital, Spain

Introduction. Music is still considered one of the biggest challenges for CI users due to technological, biological, and acoustic limitations. Differences are found in the way pediatric and adult population of CI users cope with this challenge.

The aims of this study were: (i) to evaluate different music tasks through the Meludia music platform in experienced CI users, (ii) to compare the results among three age groups and (iii) to compare with their normal hearing (NH) peers.

Methods. This cross-sectional study included CI users and their NH peers divided in children (6-10y), adolescents (11-16y), and adults (≥17y). The evaluation tool was the "Discovery" level of Meludia. Four music tasks were evaluated: Rhythm, Spatialization, Stable/Unstable, Melody, and Density. Each task comprises five levels of difficulty. The scoring system for each task was 0, 1, 2 or 3 points. The percentage of participants who were able to finish the entire task was also considered.

The music related quality of life (MuRQoL) questionnaire for adults, and a music questionnaire for pediatric population (MuQPP) created for participants aged 6-16y were used to evaluate music background.

Results. Sixty-nine CI users were enrolled: 14 children, 16 adolescents, and 39 adults, and the same number of age matched NH.

The percentage of adolescent CI users who completed the five levels of Spatialization, Rhythm, Melody, and Density (100%, 81%, 50%, 44%, respectively) was significantly higher than the other age groups.

The percentage of NH adults that completed each task was higher than implantees. However, both CI children and adolescents had similar results to their NH peers in most categories.

In terms of MuRQoL outcomes, adult NH scored better than CI users regarding music frequency (68 vs 55, $p<0.01$) but both groups got similar scores in terms of music importance (62 vs 58, $p=0.340$).

When comparing pediatric groups with their NH peers, both scored similarly with the MuQPP, except implanted children whose mean score in their musical profile was higher than their NH peers (54.2±12.9 vs 40.9±12.1, $p=0.009$).

Conclusions. Meludia is an adequate tool to evaluate music performance in CI users, including children. Adolescents perform better than children and adult CI users in most musical tasks. Pediatric CI users are more similar to their NH peers than adults regarding musical perception. The importance of music in adult CI users was comparable to their NH peers. ClinicalTrials.gov (NCT05319678).

Symposium 10

Music Perception and Sound Localization
SP 10-3

Factors underlying masking release by voice-gender differences and spatial separation cues in multi-talker listening environments in listeners with and without hearing loss

Yonghee OH

Department Of Otolaryngology, Head And Neck Surgery And Communicative Disorders, University Of Louisville, USA

Background: Speech perception in multi-talker listening environments is challenging for all listeners and even more so for persons with auditory deficits associated with hearing loss. Many previous studies have reported that speech segregation performance in multi-talker environments can be enhanced by two major acoustic cues: 1) vocal gender differences between talkers; 2) spatial separation between talkers. Here, the improvement they can provide for speech segregation is referred to as "release from masking". The goal of this study was to investigate the relationship of voice-gender difference benefit to the breadth of binaural pitch fusion, the perceptual integration of dichotic stimuli that evoke different pitches across ears, and the relationship of spatial separation benefit to localization acuity, the ability to identify the direction of a sound source.

Methods: Thirty-six hearing impaired (HI) listeners (age from 30 to 75 years) and eleven normal hearing (NH) listeners (age from 36 to 67 years) were tested in the following three experiments. First, speech-on-speech masking performance was measured as the threshold target-to-masker ratio (TMR) needed to understand a target talker in the presence of either same- or different-gender masker talkers. These target-masker gender combinations were tested with two spatial configurations (maskers co-located or 60° symmetrically spatially separated from the target) in both monaural and binaural listening conditions. Second, binaural pitch fusion range measurements were conducted using harmonic tone complexes around a 200-Hz fundamental frequency for hearing aid users and using direct electrode stimulation for cochlear implant users. Third, absolute localization acuity was measured using broadband (125-8000 Hz) noise and one-third octave noise bands centered at 500 and 3000 Hz.

Results: Voice-gender differences between target and maskers improved TMR thresholds for both listener groups in the binaural condition as well as both monaural (left ear and right ear) conditions, with greater benefit in co-located than spatially separated conditions.
Voice-gender difference benefit was correlated with the breadth of binaural pitch fusion in the binaural condition, but not the monaural conditions, ruling out a role of monaural abilities in the relationship between binaural fusion and voice-gender difference benefits. Spatial separation benefit was not significantly correlated with absolute localization acuity. In addition, greater spatial separation benefit was observed in NH listeners than in HI listeners, indicating a decreased ability of HI listeners to benefit from spatial release from masking.

Conclusions: These findings suggest that sharp binaural pitch fusion may be important for maximal speech perception in multi-talker environments for both NH and HI listeners. In particular, for hearing-impaired listeners, restoring sharply tuned pitch fusion is important for optimal binaural benefit in noisy environments. Increased understanding of factors that affect binaural benefits for speech perception for hearing-impaired listeners will be clinically essential for the future design of training- and device-based rehabilitative strategies to improve speech perception in quiet and noise.

Symposium 10

Music Perception and Sound Localization
SP 10-4

Unveiling Asymmetric Cortical Plasticity in Single-Sided Deafness: Insights from Functional Neuroimaging and Sound Localization Tasks

Hyo-Jeong LEE[1,2]

[1]*Otolaryngology-Head and Neck Surgery, Hallym University College of Medicine, Korea*
[2]*Laboratory of Brain & Cognitive Sciences for Convergence Medicine, Hallym University College of Medicine, Korea*

Cortical plasticity in single-sided deafness (SSD) has been a subject of intense investigation, with consistent findings of heightened auditory cortex activity on the side ipsilateral to the hearing ear. This enhanced response has been associated with auditory localization performance and the outcomes of aural rehabilitation in neuroimaging studies involving passive listening tasks. However, our understanding of neuroplasticity directly related to binaural processing, especially auditory localization, remains limited in the SSD population. Moreover, it remains unclear whether this plasticity is specific to the ear side of deafness.

In this study, we examined two distinct groups of individuals with single-sided deafness, characterized by differing ear sides of deafness (17 with left-sided SSD and 18 with right-sided SSD), alongside a control group of 13 normal-hearing individuals. Participants underwent functional MRI experiments involving an auditory localization task. Additionally, the normal-hearing group conducted the same experiment with each ear acutely plugged.

Our investigation delved into the cortical network responsible for auditory localization, comparing and contrasting results across the SSD and normal-hearing groups. Correlation analyses were employed to uncover regions of activity associated with the duration of SSD and localization performance. We also conducted an analysis of response laterality in the cytoarchitectonically defined auditory cortex in both right and left SSD groups, comparing them to controls in binaural, right-monaural, and left-monaural conditions.

Our findings revealed that the extended duration of single-sided hearing significantly influences auditory cortical response, particularly within the right primary auditory cortex. Notably, the direction of change varied based on the side of the deaf ear, ultimately resulting in a reduction in asymmetry within this early auditory area. Further analysis of laterality demonstrated that functional asymmetry in the primary auditory cortex decreased with prolonged SSD, especially when localizing sound from the impaired ear side.

Additionally, we identified areas in the posterior superior temporal gyrus (STG), situated within the dorsal auditory pathway in the hemisphere contralateral to the intact ear, which played a crucial role in enhancing localization performance. Furthermore, increased activity within the cingulo-opercular attention network was observed in left-sided SSD and was linked to improved localization performance in right-sided SSD.

In conclusion, our study demonstrates that auditory cortical response in spatial tasks is differentially modulated by the side of deafness. Furthermore, the engagement of cortical attentional resources contributes significantly to auditory spatial behavior in individuals with SSD, particularly when hearing impairment affects the left ear. These findings shed light on the intricate interplay between cortical plasticity and auditory localization, providing valuable insights into the functional consequences of SSD.

Symposium 10

Music Perception and Sound Localization
SP 10-5

Suppression of the responses to the hearing ear by deaf ear in congenical single-sided deafness

Andrej KRAL[1,2]

[1]*Institute of AudioNeurotechnology & Dept. of Experimental Otology, ENT Clinics, Hannover Medical School, Hannover, Germany*
[2]*Dept. of Biomedical Sciences, School of Medicine and Health Sciences, Macquarie University, Sydney, Australia*

Performance of sequential cochlear implantations in prelingually deaf children shows that the second implanted ear underperforms in speech comprehension (Gordon and Kral, 2019, Hear Res). An inhibition between the ears in such condition has been suggested (Burdo et al., 2016, Eur Ann ORL), but the physiological mechanism remained elusive. In cats with single-sided congenital deafness (SSD) the aural preference shifted towards the hearing ear on both hemispheres (Kral et al., 2013, Brain). Binaural integration was also compromised (Tillein et al., 2016 Cereb Cortex). The present study investigated the nature of binaural interactions with focus on excitation and inhibition.

In the present study, 9 adult hearing controls (HCs), 9 adult bilaterally congenitally deaf cats (CDC) and 2 adult SSD cats were used. All animals were acutely electrically stimulated by cochlear implants (CI). Cortical responses were evoked by a train of 3 biphasic electric pulses (200 µs/phase, 500 Hz). Intensities up to 12 dB above auditory brainstem response threshold were used, whereas the contralateral ear was kept constant at 6 dB above threshold, and the current level of the ipsilateral ear was varied from -2 to 12 dB above threshold. Multiunit activity was recorded using 16-channels arrays covering all layers of the primary auditory cortex. Responses were classified to excitation or inhibition depending on whether the stimulation at the ipsilateral ear significantly increased or reduced the firing rate with increasing level.

In HCs, the ipsilateral ear induced inhibition of the responses to the contralateral ear in ~40% of recording sites, whereas in CDCs this proportion was smaller (~30%). In SSD animals, the deaf ear consistently induced suppression of the responses to the hearing ear in ~60% of units, whereas vice versa the hearing ear caused excitation and inhibition was exceptionally rare (< 2%). These data document the extraordinary extend of the reorganization of binaural interactions and demonstrate that the previously deaf ear causes inhibition of the responses to the hearing ear in abnormally high proportion of units. That explains why after long periods of unilateral early deafness learning speech comprehension through the previously deaf ear is difficult and does not profit from what was learned through the other ear. Early binaural hearing is necessary in preventing these adverse consequences.

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Symposium 11

Future Technology & Electrode
SP 11-1

Experience with two novel therapies delivered associated with the cochlear implant device: steroid eluting array; and Cochlear Implant Neurotrophin Gene Therapy (CINGT)

Catherine BIRMAN[1,2,3,4]

[1]NextSense Cochlear Implant Program, NextSense, Australia
[2]Medicine and Health, Sydney University, Australia
[3]Medicine and Health Sciences, Macquarie University, Australia
[4]ENT Department, Royal Prince Alfred Hospital, Australia

Introduction

Novel intracochlear therapies aim to improve hearing outcomes with cochlear implants (CI).
Two delivery techniques have been trialed at NextSense Cochlear Implant Program: steroid eluting array and Cochlear Implant Neurotrophin Gene Therapy (CINGT). The CINGT study uses electroporation to drive the DNA into the cells lining the scala tympani, which then produce neurotrophins- BDNF and NT3. These neurotrophins stimulates the spiral ganglion neurites to regrow, growing the nerve endings closer to the cochlear implant electrodes and closing the neural gap. This is expected to give greater fidelity. The cells are naturally turned over, so the production of neurophins is for a limited time.

Method
This presentation shares our experience with the two different novel research delivery devices.

The steroid eluting array research was in collaboration with the Hearing CRC, Melbourne Cochlear Implant Program, the Sydney Cochlear Implant Centre (now known as NextSense Cochlear Implant Program) and Cochlear Pty Ltd. It used a novel research steroid eluting CI512 device.

The Cochlear Implant Neurotrophin Gene Therapy (CINGT) trial was in collaboration with University of NSW, University of Melbourne, Macquarie University, Sydney University and NextSense Cochlear Implant Program and Cochlear Pty Ltd. The study uses a novel gene delivery probe with electrical pulses delivered into the scala tympani to move the gene plasmid into the cells, followed by routine insertion of a cochlear implant.

Results
The research CI steroid eluting cochlear implant enabled localized dexamethasone to be delivered to the cochlea resulting in markedly lower and stable impedance levels post-operatively. The published results will be presented, along with our Centre's experience.

For the CINGT study, the background and operative technique will be presented. The CINGT study is ongoing but preliminary results will be presented. Nineteen patients received the gene therapy along with routine cochlear implantation, in whom we have seen hearing preservation in one patient; overall good speech outcomes; and for some participants markedly reduced current levels eliciting psychophysiological threshold responses, the lowest is a current level of nine in BP+2 mode. The trial commenced in 2020 and is ongoing and to date there have been minimal issues and no major complications.

Conclusion
Two novel therapies, steroid eluting array and Cochlear Implant Neurotrophin Gene Therapy can enhance localized tissue responses and optimize outcomes.

Symposium 11

Future Technology & Electrode
SP 11-2

Long term behavior of dexamethasone-loaded cochlear implants: In vitro & in vivo

Christophe VINCENT

Univ. Lille, Inserm, Otology Department - CHU Lille, U1008, F-59000 Lille, France

Background:

Dexamethasone-loaded silicone cochlear implant electrode array offer an interesting potential as innovative drug delivery system. In animal models, benefits have been demonstrated for this novel device: better residual hearing, lower impedances. However, very long drug release periods are targeted: several years/decades. This renders the development and optimization of novel drug products cumbersome: experimental feedback on the impact of the device design is obtained very slowly. The aim of this study was to better understand the long-term behavior of silicone-based cochlear implants loaded with dexamethasone.

Materials and Methods:
Different types of cylindrical, cochlear implants were prepared by injection molding, varying their dimensions (being suitable for use in humans or gerbils) and initial drug loading (0, 1 or 10 %). Dexamethasone release was monitored in vitro upon exposure to artificial perilymph at 37 °C for >3 years. Optical microscopy, X-ray diffraction and Raman imaging were used to characterize the implants before and after exposure to the release medium in vitro, as well as after 2 years implantation in gerbils. Importantly, in all cases dexamethasone release was reliably controlled during the observation periods.

Results:
Diffusional mass transport and limited drug solubility effects within the silicone matrices seem to play a major role. Initially, the dexamethasone is homogeneously distributed throughout the polymeric matrices in the form of tiny crystals. Upon exposure to aqueous media or living tissue, limited amounts of water penetrate into the implant, dissolve the drug, which subsequently diffuses out. Surface-near regions are depleted first, resulting in an increase in the apparent drug diffusivity with time. No evidence for noteworthy implant swelling or shrinkage was observed in vitro,

nor in vivo.

Discussion and Conclusions:

Silicone-based cochlear implants for use in humans and animals (e.g., gerbils) can reliably control dexamethasone release over several years. Diffusional mass transport combined with drug saturation effects within the implants seem to play a major role. A simplified mathematical model can be used to predict the resulting drug release kinetics as a function of the implant's design.

Symposium 11

Future Technology & Electrode
SP 11-3

Improving the Electrode-Nerve-Interface of Cochlear Implants

Volkmar HAMACHER

Research&Technology and Clinical Affairs, Advanced Bionics, Germany

To further improve outcomes for CI recipients, we work continuously on new concepts and technologies to optimize the electrode-nerve interface.
An example is AIM, a medical grade tablet providing the surgeon with real-time feedback from the residual hair-cells as the electrode array is inserted. The intent is to minimize trauma, to preserve the delicate cochlear structures, and ultimately to improve outcomes with the implant. With the electrode array fully inserted, AIM can also assess whether the placement is optimal, without any tip fold-over or extrusion of electrode contacts, extrusion being a currently under reported problem with straight electrode array designs.
In addition, AIM offers post-operative applications, including the gathering of electrode impedance to ensure that the electrode array is working well, neural responses to confirm successful electrical stimulation, and the prediction of acoustic hearing thresholds.

An exciting new research area involves measuring evoked potentials, originating from the higher auditory pathway, directly via the CI electrode array, without the need for any scalp electrodes. Such measures would provide objective insights into how the brain perceives the electrical stimulation, so could be invaluable for speech processor programming and confirming progress of babies implanted within their first year of life, or other recipients who are currently extremely difficult to accurately assess.

Innovative technologies are under investigation to make electrode arrays even more gentle to insert: so further protecting cochlear structures, as well as improving cochlear coverage.
The "Peristraight" electrode array concept is a first step in this direction, combining advantages of ease of insertion of a straight design for the apical part with an improved modiolar position for the basal part.
An ambitious self-curling electrode design, initially a straight array that after insertion gently takes on a modiolar location appears very promising. Novel functional coatings of the electrode array, intended to reduce friction during insertion, or release drugs to minimize intracochlear inflammatory and foreign-body reactions are research activities, which will be also be discussed in this talk.

Symposium 11

Future Technology & Electrode
SP 11-4

32-channel Cochlear Implant System for Clinical Use

Kyou Sik MIN

Cochlear Implant Division, Todoc Co., Ltd., Korea

One of the main reasons making cochlear implant cost high is manual fabrication of electrode array. For decades, there have been efforts to make affordable CI systems with safety and efficacy to reduce the cost of conventional cochlear implant. However, approaches using manufacturable and automated process accompanies problems in biocompatibility qualification and manufacturing yield, respectively.

In this study, we introduce 32-channel cochlear implant system for clinical use. Electrode array comprising of electrodes and lead wires is micro-machined using picosecond laser at once on platinum-iridium alloy film which has been used as raw material for commercial cochlear electrode array for nearly 40 years. Patterned electrode contacts and wires array is encapsulated by silicone elastomer forming carrier. The dimensions of the electrode array are 20 to 24 mm in length and 0.45 to 0.8 mm in diameter from the tip to the base. For electrode array is manufactured in layer-by-layer deposition scheme, the planar structure of the lead wire array are formed in 3-dimensional wavy structure for flexibility of the lead. To assess the clinical feasibility of the electrode array, its mechanical and electrochemical characteristics are measured by universal testing machine and potentiostat, respectively. The team also has developed 32-channel stimulator and receiver ASIC with novel I-DAC technology which adjusts amplitude resolution according to gap between C-T level of each channel. For clinical application, implant circuits and components are hermetically packaged in Ti6Al4V alloy cavity and platinum-ceramic feedthrough using brazing and laser-welding. Authors use commercial hearing-aid audio processor to minimize additional development cost. Developed CI system have gone through GLP-compliant tests for biological safety qualification. Using same manufacturing scheme, we introduce 16-channel electrode array and system which has less manufacturing cost than 32-channel electrode array. We are currently planning to do clinical trials of suggesting cochlear implant systems as next step.

Symposium 11

Future Technology & Electrode
SP 11-5

Minimizing Trauma in Cochlear Implantation with a Novel Self-Coiling Array Using Shape Memory Polymers

Kenneth H LEE

Otolaryngology - Head & Neck Surgery, University of Texas Southwestern Medical Center, USA

Shape Memory Polymers (SMPs) belong to a class of smart materials that can change shape in response to a stimulus, such as temperature change. Using these polymers, we have developed a cochlear implant electrode array that changes its shape from straight at room temperature to coiled to match the turns of the cochlea once inserted and warmed to body temperature. We demonstrate that use of an SMP based self-coiling cochlear implant electrode array can reduce insertion trauma and optimize intracochlear array position to potentially improve cochlear implant function and outcomes. Self-coiling SMP based electrode arrays as well as standard silicon arrays were inserted into a cochlear model with continuous video capture for independent review. SMP and straight silicon arrays were also inserted into rat cochleae and histological analyses of paraffin embedded sections were performed. Evaluation of these sections were done to determine the degree of trauma to the lateral wall of the cochlea and the intracochlear position of the arrays. The self-coiling arrays inserted into cochlear models at body temperature (37°C) demonstrated that full insertion was achieved with minimal contact with the walls of the cochlea on review of insertion videos. In contrast, the standard straight arrays had continuous contact with the lateral wall following initial contact at the basal turn. Histological analyses of the rat cochleae after insertion of arrays showed less tissue trauma resulting with the self-coiling arrays compared to that of standard straight cochlear implant arrays. In addition, analyses for intracochlear location of arrays revealed that the self-coiling arrays maintained a more medial position within the scala of the middle turn of the cochlea. We demonstrate proof of concept that shape memory polymers can be used to generate a self-coiling cochlear implant array. These prototype arrays demonstrate insertion with reduced tissue trauma and more consistent mid-scalar positioning within the cochlea once fully inserted.

Symposium 12

Tinnitus
SP 12-1

CI as a long-term treatment for ipsilateral incapacitating tinnitus in subjects with SSD: Antwerp experience.

Vincent VAN ROMPAEY[1,2]

[1]*Otorhinolaryngology, Antwerp University Hospital, Belgium*
[2]*Translational Neurosciences, University of Antwerp, Belgium*

Introduction: The authors previously demonstrated that tinnitus resulting from unilateral hearing loss (UHL) can be treated with electrical stimulation via a Cochlear Implant (CI). The study aimed to do a long-term (LT) evaluation of CI in subjects suffering from UHL and accompanied incapacitating tinnitus up to 10 years. The primary focus of the study is on LT tinnitus reduction.

Subjects: LT evaluation was derived from 23 subjects suffering from UHL and accompanied incapacitating tinnitus. They were cochlear implanted at a median age of 55 years (22-71 yr). The subjects were categorized into two groups: a Single-Sided Deaf Group (SSD) and an Asymmetric Hearing Loss Group (AHL). The SSD group comprises subjects with contralateral normal hearing (i.e. air conduction pure tone average (PTA0.5, 1, 2 and 4 kHz) ≤ 30 dB HL) and the AHL group subjects with contralateral mild to moderate hearing loss (i.e. air conduction PTA0.5, 1, 2 and 4 kHz > 30 dB HL).

Methods: In order to obtain a LT structural overview of the CI use in UHL subjects, a structured interview was conducted including questions about daily amount of CI use, residual inhibition of the tinnitus after switch off, tinnitus type, etc. The VAS tinnitus loudness and the Tinnitus Questionnaire were obtained pre-operatively and up to 10+ years post-operatively.

Results: The structural interview revealed that all patients (23/23) still wear their CI seven days a week. It appeared that in all subjects but one CI switch-on is the first act when rising and CI switch-off is the last act before bedtime. In the SSD group, tinnitus suppression is still the primary benefit reported (83%), whereas in the AHL the majority of the subjects (55%) report that the primary benefit shifted to improved hearing. In the majority of the subjects the tinnitus reduction starts within 1 min (in 70% of the cases) and the residual inhibition after CI switch-off is less than a minute (in 65% of the cases). The VAS and TQ scores significantly improved up to three months after the first-fitting and remain stable up to the LT test interval.

Conclusion: Access to binaural hearing is important for subjects with SSD. CI users with SSD experience long-term benefits in speech understanding, sound localization, and quality of life.

Symposium 12

Tinnitus
SP 12-2

Tinnitus suppression after cochlear implant (CI) : Japanese experience

Sho KANZAKI

National Institute of Sensory Organ, National Hospital Organization of Tokyo Medical Center, Japan

Japanese tinnitus guidelines recommend cochlear implant (CI), especially for single-sided deafness (SSD) (Ogawa K, Kanzaki S et al. 2020), but they are not reimbursed at this time. Here we describe our experience with a small number of CI cases for SSD that have been studied in Japan.

CI for Japanese SSD patients resulted in improved speech perception, increased sound localization accuracy, and reduced tinnitus handicap inventory (THI). All the cases presented immediate improvement in THI, with gradual improvement over the course of a year (Kitoh R, Kanzaki S et al 2016).

The mechanisms by which CI may be effective for tinnitus are as follows. Phosphorylation of cyclic AMP/Ca(2+)-responsive element-binding protein (CREB) is induced by electrical stimulation in neuron. CREB activates the transcription of brain-derived neurotrophic factor (BDNF), which is needed for synaptic transmission and long-term potentiation (Tan J et al 2008). Sensorineural hearing loss or chronic tinnitus reduced the expression of pCREB and BDNF (Tan J et al 2008) (Goto F,Kanzaki S et al 2012). In addition, BDNF levels are also decreased in depressed patients.

Deafened subjects to long-term, intracochlear electrical stimulation exhibited an increased expression of pCREB and BDNF in the contralateral auditory cortical neurons (Tan J et al 2008). It has also been found that electrical stimulation of neurons by the CI increases BDNF (serum levels) and suppresses tinnitus distress or tinnitus handicap inventory.

Symposium 12

Tinnitus
SP 12-3

CI-induced cortical changes in SSD with tinnitus

Jae-Jin SONG

Otorhinolaryngology-Head and Neck Surgery, Seoul National University Bundang Hospital, Korea

The development of tinnitus is frequently deemed to be a neuroplastic response to sensory deprivation. This assumption is supported by a transient perception of tinnitus after experimentally induced partial and complete temporary auditory deprivation in normal subjects, and was further reinforced by lack of tinnitus in congenitally deaf animal models. Furthermore, analogous to phantom limb pain, the tinnitus spectrum corresponds to auditory deprived frequencies.

In patients with severe peripheral auditory deafferentation, reafferentation of the ascending auditory nervous system with cochlear implants (CI) may abate tinnitus. Indeed, CI improved tinnitus significantly in 66–100% of CI users with bilateral profound hearing loss. Also, improvement of tinnitus by CI was reported in patients with single-sided deafness (SSD) and ipsilesional debilitating tinnitus. In a recent meta-analysis, CI showed a statistically significant improvement in the severity of tinnitus. In this regard, CI is a promising treatment option for patients with SSD and combined severe tinnitus.

However, the exact mechanism of tinnitus suppression after CI in patients with SSD is not fully understood. Some researchers have claimed that acoustic masking provided by CI is the primary mechanism of tinnitus suppression, by distracting attention from tinnitus, while others have suggested that plastic changes in the central auditory system by prolonged CI stimulation and electrical stimulation resulting in contralateral residual inhibition are possible mechanisms of tinnitus suppression.

In this talk, the current status of CI in patients with SSD and debilitating tinnitus will be addressed by reviewing recent studies. Also, the possible mechanism of tinnitus suppression by CI will be suggested by introducing recent functional imaging studies comparing pre-CI vs. post-CI cortical activities using quantitative electroencephalography (qEEG).

Symposium 12

Tinnitus
SP 12-4

The impact of CI and BCI on tinnitus in the patients with SSD or asymmetric hearing loss

Shi Nae PARK

Department of Otolaryngology-Head and Neck Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

The main mechanisms of the generation and persistence of tinnitus have been known to be the filling-in phenomenon of the tinnitus network in the brain. Therefore, sound therapy with hearing aids for the tinnitus patients with hearing loss are reasonable. Considering this conceptual predictive network hypothesis of tinnitus, we may high-lighten the therapeutic role of various implantable hearing devices(IHD) for the tinnitus patients of deafness. The effect of cochlear implantation on tinnitus in patients with bilateral hearing loss has been already well proved and a decrease or even total suppression of tinnitus after cochlear implantation was reported in up to 45% of the patients. We also reported the impact and the role of cochlear implantation on tinnitus reduction in patients with bilateral deaf. Our recent clinical studies are mostly focusing on the impact of cochlear implant(CI) and bone conduction implant(BCI) on tinnitus in the patients with single sided deafness(SSD) or asymmetric hearing loss(AHL) to provide more information on the selection of the device for the better results in terms of tinnitus management. Due to the different audiological indications as well as the cost of two different IHD, clinicians need to select the proper devices and to counsel the patients to have a proper expectation. For better understanding of the role of CI or BCI for the tinnitus management in the patients with SSD or AHL, we retrospectively reviewed 21 BCI recipients with SSD or AHL and revealed the significant improvement of their tinnitus measured by tinnitus questionnaires($P<0.05$). Another comparison study of 15 CI and 15 BCI recipients in AHL showed the significant effect of both CI and BCI on tinnitus reduction, although CI was superior in reducing loudness of tinnitus compared to BCI($P<0.05$). Therefore, we could conclude that both CI and BCI were very effective management options not only for hearing rehabilitation but also for the alleviation or even cure of tinnitus in the patients with SSD or AHL. However, it seems like that CI has a superiority to BCI, which needs to be validated in the future in a larger case series.

Symposium 12

Tinnitus
SP 12-5

Update on Sudden Sensorineural Hearing Loss

Kyung Wook HEO

Otorhinolaryngology-Head & Neck Surgery, Inje University Busan Paik Hospital, Korea

Sudden hearing loss is a frightening symptom that often prompts an urgent or emergent visit to a health care provider. It is frequently but not universally accompanied by tinnitus and/or vertigo. Sudden sensorineural hearing loss (SSNHL) affects 5 to 27 per 100,000 people annually, with about 66,000 new cases per year in the United States. SSNHL has defined as a rapid decline (less than 3 days) of more than 30 dB sensorineural hearing loss in at least three contiguous frequencies without any identifiable cause. SSNHL may be classified as primary SSNHL and secondary SSNHL. Primary SSNHL has three proposed major etiologies, namely viral infection, vascular insufficiency, and autoimmune disorder. It has also been hypothesized that pathologic activation of the cellular stress pathway involving nuclear factor kappa B within the cochlea could develop primary SSNHL. In secondary SSNHL, causes include neoplasm, stroke, and irradiation, after excluding those with acoustic trauma, head injury, Meniere's disease, perilymph fistula, and ototoxicity. These excluding disorders initially mimic acute sensorineural hearing loss but finally manifest as different disease entities. An inner ear test battery in SSNHL patients helps determine its etiology, and provides comprehensive information on the affected territory to assess the involvement severity in the inner ear. Corticosteroids, antiviral agents, vasodilators, and hyperbaric oxygen therapy (HBOT) are the currently available treatment options for SSNHL, but their comparative efficacy is unclear. To date, the most widely used treatment for SSNHL is systemic and/or intratympanic corticosteroids. As another option, HBOT is a treatment that may relieve edema and ischemia by administering high-pressure oxygen into the inner ear to restore hearing. This presentation would provide an overview of the different causes and differential diagnosis of the different types of SSNHL as reported in the existing literature.

Roundtable 01

Challenging Cases Ⅰ
RT 01-1

Role of Cochlear implantation in intralabyrinthine Schwannoma

Jong Woo CHUNG

Otorhinolaryngology-Head and Neck Surgery, Asan Medical Center, University Of Ulsan College Of Medicine, Korea

Objectives: Intralabyrinthine schwannomas (ILS) are rare benign tumors, which arise from neural portions within the labyrinth. Cochlear implantation in ILS patients is challenging due to the tumor's location and the potential for residual tumor tissue after surgery. I intend to review the experience with CI and the audiologic outcomes in this unresolved condition.
Methods: Four consecutive patients with profound sensorineural hearing loss caused by intralabyrinthine schwannoma who underwent single sided CI by the same surgeon were included in the study. Two patients had only ILS, while in two other patients, schwannomas were found in both the internal auditory canal (IAC) and cochlea; one of these patients was diagnosed with NF2. In the last patient, gradual reduction in CI function was observed in the recipient ear. Schwannoma was identified in both the cochlea and IAC in this case.
Results: In two patients, ILS was identified before surgery, and CI was performed simultaneously with tumor excision. In these cases, 2-year post-operative word recognition score (WRS) improved to 52% and 76% respectively, from 0% before surgery. For the NF2 patient, stereotactic radiosurgery was conducted, followed by CI. However, the patient's speech recognition did not improve after surgery. In the last patient, during the revision surgery for the CI, an intracochlear tumor was discovered and removed. Subsequent MRI demonstrated a 1.6 cm IAC VS. Despite the revision CI surgery, speech recognition did not improve beyond the level of deafness.
Conclusion: In cases where a tumor occupies a localized area within the cochlea, simultaneous CI following tumor resection has shown promising results in terms of achieving good hearing recovery and experiencing rare complications after surgery. However, the long-term efficacy of the CI due to tumor growth is still unknown, which requires continuous cohort studies to be established.

Roundtable 01

Challenging Cases Ⅰ
RT 01-2

ROUND WINDOW STENOSIS/ATRESIA

Neelam VAID

ENT, K.E.M. HOSPITAL, India

The round window is the most important surgical landmark in cochlear implant surgery. Correct identification of this landmark ensures placement of the electrode array into the scala tympani which is very important to ensure good outcomes. Accurate preoperative identification of any round window abnormality is essential to plan surgical strategy and reduce complications.
There are various developmental, acquired and neoplastic processes that can affect the round window membrane and niche.
This presentation is focused on the experience in our institution with patient with round window stenosis who underwent cochlear implantation. The aim to increase awareness of this anatomical challenge, preoperative diagnosis by imaging and how to deal with this surgical challenge.

Roundtable 01

Challenging Cases Ⅰ
RT 01-3

Cochlear Implantation in Ossified Cochlea: Our experience

Sunil Narayana DUTT

Department of Otolaryngology (ENT) & Head-Neck Surgery, Apollo International Hospitals, India

Introduction
Labyrinthine Ossificans (LO) is a known complication of bacterial meningitis which results in severe to profound hearing loss. Historically, LO was considered a contraindication for Cochlear Implantation (CI). However, with advances in technology, CI is an accepted treatment for hearing loss in LO.
Materials and methods
12 cases with varying degrees of ossification in the cochlea were evaluated and treated at our centre. The etiology, radiology, intra-operative findings and treatment protocols followed in these patients are discussed.
Results
10 of the 12 patients could successfully be implanted while one patient is awaiting CI and one, Auditory Brainstem Implant (ABI).
Scenario 1: Partial ossification limited to the basal turn. The lumen was accessible after minimal drilling and a complete insertion could be achieved.
Scenario 2: Significant ossification of the basal turn. No lumen could be identified in the sca
Scenario 6: Complete white-wash effect on CT and black-out effect seen on the MRI pre-operatively. Patient is awaiting ABI.la tympani, but scala vestibuli was found to be patent and hence, scala vestibuli insertion was done.
Scenario 3: Significant ossification of the basal turn of cochlea. Here no lumen could be achieved in the basal turn even after complete drill out. Hence a middle-turn cochleostomy was done and an anterograde insertion into the apical turn was achieved.
Scenario 4: Significant ossification of the semicircular canals on radiology. Intra-operatively no lumen could be identified in basal turn. Middle-turn cochleostomy was done and electrode insertion was done, peri-operative radiology showed the electrode to have progressed retrogradely into the basal turn.
Scenario 5: No lumen could be found in the basal turn and a very limited lumen was found in middle-turn, hence a split-array was used to maximise the number of electrodes inserted.
Scenario 6: Complete white-wash effect on CT and black-out effect seen on the MRI pre-operatively. Patient is awaiting ABI.
Conclusion
We propose a protocol for the order of choice of electrode and site of insertion in various cases of LO depending on the degree of ossification, which is: scala tympani of basal turn → scala vestibuli of basal turn → second turn, anterograde insertion → second turn, retrograde insertion → split array → ABI.

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Roundtable 01

Challenging Cases Ⅰ
RT 01-4

Stapes footplate fistula in inner ear malformations

Levent SENNAROGLU

Department of Otorhinolaryngology-Head & Neck Surgery, Hacettepe University, Türkiye

Roundtable 01

Challenging Cases Ⅰ
RT 01-5

Superficial siderosis: clinical course and outcome of cochlear implant

Ja-Won KOO

Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

Background: Superficial siderosis (SS) is a rare condition in which hemosiderin, an iron storage complex, is deposited in neural tissues because of recurrent subarachnoid bleeding. Hemosiderin deposition in the vestibulocochlear nerve (CN VIII), brain, spinal cord and peripheral nerve can cause sensorineural hearing loss (SNHL) and postural imbalance, but much remains unknown about the vestibular manifestations of SS. Objective: To report the clinical course, cochleovestibular status, and patterns ofvestibulopathy during follow-up of a relatively large case series, and to discuss the possible pathophysiological mechanism of vestibular deterioration.
Methods: Six patients diagnosed with SS by magnetic resonance imaging (MRI) were enrolled. Their medical records and radiological findings were retrospectively reviewed, particularly in terms of progression of the vestibulocochlear manifestations and the radiological characteristics.
Results: All six patients had SNHL. Five of them exhibited progressive hearing loss over years, which was asymmetric in four. On their most recent evaluations, patients showed cerebellar ataxia with combined central and peripheral vestibulopathy on both sides (n=4), a bilateral peripheral vestibulopathy (n=1) or isolated central vestibulopathy (n = 1). Notably, the former four patients showed an evolution of isolated central vestibulopathy into combined central and peripheral vestibulopathy. Hypo-intense lesions on T2 weighted MRIs were evident around the cerebellum in all patients, but such lesions were observed around the brainstemin five and the CN VIII in four. The cochlea-vestibular dysfunction generally progressed asymmetrically, but no left-right asymmetry was evident on MRI.
Conclusions: SS typically presents as bilaterally asymmetric, progressive cochleovestibular dysfunction with cerebellar ataxia. The pattern of vestibular dysfunction is usually combined central and peripheral vestibulopathy on both sides. Thus, precise identification of audiovestibular dysfunction and central signs is essential in SS, and patients with SS should undergo regular, comprehensive neurotological evaluation to optimize their treatments and prognosis

Roundtable 01

Challenging Cases Ⅰ
RT 01-6

Retrofacial approach for cochlear implantation

Kuang Chao Joshua CHEN

Holistic Hearing Healthcare Center, China Medical University Hospital, Taiwan

Cochlear implant surgery has become well standardized. The facial recess (posterior tympanotomy) is commonly used to get access to the round window niche. After exposing the round window membrane, a cochleostomy or round window approach is performed. However, all portions of the temporal bone could have variant anatomy. These anomalies included sclerotic mastoid, cholesteatoma, posteriorly positioned round window, bifid mastoid segment of the facial nerve, narrow facial recess, and anteroinferior displacement of the nerve (high facial nerve). These would affect the surgeon's ability to expose the round window, open the scala tympani, and insert the electrodes. During CI operations, if the surgeons encounter these difficulties, retrofacial (subfacial) approach allows access to the posterior mesotympanum and thus to the round window.
Twenty-one cases, 6 children and 15 adults, in 1156 CI recipients were implanted via retrofacial approach by our team. All of them had high positioned facial nerve with a narrow facial recess (<2mm), except one patient with COM. After posterior ear canal wall was thinned, even we utilized endoscope, the round window still could not be visualized. Under such condition, retro

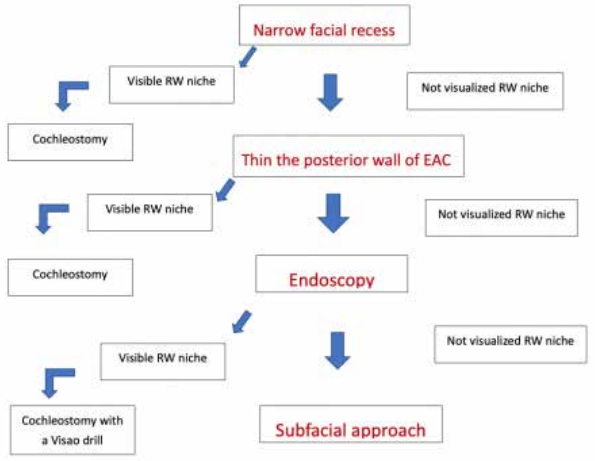

Figure Time to do retrofacial approach

facial recess was created to locate the round window. CI electrodes were fully inserted through round window in all these patients.
The retrofacial approach requires good anatomic knowledge of the facial nerve anatomy and of the semicircular canal. It is an alternative when the facial recess approach does not allow access to the round window, thereby precluding a safe cochlear implant insertion without damaging the facial nerve.

Roundtable 01

Challenging Cases Ⅰ
RT 01-7

Hearing rehabilitation in patients with intralabyrinthine schwannomas. A single centre experience from 72 patients

Stefan K. PLONTKE

Dept. of Otorhinolaryngology, Head and Neck Surgery, Martin Luther University Halle-Wittenberg, Germany

Introduction:
Intralabyrinthine (inner ear) schwannomas (ILS, IES) are a rare differential diagnosis of sudden hearing loss and vertigo. The common management of these tumors is often a "wait-and-test-and-scan (W&T&S)" strategy. We here report the results of management of these tumors with surgical tumor removal and cochlear implantation (CI) in a single academic center.

Methods:
In a personal case series of 102 patients with intracochlear, intravestibular, intravestibulocochlear, transmodiolar (including with cerebello-pontine angle extension), transmacular, transotic, or multilocular location, surgical tumor removal was performed in a total of 72 patients in combination with a Cochlear implant. Word recognition score (WRS) and vestibular receptor function were the primary outcome parameters.

Results:
Most tumors were managed with subtotal or partial cochleoectomy and/or labyrinthectomy or translabyrinthine surgery (for the transmacular tumors).
In the intracochlear tumors, WRS at 65 dB SPL was 96% for numbers and 73% for monosyllables aftre 12 months.
Vestibular receptor functions could be preserved in nearly all patients with intracochlear tumors and subtotal cochleoectomy.

Conclusion:
We suggest surgical tumor removal and CI in cases of „unserviceable hearing". The CI worked astonishingly well in these patients. Function of the vestibular labyrinth can be preserved despite of major trauma to the cochlea.
These surprising observations have important implications for our understanding of the function and the surgery of the peripheral auditory and vestibular system and the function fo cochlear implants.

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Roundtable 01

Challenging Cases Ⅰ
RT 01-8

Revision Surgery for cochlear implant

Mohnish GROVER

ENT, SMS Medical College, Jaipur, India

Revision surgery for cochlear implants is a harsh reality which all of us have to accept. This could be due to different indications like misplaced electrodes, implant failure, implant extrusion, displaced magnet, etc. Like any other revision surgery, revision surgery for cochlear implants entails many issues including decision making, consent, fibrosis, neo-osteogenesis and difference in technique. This would also vary with different kind of indication for revision.

The talk is a retrospective study of such cases which have been referred to SMS Medical College, a tertiary referral centre in India.

In this talk, the author will present surgical techniques for all these indications. The risks involved, the challenges which needed to be handled and the mistakes made will be discussed in detail. It is a mixed bag of stories of success and failures. There are times when implant could be salvaged but at other times it had to be explanted. The presentation will also entail various tips and tricks to deal with such situations.

Roundtable 02

Genetic Landscape of Hearing Loss
RT 02-1

Genetic landscape of HL in Japan

Shin-Ichi USAMI

Hearing Implant Sciences, Shinshu University, Japan

Background:
Genetic diagnosis ensures a more accurate diagnosis and suitable clinical interventions based on the predicted phenotype. More than 100 responsible genes have been reported to be associated with non-syndromic hearing loss and we have recently clarified the genetic etiology of 10,047 hearing loss patients in Japan (Usami and Nishio, 2022). When focusing on patients receiving CI/EAS, those possessing a variety of deafness gene mutations have achieved satisfactory auditory performance, suggesting that the identification of the genetic background facilitates the prediction of post-CI/EAS performance (Usami et al., 2020).

Methods:
To clarify the genetic etiology of deafness, a common platform using a diagnostic DNA panel carrying 63 deafness genes and a common filtering algorithm were applied to 10,047 samples obtained from patients undergoing social health insurance-based genetic testing for hearing loss in Japan. In addition, patients receiving CI/EAS were analyzed from a genetic perspective.

Results and Discussion:
The most remarkable result obtained in our comprehensive study was that the data allowed clarification of the genetic epidemiology from congenital/early-onset deafness to late-onset hearing loss. The overall diagnostic rate was 38.8%, although the rate differed for each age group; 48.6% for the congenital/early-onset group (~5y.o.), 33.5% for the juvenile/young adult-onset group, and 18.0% for the 40+ y.o. group. It was also revealed that the types of genes differed within the groups according to severity; i.e., GJB2, SLC26A4, and CDH23 were more commonly found in the severe-to-profound hearing loss group (which is an indication for CI/EAS). Interestingly, each age- and severity-based subgroup showed a different kind of causative gene. Our comprehensive review clarified the detailed clinical characteristics (onset age, severity, progressiveness, etc.) of hearing loss caused by each gene, and will provide useful information for future clinical application, including genetic counseling and selection of appropriate interventions. In our investigation of whether the types of causative genes differ depending on country, a literature review indicated that
GJB2 is particularly frequent in all countries, and similar major genes (SLC26A4, MYO15A, STRC, etc.) have been found. Interestingly, even though the causative gene is the same, it was found that the mutational spectra are ethnicity specific, which reflects the existence of founder effects.

Among the various etiologies observed in cochlear implant (CI) or electric acoustic stimulation (EAS) patients, genetic etiologies are believed to be the major cause of HL. Genetic screening successfully identified the causative mutation in CI/EAS patients. As expected, patients with specific deafness gene mutations showed relatively good results. Further, patients possessing mutations in a number of deafness genes known to be expressed within the inner ear achieved satisfactory auditory performance, suggesting that the identification of the genetic background facilitates the prediction of post-CI performance. Therefore, determination of the involved region inside/outside of the cochlea by identification of the responsible gene is essential.

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Roundtable 02

Genetic Landscape of Hearing Loss
RT 02-2

The genetics of hearing loss in UK

Shakeel SAEED

Department of Otology/Neuro-otology, University College London Ear Institute, UK

Roundtable 02

Genetic Landscape of Hearing Loss
RT 02-3

An international multi-center study on the natural history of TMPRSS3 and related cochlear implant outcomes

Xue Zhong LIU

TMPRSS3 Consortium, USA

Introduction and Background

There are over 120 genes known to be related to non-syndromic hearing loss (NSHL). TMPRSS3 is a high confidence NSHL gene that codes for a serine protease expressed by multiple cell of the inner ear, including supporting cells, hair cells, and SGNs. TMPRSS3 mutations are an important cause of NSHL, accounting for ~2% of cases. It is necessary to have well-powered, genotype-to-phenotype correlations to best understand the natural history of TMPRSS3 variants and their implications for care, decision making, and future clinical trials of gene therapy. Here we present the largest TMPRSS3 natural history study to date, involving 141 individuals from 10 institutions across 6 countries.

Methods and Design

A request for data was sent to 14 institutions in six countries. This data included demographics, such as sex, race, and age at hearing loss onset. TMPRSS3 mutations were provided by cDNA, protein change, and locus identifier. Serial audiograms were collected for each participant, both before and after cochlear implantation. Individuals with variants in other known hearing loss genes were excluded from analysis. Individuals were assigned to three groups by the combination of missense (M) and loss of function (LoF, premature stop and splice variations) alleles: M/M, M/LoF, LoF/LoF. Individuals were also grouped by the protein domain in which specific variants occurred. We stratified by sex and race. Audiograms were averaged for each grouping by participant age to correlate specific genotypes and protein domains with phenotypes over time.

Results

We analyzed data from 10 institutions in 6 countries on 141 individuals with confirmed TMPRSS3 variants. 9 individuals were excluded due to variants in other known hearing loss genes. Grouping by genotype showed 66% M/M, 28% M/LoF, and 6% LoF/LoF. The SRCR domain carried the most variants of any of the TMPRSS3 protein domains. The population was 57% female. Audiologic phenotype analysis by genotype group, demographics and age, pre and post CI, and protein domain is ongoing and will be completed by the time of presentation.

Conclusions and Future Directions

All patients with TMPRSS3 mutation display severe to profound hearing loss. Understanding the natural history of the TMPRSS3 mutations is the first step towards developing interventions. To our knowledge, we have assembled the largest genotypic and phenotypic data set to date on TMPRSS3. M/M genotypes are the most common variations in TMPRSS3. Completion of the audiologic phenotype analysis will determine the severity and progression of each genotype, and analysis after cochlear implantation will determine the efficacy of CI for specific TMPRSS3 variants. This analysis will facilitate robust clinical care and decision making. The most commonly mutated protein domain is the SRCR domain. We will explore the molecular effects of mutations in this domain in the lab to better understand the function of the TMPRSS3 serine protease in hearing and HL.

Roundtable 02

Genetic Landscape of Hearing Loss
RT 02-4

Genetic evaluation and treatment of hearing loss: Are we there yet?

Emre OCAK

Otolaryngology, Ankara University, Türkiye

Emre OCAK, MD, MSc, FEBORL-HNS
Ass. Professor, Department of Otolaryngology, Ankara University
Ankara, TURKEY

In this presentation we will present our experience on genetic evaluation of the patients with hearing loss and possible genetic treatment options with regard to appropriate patient selection for cochlear implantation.
The clinician's role in managing the patient has gone beyond defining the characteristics of the auditory phenotype as knowledge of the genetic basis of hearing loss rapidly develops. Literature and personal experience indicate that the clinicians' knowledge about the genetics of hearing loss will facilitate the timely referral of patients to appropriate specialists and the management of related conditions. Thanks to the advancing technology today, it is possible to diagnose patients with genetic tests, to provide genetic counseling and to ensure that families have children who are not affected by hearing loss. Moreover, it is thought that individuals with genetically-induced hearing loss can be treated in the long term, thanks to gene editing technologies, and studies on the subject are ongoing.

Roundtable 03

Residual Hearing Preservation Ⅱ
RT 03-1

Complete preservation of residual hearing after cochlear implantation with minimal invasive approach

Pu DAI

College of Otolaryngology Head Neck Surg, Chinese PLA General Hospital, China

Background: As the indication for CI have expanded in recent years, residual hearing preservation are important for recipients, which could improve their speech recognition and sound quality. Fully opening the round window membrane, slower insertion speed, and the use of corticosteroids result in a higher rate of hearing preservation was reported previously. This study aims to evaluate the combined value of a minimal invasive procedure and the use of dexamethasone during surgery on complete hearing preservation in patients with functional residual hearing.
Methods: CI recipients with residual hearing from Chinese PLA hospital ENT department was concluded in this study since July 2022 to August 2023. Minimal invasive procedure was performed on all patients by Surgereal 4K 3D exoscope system, which included small incision, sufficient contouring of facial nerve and chorda tympani, fine penetration of round window membrane and slow insertion speed. Dexamethasone was administered at 2mg/kg10mg (0.5mg/kg for children) before insertion and 0.5mg/kg 2.5mg/day(0.1mg/kg for children) preoperatively and postoperatively. Residual hearing was assessed 5 days after postoperatively and the preservation rate was calculated using Skyrynsky's formula .
Results: Fourteen patients were concluded in this study. All the cases were achieved clear contouring of facial nerve and chorda tympani, and round windows were fully exposure. Complete preservation was achieved in 2 cases for full frequency, 6 cases for low frequency. Partial preservation was achieved in 5 cases.
Conclusion: This study underscores the importance of minimal invasive surgical approach with atraumatic round window opening and slow insertion speed based on sufficient facial recess exposure, and the use of dexamethasone for residual hearing preservation.

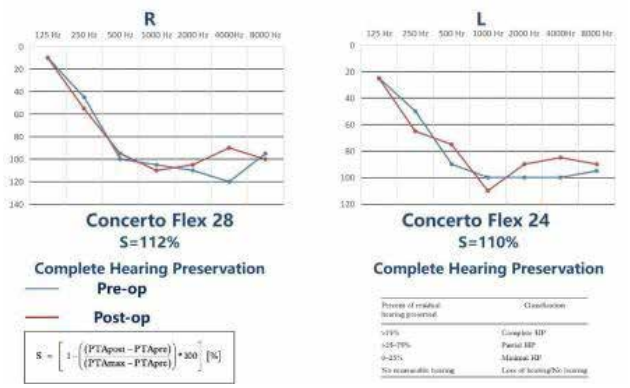

Figure Complete hearing preservation and calculation formula

Roundtable 03

Residual Hearing Preservation Ⅱ
RT 03-2

Hearing Preservation outcomes of lateral wall and perimodolar electrodes at NextSense Cochlear Implant Center, Sydney, Australia.

Melville John DA CRUZ

Sydney Medical School, University of Sydney, Australia

Aim: Evolution in cochlea implant electrode design over the last 40 years has given surgeons, clinicians and patients increasing device choice for rehabilitation of hearing loss. Review of clinical outcomes data for groups of patients receiving either lateral wall or perimodiolar electrodes indicates possible advantages and limitations of each device. This study compares the hearing preservation outcomes of the most used lateral wall electrode (CI522/622) and perimodiolar electrode (CI532/632) at the NextSense Cochlear Implant Centre, Sydney, Australia between April 2015 and January 2021, there by contributing to the evidence base available to clinicians for device choice.

Methodology: The study was conducted on retrospective audiometric data collected prior to cochlear implantation and up to 48 months following switch-on of the device. From an initial cohort of 903 consecutive cases, hearing preservation subset were extracted in patients with preoperative FFPTA of better than 80dB for further analysis of residual post operative hearing. This hearing preservation cohort comprised CI522/622 (n=244) and CI 532/632 (n=89).

Hearing preservation results were calculated as audiometric differences between the pre and post op thresholds averaged over four frequencies (.25,.5, 1, 2kHz), at 250Hz and, as a percentage hearing preservation using a standardized formula. Statistical comparisons of the two electrode groups were made using tests for non-parametric data.

A post-operative averaged threshold changes of less than 20dB was required for reporting of successful hearing preservation. More relaxed criteria were also applied by analysis of hearing preservation at only 250Hz. Calculation of hearing preservation rates for both electrode groups was affected by audiometric selection criteria and threshold levels for successful preservation.

Results: Hearing preservation rates for the CI532/632 device were (n=89, 30% <20dB change, 34% at 250Hz, and 71% for any measurable hearing). Hearing preservation rates for the CI522 device were (n=244, 33% <20dB change, 35% at 250Hz, and 70% for any measurable hearing). Box plots of both datasets were created for presentation. Multi variate analysis was undertaken to look for determinates of successful outcomes including patient characteristics (age, gender) and clinical factors (degree of residual hearing). There was minimal difference between the two groups with minor trends indicating marginally improved preservation rates for younger patients receiving the CI532/632 device.

Conclusion: This study demonstrates modest hearing preservation rates of similar degree for both the lateral and perimodiolar electrodes commonly used. This knowledge can be used as an evidence base in patient discussion and for surgeons in making decisions on electrode choice. Electrode choice is more likely to be based on electrode design characteristics and surgeon preference rather than hearing preservation properties.

Roundtable 03

Residual Hearing Preservation Ⅱ
RT 03-3

CI surgery with slim modiolar electrode

Tadao YOSHIDA

Otorhinolaryngology, Nagoya University, Japan

The Slim Modiolar (CI532/632) electrode, which is designed to be placed close to the cochlear modiolus, has been shown to result in better postoperative outcomes and a lower risk of cochlear damage and scala tympani translocation compared to the Slim Straight (CI522/622) electrode, which is placed on the outer wall of the cochlea. However, the Slim Modiolar is associated with challenges in insertion technique, such as difficulty in sheath insertion and the potential for tip fold-over. In a 2017 report (1) on the early adoption of the Slim Modiolar electrode, a survey of surgeons found that many selected "disagree" or "strongly disagree" in the section "Insertion of the sheath into the cochlea was uncomplicated". The Slim Modiolar electrode is our first choice for normal cochlea and is also used in some cases of incomplete partition type II (IP-II). The Slim Modiolar electrode has a sheath attached to the electrode that is slightly thicker than the Slim Straight electrode. The electrode is inserted after the sheath is in the stopper position, making it difficult in many cases to insert the electrode through the round window. When inserting the Slim Modiolar electrode, we avoid the risk of tip fold-over by opening up the posterior tympanum widely and removing the bony protuberances around the oval window before exposing the round window niche. Additionally, we remove sufficient bone around the oval window and, if necessary, enlarge the round window. As a result, Slim Modiolar electrodes were used in 108 patients, and in 66.7% of these cases, it was possible to insert the electrode through the round window. In 31 ears, it was possible to evaluate electrophysiology and audibility. Neural response telemetry (NRT) thresholds and impedances for the Slim Modiolar were lower at the electrodes around the cochlear cupula than for the Slim Straight. No difference was observed between the two electrodes at the time of surgery or in short-term postoperative hearing and clinical performance. There are many reports from different centers regarding the preservation of residual hearing. The lowest rate reported was 25% (2), and the best preservation rate was 90% (3). The US multicentre study (4) reported a 31% preservation rate in 75 subjects. At our institution, 26 patients with residual hearing of 80 dB or less in one or more of the three lowest frequencies were evaluated for preservation, resulting in a preservation rate of 49.1%. In this report, we compare the surgical techniques and outcomes of the Slim Modiolar and the conventional Slim Straight electrode.

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Roundtable 03

Residual Hearing Preservation Ⅱ
RT 03-4

How clinically useful are efforts to preserve residual hearing in cochlear implant surgery?

Young-Myoung CHUN

Soree Ear Cliic, Soree Ear Clinic, Korea

Background
As EAS begins to be used clinically, the number of people eligible for cochlear implant surgery is expanding significantly. Patients with a significant degree of residual hearing were able to hear sounds that could not be heard with hearing aids through cochlear implants, and on the other hand, various hearing abilities that could not be solved with conventional cochlear implants could be solved through EAS. Preservation of residual hearing is essential for successful EAS, and although advances in electrodes and surgical methods have increased the likelihood of preserving hearing, there has been no standardized guideline that can be predicted before surgery. In particular, it is very difficult to predict the applicability of EAS after surgery uniformly depending on the operator, patient, and type of electrode. This study aims to provide appropriate guidelines based on the clinical experience of the authors to find out how much hearing preservation was actually possible after surgery for patients with varying degrees of residual hearing, and how successfully EAS could be applied depending on the degree of preservation of residual hearing after surgery.

Materials & Methods
Among the patients recommended for cochlear implantation, 134 ears were included in patients who could plan to apply EAS before surgery (patients with a hearing threshold within 70 dBHL that can be sufficiently functional gain with hearing aids in the low-frequency region below 500 HZ). This group was further divided into seven groups according to the residual hearing threshold by frequency as follows: (Gr.1 = threshold below 500Hz to 30dB or less. Gr.2=threshold below 250 Hz and below 30 dB. Gr3=threshold below 30dB at 125Hz. Gr.4=70-30dB threshold below 500Hz. Gr.5=70-30dB threshold below 250Hz. Gr.6=70-30dB threshold below 125Hz). In addition, cases outside this range were classified as Gr.7. The degree of hearing fluctuations was analyzed in adults and children by measuring the residual hearing after surgery for each group, and the use of EAS according to the time fluctuations and hearing fluctuations were analyzed. In addition, the types of electrodes to know the factors affecting hearing preservation outcomes. We analyzed the success of soft surgery and the outcomes according to the patient.

Results
From 1 to 12 months postoperatively, the HP rate was 55-72%, and the HP rate was higher with LFPTA within 30 dBHL (Gr.1-3) than with 30-70 dBHL (Gr.4-6). This was equivalent to successful HP in 87% of cases, which was higher in children (100%) than in adults (80%), with a higher success rate in Gr.1-3 in adults and a higher success rate in all groups in children. Postoperative group variation was group variation in most but about 20%, and Gr.6 or 7 in more than half of the cases. However, in the case of Gr 1-3, which has a lot of low-frequency residual hearing, there was a variation within Gr.5 (adults = 94%, children = 89%), and postoperative EAS was used in 58.8% of adults and 92.6% of children. In adults, 50% of those who went down to Group 6 preferred to use EAS, and most of those who went down to Gr 7 could not use EAS, but in children it was possible to use it at a high frequency in Gr6 and Gr7. In the study of factors affecting hearing preservation, although there was no statistical significance, it was thought that electrodes capable of soft atraumatic and pure RW insertion should be used, and that surgeon's experience and philosophy, as well as the patient's age and medical condition, should be involved.

Conclusions
1.Hearing preservation outcomes vary depending on the individual, but on average, 30-40% of hearing loss is expected after surgery, and 50% of the cases are outside the EAS possible group (Gr.1~5). However, when low-frequency hearing was within 30 dB, the success rate was very high in both adults and children.
2.Despite postoperative hearing fluctuations, it was confirmed that long-term use of postoperative EAS was possible at a very high rate in adults and children who had experience wearing hearing aids before surgery.
3.For successful HP, it is considered that the selection of appropriate electrodes, adherence to surgical principles as much as possible, and a high awareness of the value of residual hearing in cochlear implant surgeons are essential conditions.

Roundtable 03

Residual Hearing Preservation Ⅱ
RT 03-5

Comparison of hearing preservation related to cochlear implantation between slim modiolar and lateral straight electrodes

Byung Yoon CHOI

Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

Roundtable 04

Auditory Brainstem Implant
RT 04-1

Outcomes of minimal invasive surgery and tone acquisition in paediatric ABI in Chinese

Michael Chi Fai TONG

Department of Otorhinolaryngology, Head and Neck Surgery, and Institute of Human Communicative Research, the Chinese University of Hong Kong, Hong Kong SAR

Introduction:
The aim of this study was to review the clinical outcomes and tone acquisition in a cohort of pediatric patients who underwent auditory brainstem implant (ABI) surgery at a single tertiary referral center in Hong Kong SAR, China.

Methods:
We conducted a retrospective analysis of clinical information, surgical outcomes, and complications for 21 patients who underwent ABI using the minimally invasive retrosigmoid approach from 2009 to 2022. The main outcomes of interest were tone acquisition and production.

Results:
Between 2009 and 2022, a total of 21 non-NF2 children aged 18 months to 9 years underwent 25 ABI surgeries at the center. Four of those surgeries were revisions due to implant malfunctions or electrode migration. Post-operative complications included three cases of cerebrospinal fluid (CSF) effusion at the surgical sites and one case of subclinical meningitis, which resolved with intravenous antibiotics. Eventually, all children achieved confirmed auditory stimulation after primary or revision surgeries.

In terms of tone acquisition and production, seven subjects from the cohort underwent adequate assessment. When compared to a group of cochlear implantees, these subjects demonstrated varying degrees of ability to perform tone imitation and production. Generally, a time lag of 1-2 years was observed for the development of these skills. Additionally, a long-term follow-up of 12 children, with three of them surpassing 10 years, revealed that the age of implantation played a significant role in the success of ABI, along with the absence of co-disabilities.

Discussion:
This study highlights the importance of considering potential complications when opting for a minimally invasive approach for pediatric auditory brainstem implant surgery. The findings demonstrate comparable surgical outcomes within a single institution. Additionally, the study showcases the ability of Chinese children to imitate and produce tones, emphasizing the significance of early surgery in achieving favorable long-term outcomes. Further research and follow-up studies are necessary to gain a deeper understanding of the factors influencing the success of ABI in pediatric patients.

Roundtable 04

Auditory Brainstem Implant
RT 04-2

Audiological Outcomes of Auditory Brainstem (ABI) Implant in Postlingual Patients

Ing Ping TANG[1,2]

[1]*ORLHNS, Univesiti Malaysia Sarawak, Malaysia*
[2]*ORLHNS, Sarawak General Hospital, Malaysia*

Auditory brainstem Implant (ABI) is a one of the choices of otological implants for candidate who has postlingual bilateral profound sensorineural hearing loss and is ineligible for cochlear implantation (CI) due to anatomic constraints. The suitable postlingual candidates for ABI can be divided into tumour and non-tumour cases. Bilateral vestibular schwannomas in neurofibromatosis type 2(NF2) is the main cause for tumour cases. For non-tumour cases, the main causes are labyrinthitis ossificans from bacteria meningitis, extensive cochlear otosclerosis and temporal bone fractures that involve the cochlea or internal auditory canal.

NF2 is an autosomal dominant genetic syndrome with increased risk of central nervous system tumours including bilateral vestibular schwannoma, meningiomas and ependymomas. They often develop postlingual profound sensorineural hearing loss as their disease progresses and may not suitable for CI. Recent trials have shown that the majority of NF2 patients implanted with ABI achieve some speech discrimination and environmental sound awareness with meaningful auditory sensations. Minority of ABI users achieve open set speech discrimination and the majority of them still rely on lip-reading to enhance their verbal communication needs.

For non-tumour postlingual cases, recent data revealed superior audiological outcomes with ABI, when compared with NF2 patients. A significant number of non-tumour patients (cochlear ossification cases and bilateral labyrinthine fractures in head trauma) achieve open set speech perception and recognition and could engage in normal conversation without lip reading.

We have performed 9 cases of ABI in postlingual patients from June 2016 to June 2023. The patients' age ranged 27 to 59 years old. Seven patients had neurofibromatosis Type 2 (NF2) with bilateral acoustic neuromas and 2 patients had post meningitis cochlear ossification bilaterally. All of them implanted via translabyrinthine approach with most of them had 12 electrodes stimulated during switch on at 2 months post surgery. Their hearing was restored significantly after the implantations. However, the improvement was variable. Both patients with cochlear ossifications performed better compared with NF2 patients audiologically during follow up.

Despite the improvement in current ABI technology with multi-channel ABI system, several challenges still remained. The most notable limitation is the unpredictable and often highly variable audiological outcomes especially in NF2 patients. The location and size of the tumour, the duration of deafness, the surgical removal techniques, position of the ABI array, number of pitch electrodes, perceptual levels, ABI stimulation rate and non-auditory side effects may determine the final audiological outcomes in postlingual hearing loss ABI patients.

Roundtable 04

Auditory Brainstem Implant
RT 04-3

Using the test electrode to decide between cochlear implants and ABI in vestibular schwannoma patients

Javier GAVILAN

Otorhinolaryngology, La Paz University Hospital, Spain

In patients with bilateral vestibular schwannomas (VS) and those with VS in the only hearing ear there are only two options two restore hearing after tumor removal. These are auditory brainstem implants (ABI) and cochlear implants. As an overall rule, the outcomes of cochlear implants are better than those with ABI.
For a cochlear implant to be an option in these patients we need to preserve the anatomy of the nerve, as well as its function. Preserving the anatomy of the cochlear nerve is possible especially in small tumors. However, anatomical preservation does not always result in function preservation. To assess the function of the cochlear nerve after VS removal, we have designed an intracochlear test electrode that allows intraoperative electrophysiological measurement of electrical auditory brainstem responses (eABR), thus providing sensible information of the functional status of the nerve once the tumor has been removed.
To assess the validity of intraoperative eABR measurements with the test electrode we have compared the eABR obtained with this system with the eABR elicited by cochlear implants in regular patients submitted for cochlear implantation.

Roundtable 04

Auditory Brainstem Implant
RT 04-4

Pediatric Auditory Brainstem Implantation: Surgical Considerations

Mohan KAMESWARAN

Ent, Madras Ent Research Foundation, Chennai, India

Introduction: Auditory Brainstem Implant (ABI) is increasingly used for non-tumoral indications, especially in pre-lingually deaf children born with bilateral cochlear / cochlear nerve aplasia. Apart from cochlear aplasia and cochlear nerve aplasia, complete labyrinthine aplasia, cochlear aperture aplasia are well-defined congenital indications for ABI. The ABI bypasses the cochlear nerve and directly stimulates the cochlear nucleus in the brainstem.
Objectives: This work reflects the pediatric ABI experience over two decades. 83 children with bilateral cochlear aplasia and cochlear nerve aplasia underwent ABI surgery using the retrosigmoid approach. The surgical considerations, anatomical variants and intra-operative difficulties of auditory brainstem implantation in a series of 83 pediatric ABI recipients will be presented.
Results: The surgical issues encountered were managed successfully in all patients. Flocculus of the cerebellum was found to be of different grades and was classified into four types. In patients with higher flocculus grading, more dissection of flocculus / retraction was required for visualization of root entry zone of lower cranial nerves. Higher flocculus grading was also associated with temporary vestibular disturbance post-operatively. Higher flocculus grading did not impact the outcomes. Longer duration of habilitation is required after ABI to achieve optimal auditory and speech development.
Conclusion: Indications for pediatric ABI have evolved over the years. Appropriate selection of patients, thorough knowledge of anatomy, meticulous surgical technique and intensive post-operative habilitation are vital to achieve optimal outcomes. Higher grading of flocculus can make the placement of ABI electrodes difficult but does not affect ABI outcomes.

APSCI Prize Session 01

Basic Research
AP 01-1

Genomic Foundation of Sensorineural Hearing Loss

Sang-Yeon LEE[1], Myung-Whan SUH[1], Moo Kyun PARK[1], Jun Ho LEE[1], Seung Ha OH[1]

[1]Department of Otorhinolaryngology, Seoul National University College of Medicine, Seoul National University Hospital, Korea

Sensorineural hearing loss (SNHL) is a prevalent sensory disorder with genetic factors contributing to 50% of cases. Despite advances in understanding the genetic architecture of SNHL in humans, the genome-wide landscape and associated phenotypic attributes of SNHL remained poorly understood. Through a stepwise genomic approach from single-gene sequencing to whole-genome sequencing (WGS) on a prospective cohort of 394 Korean families with SNHL, we discovered various genomic alterations in SNHL-related genes that were detectable only through WGS, achieving additional diagnostic yield of 23.6% in previously undiagnosed patients. This finding also informed clinical managements and facilitated targeted therapies such as antisense oligonucleotide-based gene therapy that are therefore awaiting clinical trials. On multivariate analysis, early identification of SNHL and a family history correlated with enhanced overall diagnostic yield. Furthermore, previously captured, clinically relevant pathogenic coding variants uplifted the genetic diagnosis through WGS. These data constructed a comprehensive phenotypic and genotypic map (Rare-grid Plot), highlighting the mutational drift associated with specific clinical manifestations and uncovering distinct phenotypes linked to the molecular mechanisms of inner-ear functions. Our stepwise genomic approach, encompassing WGS, defines the clinical utility of WGS in improving diagnostic yield and facilitating effective clinical adaptation, and develops the comprehensive map of SNHL to identify previously undescribed genotype-phenotype correlations and guide clinical interventions.

Keywords : Sensorineural hearing loss, Cohort, Whole-genome sequencing

APSCI Prize Session 01

Basic Research
AP 01-2

BEARS (Both Ears) - Virtual Reality training to improve binaural hearing in children

Helen CULLINGTON[1], Deborah VICKERS[2], Dan JIANG[3]

[1]Auditory Implant Service, University of Southampton, UK
[2]Department of Clinical Neurosciences, University of Cambridge, UK
[3]Hearing Implant Centre, Guy's and St Thomas' Nhs Foundation Trust, UK

Background and aims
Although people with bilateral cochlear implants typically have better sound localisation and speech-in-noise perception than those with one implant, these skills are far below people with normal hearing. There is evidence to show that computer-based training improves speech-in-noise perception for people with bilateral cochlear implants.

We used participatory design to develop virtual reality (VR) games to help children and young people with bilateral cochlear implants hear better in noise. The stakeholders involved were children and young people using bilateral implants, family and friends, teachers, engineers and developers, speech and language therapists, music therapists, and audiologists.

Method
We are running an eleven-centre trial of the games for children aged 8 to 16. The games involve speech-in-noise perception, music listening, and sound-source localisation. Recruitment target is 384. Participants are randomised to either use the VR games at home for 3 months or follow their usual care pathway.

Results
The primary outcome measure is the difference between baseline and 3 month score on the spatial speech in noise (SSiN-VA) test, with secondary outcomes of scores at three and 12 months on other measures of spatial hearing, language, and quality of life. We are also assessing health economic outcomes. Recruitment began in May 2023 and continues until September 2024; we will present early results.

Conclusion
If using the BEARS games significantly improves spatial hearing and/or quality of life in children and young people with cochlear implants, we will be scaling up the intervention across all UK centres offering bilateral cochlear implants to children.

Keywords : Binaural hearing, Virtual reality, Telemedicine

APSCI Prize Session 01

Basic Research
AP 01-3

Prediction of Cochlear Implant Fitting by Machine Learning Techniques

Hajime KOYAMA[1], Akinori KASHIO[1],
Tatsuya YAMASOBA[1]

[1] 1) department of Otolaryngology and Head and Neck Surgery, The University of Tokyo Hospital, Japan

Objective
The study aimed to evaluate the correlation between the evoked compound action potential (ECAP) thresholds and postoperative T levels in children who underwent cochlear implantation and to create machine learning models to predict T levels more accurately.
Methods
We reviewed the charts of 124 ears of children with severe to profound hearing loss who underwent cochlear implantation of the Nucleus CI device. ECAP thresholds and T levels from different electrodes were compared, and correlations between ECAP thresholds and T levels were calculated. Machine learning prediction models of T levels at switch-on and 6 months after surgery were created. The accuracy of prediction was estimated by the mean percent error (MPE) in each model.
Results
ECAP thresholds of slim modiolar electrodes were significantly lower than those of straight electrodes on the apical and intermediate sides, but there was no significant difference in NRT thresholds between the two electrodes on the basal side. At switch-on mapping, T levels of the slim modiolar electrodes were significantly lower than those of the straight electrodes in many mid to basal electrodes, but at 6 months postoperatively, the difference was significant only in the apical electrodes. The machine learning prediction model showed that lasso regression achieved the most accurate prediction of T levels at switch-on (MPE = 11.1%) and the random forest algorithm achieved the most accurate prediction of T levels at 6 months after surgery (MPE = 9.6%).
Conclusion
Correlation coefficients between ECAP thresholds and T levels were affected by electrode type, with basal side electrodes having low correlation coefficients for all electrode types. Machine learning techniques including clinical data other than ECAP thresholds allowed high prediction even in the basal side and therefore may be a useful tool for accurate prediction of postoperative T levels after cochlear implantation in children.

Keywords : Machine learning, Children, Fitting

APSCI Prize Session 01

Basic Research
AP 01-4

Long term effects of early age at cochlear implantation on metaphor comprehension in Swedish adolescents and young adults

Malin DAHLBY SKOOG[1], Tamara KALANDADZE[2],
Björn LYXELL[3], Eva KARLTORP[1], Ulrika LÖFKVIST[1,4]

[1]Department of Clinical Science, Intervention and Technology, Karolinska Institute, Sweden
[2]Department of Education, Ict and Learning, Østfold University College, Norway
[3]Department of Special Needs Education, University of Oslo, Norway
[4]Department of Public Health and Caring Sciences, Uppsala University, Sweden

Introduction: Early age at cochlear implantation (CI) in congenitally deaf children has positive effects on early spoken language by reducing the period of auditory deprivation. There is an urgent need for more research on the long-term effects of early implantation on higher-level language skills. Higher-level language includes figurative language, such as metaphors, where words are used beyond their literal meaning. Metaphor comprehension starts to develop early in childhood and continues through adolescence. The mechanisms behind understanding metaphors has not been fully explained, but core language skills, executive functions and theory of mind are of importance.
The aim of this study is to investigate long term effects of early cochlear implantation on metaphor comprehension in Swedish adolescents and young adults, both in comparison with normal hearing peers and in relation to age at 1st cochlear implantation.
Knowing that early age at 1st CI has positive effects on core language skills and cognitive processing, we expect that early age at CI will also have a positive effect on the understanding of metaphors.
Methods: Data collection is ongoing, with the final cohort estimated to be around 47 individuals (12 to 21 years old, fitted with CI before 30 months of age) and an age matched control group with normal hearing. Metaphor comprehension is measured using a multiple-choice task. Linguistic and cognitive skills (including vocabulary, reading and executive functions) are assessed using standardized tests.
Results: Preliminary analysis of results from 20 individuals (mean age 16,6 years, mean age at CI 15,8 months +- 6,8) indicate a moderate negative correlation ($r = -0.48$, $p<0.05$) between metaphor comprehension and age at implantation. The final results will be presented at the conference.
Conclusions: Preliminary results indicate that earlier age at 1st CI is associated with better metaphor comprehension in adolescents and young adults growing up with CI.

Keywords : Early cochlear implantation, Linguistic development, Metaphor comprehension

APSCI Prize Session 01

Basic Research
AP 01-5

Attentional modulation of brain responses is related to speech perception abilities in cochlear implant users.

Ji-Hye HAN[1], Andrew DIMITRIJEVIC[2]

[1]Laboratory of Brain & Cognitive Sciences For convergence Medicine, Allym University College of Medicine, Korea
[2]Sunnybrook Health Science Centre, Otolaryngology-head and Neck Surgery, University of Toronto, Canada

The sources of variability of outcomes after cochlear implant (CI) surgery are largely unknown but may be related to cognitive factors such as attention and memory. In this report we demonstrate that attentional modulation of brain responses is related to speech perception in CI users. Adult CI users performed a consonant identification task while multichannel electrophysiological data was recorded. Cortical evoked potentials and oscillatory brain activity were related to speech perception outcomes. We found that high performing CI users showed systematic latency changes in auditory cortical potentials while poor performers showed no such change. Importantly, when the CI users passively listened to the identical stimuli no differences were observed between high and low performers. Frontal and temporal beta and alpha oscillations differed among the high and low performers and were predicative of speech perception scores. The results of this study demonstrate that performance variability in CI users is related to the degree of attentional modulation of electrophysiological responses.

Keywords : Neural Oscillations, Cochlear implants, Cognition and Behavior

APSCI Prize Session 01

Basic Research
AP 01-6

Preoperative estimation of surviving neurons at different cochlear sites in partially deaf rats using the electrically evoked auditory brainstem response

Woonhoe GOO[1], Doo-Hee KIM[1,2], Woongsang SUNWOO[1,3], **Seung-Ha OH**[1]

[1]Department of Otorhinolaryngology, Seoul National University Hospital, Korea
[2]Cochlear Implant Business, Todoc Co., Ltd, Korea
[3]Department of Otorhinolaryngology, Gil Medical Center, Gachon University College of Medicine, Korea

The measurement of electrically evoked compound action potential (ECAP) through the cochlear implant (CI) system has been used to estimate the function of surviving spiral ganglion neurons (SGN). However, ECAP recordings are only possible after an intracochlear electrode insertion. Instead, electrically evoked auditory brainstem responses (eEABR) by extracochlear stimulation can be measured preoperatively. To date, there are only a few studies on eEABR parameters, and even fewer investigating the dependence on cochlear sites. To identify possible predictors for the SGN status of different regions, eEABR was recorded at 3 different positions in partially deafened rats (n = 6). Applying Ouabain to the round window membrane induced selective SGN loss after 3 days. Neural degeneration was greatest near the round window and decreased toward the apex. Place-specific extracochlear stimulation was achieved by positioning a ladle shape electrode on the cochlear surface and the return electrode in the round window niche. We obtained N3P4 amplitude growth functions (AGF) from each position (100-1000 μA with 2 dB steps). We correlated eEABR parameters to functional (ABR threshold) and histological measures (SGN density) of the neural status of different cochlear regions. Consistent with histologic findings, a gradient of ABR thresholds was observed at high frequencies. For the basal and middle electrodes, slopes and maximum amplitudes of AGF were negatively correlated to the degree of hearing loss at high frequencies (20k-28k Hz). In contrast, when placing the electrode on the apical region that had relatively normal SGN density, none of the parameters exhibited significant correlations with ABR thresholds. The eEABR threshold did not correlate with functional deficits at all positions. These findings suggest that preoperative measurement of the eEABR on different cochlear sites could estimate the status of SGNs along the CI electrode array, which could be useful in a CI consultation with individual patients.

Keywords : Electrical stimulation, Spiral ganglion neurons, Cochlear implant

APSCI Prize Session 01

Basic Research
AP 01-7

Assessment of Music Perception(AMP) and Music Rehabilitation Program (MRP) for Cochlear Implant users

Sungmin JO[1,2], Seung-Ik JEON[1,3,4], Chaeyeon YU[1], **Jinsook KIM[1,5]**

[1]Department of Speech Pathology and Audiology, Graduate School, Hallym University, Chuncheon, Korea
[2]Department of Otorhinolaryngology-head and Neck Surgery, Seoul National University Hospital, Seoul, Korea
[3]Laboratory of Brain & Cognitive Sciences For Convergence Medicine, Hallym University College of Medicine, Korea
[4]Ear and Interaction Center, Doheun Institute For Digital Innovation in Medicine(d.i.d.i.m.), Korea
[5]Division of Speech Pathology and Audiology, Research Institute of Audiology and Speech Pathology, College of Natural Sciences, Hallym University, Chuncheon, Korea

Introduction: As music perception ability is important for quality of life for the hearing impaired(HI), accurate assessment of music perception and competent rehabilitation are necessary. The study aimed to develop and apply the Assessment of Music Perception(AMP) and the Music Rehabilitation Program(MRP) based on Korean culture for facilitating auditory, language, and cognitive development of the brain for the HI through music enjoyment ability.
Method: The AMP was developed with six subtests, pitch, melody, rhythm, timbre, emotional reaction, and harmony perception tests based on the data of 15 normal hearing and 15 cochlear implant(CI). In particular, Korean traditional music elements were mixed. The main component of MRP was also developed orienting six subtests of AMP with analytic and synthetic approaches including discrimination, identification, and supposition. The objective measurement, mismatch negativity(MMN) and developed questionnaire 'Music Listening Attitude and Satisfaction Questionnaire for Hearing loss(MASQ_H)' were also performed. The MRP was executed twice per week through self-directed home training for two months. The AMP was tested before and after the MRP.
Result: After applying MRP, the scores of the AMP subtest were improved. Especially, the pitch, timbre, and harmony perception test scores showed significant differences ($p<.01$). The difference in each test's score was 22.7%, 15%, 11.3%, and 15.2% for pitch, timbre with Korean musical instruments, timbre with western musical instruments, and harmony subtests and the difference area of MMN was 319.71μV·ms ($p<.01$).
Conclusion: After conducting MRP, CI users' music perception ability was improved. According to MASQ_H, the CI users answered listening to music became very interesting and showed strong desires to listen to music following rehabilitation. This study confirmed that MRP could improve language processing by facilitating auditory processing, cognitive ability, and neural plasticity of the central auditory system. The active implementation of music rehabilitation is strongly suggested.

Keywords : Cochlear implant, Music perception, Music rehabilitation

APSCI Prize Session 01

Basic Research
AP 01-8

Early postoperative benefit in receptive and expressive language development of cochlear implantation under 9 months of age in comparison to those implanted at later ages

Seung Jae LEE[1], Heonjeong OH[2], Sung Min PARK[2], Do Hyun JUNG[2], Jiyeon YANG[2], Yehree KIM[2], Bong Jik KIM[3], **Byung Yoon CHOI[2]**

[1]1department of Otorhinolaryngology-head and Neck Surgery, Inje University Ilsan Paik Hospital,, Korea
[2]Department of Otorhinolaryngology-head and Neck Surgery, Seoul National University Bundang Hospital, Korea
[3]Department of Otolaryngology—head and Neck Surgery, Chungnam National University College of Medicine, Korea

Purpose
Recently, FDA expanded eligibility of cochlear implantation (CI) to include infants as young as 9 months. Further, a very recent report demonstrated superior language development in the < 9 months group. However, early postoperative trajectory of language development from the < 9 months group in comparison to those implanted at later ages is still lacking. Herein we aim to provide such data.

Materials and Methods
We retrospectively reviewed 80 children who underwent the first CI under 18 months of age at SNUBH. In this cohort, CI timing was decided based on hearing thresholds and speech developmental status. 41 kids (7.0 mo ± 1.0) were enrolled in the off-label CI group (< 9 months of age:) and another 25 (9.9 ± 6.9mo) and the other 14 (14.0+ 3.3 mo) were classified as the early CI group (9 < to <12 m) and delayed CI group (12< to 18mo), respectively. Excluding cochlear nerve deficiency cases, we compared the early trajectories of SELSI-based receptive and expressive language development among groups.

Results
The off-label CI group (< 9 months) showed significantly better SELSI receptive percentiles at every timepoints throughout post implant 1 year and at 24 months of age than the early CI group and delayed CI Group. Of note, the off-label CI already reached the equivalent SELSI receptive age to normal hearing peers even at 24 months of age, while did not the early and delayed CI group.
Conclusion
Our findings, for the first time, show that early postimplant 1-year trajectories of SELSI receptive and/or expressive languages from very early CI group (< 9 months) exceeds even those from the early CI group (9 < to 12 mo) and those implanted later, supporting consideration of even earlier CI among etiologically-documented and speech-delayed infants, not restricted to FDA labeling criteria (> 9 months).

Keywords : Cochlear implantation, Early, 9 months

APSCI Prize Session 01

Basic Research
AP 01-9

Ensuring Auditory Cortex Activation: optimisation of a cochlear implant and its outcomes

Dayse TAVORA-VIEIRA[1,2,3], Andre WEDEKIND[1,2], Marcus VOOLA[1,2], Aanand ACHARYA[1,2]

[1]Audiology / Ent, Fiona Stanley Fremantle Hospital Group, Australia
[2]School of Surgery, The University of Western Australia, Australia
[3]School of Population Health, Curtin University, Australia

Background: The current standard programming of hearing implants relies heavily on subjective feedback from patients. However, subjective responses may not be reliable, particularly in children and patients with cognitive impairments. CAEPs may potentially remove these subjective factors and reduce the time needed to create an optimal map that produces the best hearing outcomes.

Objectives: The aim of this study was to investigate whether acoustic CAEP (aCAEP) measures could be used to verify the cochlear implant (CI) map and improve outcomes in adults with single-sided deafness (SSD) or bilateral hearing loss.

Methods: aCAEPs were measured in CI recipients using speech tokens /m/, /g/, /t/ and /s/. If aCAEP responses were present for all speech tokens, the participant's map was considered optimised and no map adjustments were implemented. If aCAEP responses were absent for one or more tokens, the CI map was considered deficient and therefore adjusted, and CAEP measures were repeated. Speech testing was conducted pre-CI, as well as before and after CAEP-guided map adjustments.

Results: Sixty-seven SSD-CI and 108 unilateral CI users participated in this study. All CIs had been mapped according to the conventional loudness perception method. Sixty-five users exhibited an aCAEP response for all four speech tokens and were therefore considered optimised at the outset. One hundred ten participants lacked an aCAEP response from at least one speech token and had their CI map adjusted accordingly. Of these, map adjustments allowed aCAEPs to be elicited for all four speech tokens in 54 individuals. Speech perception in quiet and in noise scores significantly improved pre- to post-aCAEP based adjustment.

Conclusion: aCAEP recordings were successfully used to verify CI mapping and improved resultant speech outcomes in CI users. This objective tool has the potential to overcome the limitations of subjective feedback and improve the efficiency and effectiveness of CI mapping.

Keywords : ACAEP, CI, Optimisation

APSCI Prize Session 02

Clinical Research
AP 02-1

Auditory performance and speech intelligibility development after cochlear implantation in children with additional disabilities

Shujiro MINAMI[1], Chieko ENOMOTO[1], Hidetoshi KATO[1], Natsumi TACHIBANA[1], Motoko IHARA[1], Kimitaka KAGA[1]

[1]*Department of Otolaryngology, National Hospital Organization Tokyo Medical Center, Japan*

Approximately 40% of deaf or hard of hearing (D/HH) children face medical or developmental challenges, including intellectual disabilities (ID), Attention Deficit Hyperactivity Disorder (ADHD), and Autism Spectrum Disorder (ASD). The 2022 pediatric cochlear implant (CI) candidacy criteria in Japan emphasize that D/HH children with additional disabilities require careful CI consideration if auditory compensation with CI is expected to be effective. This study investigates the outcomes of 58 CI D/HH children with ID, ADHD, or ASD, using the Revised Category of Auditory Performance (R-CAP; 0-12) and Speech Intelligibility Rating (SIR; 1-5).

Out of the 58 children, 35 were identified as having ASD exclusively or in combination with ADHD or ID, and 23 children were classified as having ADHD or ID. The median age for the first CI surgery was 29.5 months, and the median age for assessment was 86.5 months. Forty-three children (74%) displayed no or mild inner ear malformation (Grade 0 or I: modiolus present + normal cochlear nerve), while 15 (26%) had severe malformations (Grade II: modiolus deficiency + normal cochlear nerve or III: modiolus present + cochlear nerve deficiency).
Among the CI D/HH children with multiple disabilities and Grade 0-I malformations, 60% reached level 8 of R-CAP (understanding conversations with familiar speakers) or higher. In contrast, only 13% of children with Grade II-III malformations achieved this level. SIR was evaluated for 36 school-aged children. Among the CI D/HH children with multiple disabilities and Grade 0-I malformations, 59% attained level 3 of SIR (connected speech is intelligible to a listener who concentrates and lipreads) or higher, whereas 22% of children with Grade II-III malformations reached this level. This study indicates that D/HH children with additional disabilities can achieve level 8 of R-CAP through timely CI surgeries, provided they do not have inner ear malformations.

Keywords : Intellectual disability, Attention Deficit Hyperactivity Disorder, Autism Spectrum Disorder

APSCI Prize Session 02

Clinical Research
AP 02-2

Implementation of the International Classification of Functioning, Disability and Health model in Cochlear Implant recipients: a multi-center prospective follow-up cohort study

Ellen ANDRIES[1,2], Artur LORENS[3], Piotr Henryk SKARŻYŃSKI[3], Henryk SKARŻYŃSKI[3], Miryam CALVINO[4,5], Javier GAVILÁN[4], Luis LASSALETTA[4,5], Dayse TAVORA-VIEIRA[6,7,8], Aanand ACHARYA[6,7,8], Anja KURZ[9], Rudolf HAGEN[9], Ilona ANDERSON[10], Edda AMANN[10], Paul VAN DE HEYNING[1,2], Vincent VAN ROMPAEY[1,2], Griet MERTENS[1,2]

[1]Department of Otorhinolaryngology, Head and Neck Surgery, Antwerp University Hospital, Belgium
[2]Experimental Laboratory of Translational Neurosciences and Dento-otolaryngology, Faculty of Medicine and Health Sciences, University of Antwerp (ua), Belgium
[3]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[4]Department of Otolaryngology, La Paz University Hospital, Spain
[5]Biomedical Research Networking Centre On Rare Diseases (ciberer-u761), Institute of Health Carlos Iii, Spain
[6]Department of Otolaryngology, Fiona Stanley Fremantle Hospitals Group, Australia
[7]Division of Surgery, Medical School, Australia
[8]School of Occupational Therapy, Social Work and Speech Pathology Faculty of Health Sciences, Curtin University, Australia
[9]Department of Otolaryngology, University Clinic of Würzburg, Germany
[10]Clinical Research Department, Med-el Gmbh, Austria

Objectives: To define a Cochlear Implant (CI) outcome assessment protocol based on the International Classification of Functioning, Disability and Health (ICF) model and apply it in clinical routine.

Design: An international multidisciplinary core group of CI experts selected the most relevant ICF categories and codes for CI users out of the existing ICF core set for hearing loss. A well-known commonly used and internationally validated instrument or method was identified and assigned to each ICF category along with quantified ICF qualifiers. The ICF-based CI outcome assessment protocol was applied in clinical routine in a prospective longitudinal multicenter study assessing a consecutive sample of 72 adult CI candidates before and six months after implantation.

Results: The ICF-based CI outcome assessment protocol was successfully implemented and positively received in all participating centers. Overall, the CI users in our study either improved or showed stable ICF qualifiers after cochlear implantation across all ICF domains (e.g., Body Functions and Structures, Activities and Participation and Environmental factors). Auditory perception-related and communication-related categories generally improved the most after cochlear implantation, with 46% to 73% of CI users perceiving an improvement postoperatively.

Conclusion: The ICF-based CI outcome assessment protocol provides a common language and comprehensive assessment protocol for the description and measurement of CI outcomes worldwide. It can and should be adopted in the rehabilitation process of CI users to enable a patient-centered approach, addressing a unique combination of not only body functions and structure impairments but also relevant activity limitations, participation restrictions and environmental barriers, which would ultimately benefit CI outcomes.

Keywords : Cochlear Implantation, International Classification of Functioning, Disability and Health, Outcome Measurement

APSCI Prize Session 02

Clinical Research
AP 02-3

Assessment of Intracochlear Positioning of Electrode Arrays in Recipients of Cochlear Implants using Intraoperative Handheld Digital X-ray

Hyong-Ho CHO[1], Bong-Jin SHIN[1], Sungsu LEE[1]

[1]*Otolaryngology-head & Neck Surgery, Chonnam National University Medical School, Korea*

Background: Intraoperative imaging of cochlear implant (CI) electrode placement plays a crucial role in ensuring optimal outcomes, particularly for Nucleus precurved cochlear implants. The advent of handheld digital x-ray devices in the operating room has introduced a quick and accessible radiological feedback tool. This study aimed to explore the utility of handheld digital x-ray in assessing the positioning of electrode arrays following CI procedures.

Methods: A retrospective analysis was conducted on a cohort of 11 patients (12 ears) who underwent CI between December 2021 and January 2023. Intraoperative imaging using a handheld x-ray device (MINE AINU®, OTOM, Gwangju, Korea) was performed immediately after electrode array placement. The resulting images were compared with C-arm images and post-operative trans-orbital view x-rays.

Results: Intraoperative imaging was successfully conducted in all cases, revealing the correct placement of the electrode array within the cochlea. The study included 9 cases of Nucleus precurved electrode, 1 case of Nucleus contour electrode, and 2 cases of Medel flex26 electrode. A single instance of tip fold over in the implanted array was identified. The supine position provided the best visualization for determining electrode position in the anterior-posterior direction. Handheld digital x-rays also demonstrated effective visualization of electrode placement in pediatric patients.

Conclusions: The utilization of intraoperative handheld digital x-ray with the MINE AINU® device proved to be a safe, rapid, user-friendly, and dependable procedure for immediate identification of inserted electrode arrays. It offers a viable alternative to C-arm x-ray for assessing electrode positioning within the operating room, thus enhancing surgical guidance during cochlear implantation procedures.

Keywords : Diagnostic Imaging, Cochlear Implantation, Electrodes

APSCI Prize Session 02

Clinical Research
AP 02-4

Comparing clinical features of Off-the ear and Behind-the ear Speech processor users

Sung-Min PARK[1], **Byung Yoon CHOI**[1]

[1]*Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea*

Objectives: To analyze characteristics of patients who choose Off-the-ear (OTE) or Behind-the-ear (BTE) speech processor against the other.

Methods: Cochlear implant surgeries between January 2021 and February 2023 were retrospectively analyzed from the database of the department of otorhinolaryngology of Bundang Seoul National University.

Results: Among total subjects, 168 (37.2%) participants were using an off-the-ear sound processor, while 284 (62.8%) participants were using a behind-the-ear sound processor. Among 162 ears without severe inner ear anomaly in children, 67 (41.4%) use OTE and 95 (58.6%) use BTE. Meanwhile, among 48 ears with severe inner anomalies in children, 44 (91.7 %) use BTE and 4 (8.3%) use OTE. BTE was much more preferred than OTE in children with severe inner ear anomaly. Magnet strength of two different speech processors were compared. In total patients, the magnet strength was significantly greater in OTE users (2.86±1.34) than BTE users. In pediatric patients, the magnet strength was also greater in OTE users (2.16±1.36) than BTE users. Revision cases tend to be more frequent in malformation group (3, 6.3%) than non-malformation group (2, 1.2%), but it was not significantly different. Among BTE patients aged 2 years or younger, the magnet strength of revision group (1.39±0.57) was significantly greater than that of non-revision group (1.00±0.55)($p = 0.002$). In the cases of patients who strongly wanted OTE (7.7%), we placed the coil over the muscle at a higher rate than in those eager to use BTE (3.9%). The difference was not significant.

Conclusion: Children with severe inner ear anomalies are recommended to use BTE than OTE. For those who are eager to use the OTE device, positioning the coil part over the muscle layer could help. Use of stronger magnet strength was noticed in revision cases due to flap problems than in non-revision cases.

Keywords : Speech processor, Magnet strength, Revision

APSCI Prize Session 02

Clinical Research
AP 02-5

Surgical and auditory outcomes of cochlear implantation in children with CHARGE syndrome

Yun Ji LEE[1], Jee Yeon LEE[1], Woo Seok KANG[1], Joong Ho AHN[1], Hong Ju PARK[1], **Jong Woo CHUNG[1]**, Yeonjoo CHOI[1]

[1]Otorhinolaryngology-head and Neck Surgery, Asan Medical Center University of Ulsan College of Medicine, Korea

Objectives: The purpose of this study is to analyze the co-existing anomalies and performed cochlear implantation (CI) procedures in patients with CHARGE syndrome. Furthermore, we aim to investigate the outcomes of surgery and the level of language development in these patients.
Methods: A retrospective analysis was conducted on cases of CHARGE syndrome patients who underwent CI in our hospital from 2008 to 2019. Inner ear anomalies were ascertained using computed tomography (CT) and magnetic resonance imaging (MRI) modalities. The surgical procedures were scrutinized according to the operative records. Speech and language levels were assessed using the Meaningful Auditory Integration Scale (MAIS) and Categories of Auditory Performance (CAP) score before and after surgery.
Results: A total of 22 patients (37 ears) were included in our study. The mean age was 6.7 years (range 1-15 years). Fifteen patients (68.2%) underwent bilateral CI and revision CI was performed in 6 (27.3%) patients. The proportion of inner ear anomalies among 37 ears is as follows: Incomplete partition (IP) type II (13 ears, 35.1%), vestibular dysplasia (27 ears, 73%), semicircular canal dysplasia (34 ears, 92%), bony cochlear nerve canal stenosis (22 ears, 59.5%), and facial nerve anomaly (20 ears, 54.1%). When comparing the MAIS and CAP scores before surgery, 1-year and 5-year after surgery, significant improvement over time was observed ($p < 0.005$). In cases with IP type II deformity, the auditory performance tended to be worse. (MAIS; postop 1-yr $p=0.09$, postop 5-yr $p=0.007$)
Conclusion: In CHARGE syndrome, significant improvement in language development was observed during long-term follow-up after CI. Even in cases with inner ear anomalies, performing CI after careful examination before surgery can lead to favorable results.

Keywords : CHARGE syndrome, Inner ear anomaly, Facial nerve

APSCI Prize Session 02

Clinical Research
AP 02-6

The effect of intracochlear electrode design on electrically evoked compound action potential growth and spread of excitation functions

Jeong-Seo KIM[1], Sung Hwa HONG[2], Il Joon MOON[1,3]

[1]Hearing Research Laboratory, Samsung Medical Center, Korea
[2]Department of Otolaryngology, Myongji Hospital, Korea
[3]Department of Otolaryngology - Head and Neck Surgery, Sungkyunkwan University School of Medicine, Korea

Introduction: Cochlear implant (CI) electrode design has changed over the years. Perimodiolar electrode, a traditional design with electrode contacts positioned closer to the modiolus, has been transformed to be slimmer and softer. Lateral wall straight electrode, a relatively newer design with electrode contacts seated further from the modiolus, has been used with an increasing interest in less traumatic surgery and preserving residual acoustic hearing. Changes in intracochlear electrode design might influence the spread of neural activation and the number of independent channels. This study aimed to objectively characterize the influence of the intracochlear electrode design on neural excitation of the peripheral auditory system.
Methods: Thirty-seven adults who were implanted with Nucleus CI participated in this study. Twenty were implanted with lateral wall straight electrode (i.e., Nucleus CI522, 622), while seventeen were implanted with perimodiolar electrode (i.e., Nucleus CI532, 632). Electrically-evoked compound action potential (ECAP) was recorded via neural response telemetry from three electrodes (E6, 11, 17) across various levels to generate ECAP growth function and the spread of excitation (SOE) function. ECAP threshold and slope of the growth function, width at a half peak of the SOE function (SOE width), and electrode impedance were compared between groups.
Results: ECAP thresholds and slopes were not significantly different between the two groups. SOE widths quantifying channel interaction were significantly larger in subjects with lateral wall straight electrode, indicating a wider spread of excitation compared to those with perimodiolar electrode. Electrode impedance was considerably lower in the periomodiolar electrode group.
Conclusion: Perimodiolar electrode group exhibited significantly narrower SOE widths compared to the lateral wall electrode group. This indicates that the electrode array that hugged the modiolus had less overlap in neural excitation between adjacent electrodes, which results in reduced channel interaction and potentially better spectral resolution than the electrode array positioned more laterally.

Keywords : ECAP, Spread of Excitation, Channel Interaction

APSCI Prize Session 02

Clinical Research
AP 02-7

Post Cochlear Implantation Vertigo: Ictal Nystagmus and Audio-Vestibular Test Characteristics

Belinda Y C KWOK[1,2], Allison S YOUNG[1,2], Jonathan H K KONG[3,4,5], Catherine S BIRMAN[3,4,5], Sean FLANAGAN[6], Simon L GREENBERG[7], William P GIBSON[3], Emma C ARGAET[1,2], Luke FRATTURO[1,2], Jacob POGSON[1,2], Rachael TAYLOR[1,2], Sally M ROSENGREN[1,2], Gabor M HALMAGYI[1,2], Miriam S WELGAMPOLA[1,2]

[1]Central Clinical School, Faculty of Medicine and Health, University of Sydney, Australia
[2]Institute of Clinical Neurosciences, Royal Prince Alfred Hospital, Australia
[3]Department of Otolaryngology, Royal Prince Alfred Hospital, Australia
[4]Nextsense, Gladesville, Australia
[5]Faculty of Medicine, Health and Human Sciences, Macquarie University, Australia
[6]Department of Otolaryngology, Head and Neck, and Skull Base Surgery, St Vincent's Public Hospital, Australia
[7]Ear, Nose and Throat Surgery, St George Hospital, Australia

Objective: To investigate ictal nystagmus and audio-vestibular characteristics in episodic spontaneous vertigo (ESV) post cochlear-implantation (CI).

Methods: Twenty-one CI patients with ESV following cochlear implantation were recruited. Patient initiated Home Video-oculography (VOG) recordings were performed during one or more attacks of vertigo, using miniature portable home video-glasses. To assess canal and otolith function, video head impulse tests and vestibular evoked myogenic potentials (VEMPs) were recorded.

Main Outcome Measures: Nystagmus slow phase velocities (SPV), the presence of horizontal direction-changing nystagmus, post-CI audio-vestibular tests.

Results: The most common final diagnoses were post-CI delayed endolymphatic hydrops (post-CI DEH, 57%) and exacerbation of existing Meniere's disease (MD, 29%). Average SPV of ictal nystagmus was 51.8 °/sec and 64.3°/sec in these two groups. Direction-changing nystagmus was observed in 75% (post-CI DEH) and 60% (MD). One had a diagnosis of vestibular migraine (15.1 °/sec), two were undiagnosed (SPV 15.1 and 13.8 °/sec).

Video head impulse test (vHIT) gains were 0.8±0.2 (lateral), 0.7±0.2 (anterior), 0.6±0.3 (posterior) with abnormal values in 33, 35 and 35% of each canal in the implanted ear. Bone-conducted cervical and ocular VEMPs were asymmetric in 62 and 29% of patients (all concordant with implanted ear except 1 patient) with mean asymmetry ratios of 51.2 and 35.7%. Fluctuating vHIT gain was recorded in 3 patients.

Conclusion: High velocity, direction-changing nystagmus time-locked with vertigo attacks acts as a proxy to confirm EH in CI patients. Fluctuating vHIT gain holds promise as an additional marker.

Keywords : Cochlear implant, Vertigo, Nystagmus

APSCI Prize Session 02

Clinical Research
AP 02-8

Speech outcome of cochlear implantation in children with cochlear nerve deficiency: effect of Early implantation, better Modiolar Proximity, and Early Switch-on (EMPES)

Yehree KIM[1], Seung Jae LEE[1], Sooji JUNG[1], Bong Jik KIM[2], **Byung Yoom CHOI[1]**

[1]3department of Otorhinolaryngology-head and Neck Surgery, Seoul National University Bundang Hospital, Korea
[2]Department of Otolaryngology—head and Neck Surgery, Chungnam National University College of Medicine, Korea

Objective: To introduce comprehensive approach to cochear implantation (CI) for cochlear nerve deficiency (CND) aiming for Early implantation, better Modiolar Proximity and Early Switch-on and to report on the speech outcome of this EMPES approach.

Materials and methods: We identified children with CND implanted with the EMPES approach. CN was evaluated by T2-weighted-oblique sagittal MR images. The intraoperative neural response telemetry (NRT), preoperative and postoperative speech abilities (CAP score, receptive and expressive language scores) were reviewed. The NRT results were compared with those of children with CND implanted with a contour advance (CA) electrode. The preoperative and postoperative language scores were compared with those of children with normal CN size.

Results: We identified 24 children with CND who were managed with the EMPES approach, 13 children with CND implanted with CA electrodes and 36 children with normal CN size also managed with the EMPES approach. All ears showed no response in the preoperative auditory brainstem response. The percentage of positive channels from the intraoperative ECAP was significantly higher in the SME group (61.2%) than the CA group (44.0%) ($p<0.01$) in the apical electrodes. The CN status as seen on MRI were not different among the two groups. The CAP scores of children under the EMPES approach were higher than that of children implanted under the conventional approach ($p=0.02$,). Children with CND consistently showed about 60% of the language development status of those with structurally normal auditory nerves who underwent CI at the same age throughout 18 months postoperatively.

Conclusion: We present the speech outcome of the EMPES approach for CND. This approach leads to a consistent and significant speech improvement from the CND children irrespective of the severity of CND, albeit to a lesser degree than from the pediatric implantees with normal anatomy employing the same approach.

Keywords : Cochlear implantation, Cochlear nerve deficiency, Speech outcome

APSCI Prize Session 02

Clinical Research
AP 02-9

Torque, comfort and image considerations for MRI scanning of Ultra cochlear implants

James TYSOME

Ent Department, Cambridge University Hospitals, UK

Background
Cochlear implants are highly successful in treating severe to profound deafness, enabling babies to develop spoken language and allowing adults to retain their social contacts, thereby helping minimize cognitive decline. However, the presence of a magnet in the implanted component has caused issues with both the safety and efficacy of MRI examination. In recent times new magnet designs have been developed which should make MRI scanning substantially easier.
Method
Finished samples of both a traditional cochlear implant were studied: the Ultra with an axially polarized magnet and the Ultra3D cochlear implant containing a magnet assembly capable of aligning with a magnetic field in 3 dimensions. Torque measurements were made for a full 360-degree range of deflections. Additionally, the structures that could be imaged for various surgical placements of the implant device body were evaluated.
Results
There was a highly significant difference in the amount of torque acting on the Ultra and Ultra3D cochlear implants. The Ultra implant could only be studied in a 1.5 Tesla MRI machine where peak torques of 180 mNm were recorded. The Ultra3D implant could be studied in both 1.5 and 3.0 Tesla MRI machines where the maximum torque was found to be 40 mNm, despite the much higher magnetic field strength of the 3T machine. A review of a variety of placements for the implant body suggests that this can make different structures visible depending on exactly where the device body is located.
Conclusion
The new magnet assembly design of the Ultra3D implant appears suitable for both 1.5 and 3.0 Tesla MRI scanners with virtually no risk of magnet dislocation, demagnetization, or discomfort to the patient. Where the implant body is placed should be carefully considered, depending on which local anatomical features might be most useful to image following implantation.

Keywords : MRI, Magnet, Cochlear implant

APSCI Prize Session 02

Clinical Research
AP 02-10

Morphometric Angular and Linear Measurements of the Spiral Ganglion Neuron, Scala Tympani, and Cochlear Duct in Incomplete Partition Type II with Implications for Cochlear Implantation

Miryam S. SAAD[1], Gail ISHIYAMA[2], Ivan A. LOPEZ[1], **Akira ISHIYAMA[1]**

[1]Department of Head and Neck Surgery, David Geffen School of Medicine At The University of California in Los Angeles, USA
[2]Department of Neurology, David Geffen School of Medicine At The University of California in Los Angeles, USA

Objective: The objective of this study was to evaluate angular and linear measurements of spiral ganglion neurons (SGN) and to perform detailed cross-sectional measurements of the scala tympani (ST) in the Incomplete Partition Type II (IP-II) cochlea from histologic sections of human temporal bones.

Background: IP-II is a rare congenital inner ear malformation characterized by a hypoplastic modiolus and a deficient interscalar septum between the middle and apical cochlear turns. This aberrant anatomy presents challenges for cochlear implantation and can complicate electrode insertion and neural stimulation.

Methods: Three-dimensional reconstructions of 11 archival human temporal bone specimens with IP-II cochlea were generated from histopathologic slides. The SGN angular distance and linear length along the inner and outer wall of the ST were measured. The heights and cross-sectional areas of the ST were measured at 90-degree intervals. The angular distance and linear length of the cochlear duct were measured.

Results: The SGN angular distance ranged from 468.1 to 595.3°, with a mean of 1.47 turns, corresponding to an average linear distance of 12.22 mm along the inner wall and 24.73 mm along the outer wall of the ST. From 0 to 180 degrees, the vertical lateral height of the ST decreased from 0.99 to 0.72 mm and the perimodiolar height decreased from 0.84 to 0.74mm. The cross-sectional area of the ST decreased from 2.11 to 1.25 mm2 from 0 to 180 degrees. The cochlear duct angular distance ranged from 886.9 to 1111.9, with a mean of 2.6 turns, corresponding to an average linear distance of 32.44 mm, ranging from 29.04 to 33.84 mm.

Conclusion: The present study is the first to conduct detailed angular and linear measurements of SGN, cochlear duct, and scala tympani in Incomplete Partition Type II cochlea. These measurements have important implications in cochlear implantation insertion, depth, and electrode.

Keywords : 3-D Reconstruction, Incomplete Partition Type II, Temporal Bone

Oral Presentation 01

OP 01-1

The feasibility of a footswitch operated robotic arm three-dimensional exscope for cochlear implantation.

Aarno DIETZ[1,2,3], Eerika KARINEN[1], Matti ISO-MUSTAJÄRVI[1,2]

[1]Dept. of Otorhinolaryngology, Kuopio University Hospital, Finland2Microsurgery Center of Eastern Finland, Kuopio University Hospital, Finland3Institute of Clinical Medicine, University of Eastern Finland, Finland

Background: Digital high-definition three-dimensional (3D) exoscope systems have evolved to become a viable alternative to the operating microscope (OM) for otologic surgery. The objective of this study was to compare a footswitch operated robotic arm digital 3D exoscope system with a standard OM for a highly challenging setting of cochlear implantation.
Material and Methods: Cochlear implantation was performed with the exoscope on unselected patients with normal temporal anatomy. The control group that underwent cochlear implantation with the OM were case matched with respect to age, anatomy, surgical technique and type of anesthesia.
Results: 11 patients (13 ears) were successfully operated on with the exoscope. In the exoscope group, we observed one minor intraoperative complication. Image quality was deemed inferior as compared to the OM. Familiarization regarding the handling and image quality was required. The exoscope was found to be ergonomically superior particularly in patients operated under local anesthesia. There was a statistically significant difference in mean surgical time, 146 min and 129 min for the exoscope and OM group, respectively.
Conclusion: Cochlear implant surgery was found to be feasible with a 3D exoscope. However, there is a learning curve to overcome regarding handling and the different quality of the image. While the exoscope cannot currently compete with the OM in terms of image quality, it allows for better ergonomics for the surgeon. It is worth noting that the sample size of this study is small, and further research is needed to fully evaluate the efficacy and safety of using an exoscope in ear surgery.

Keywords : Exoscope, Three-dimensional (3D), Operating microscope

Oral Presentation 01

OP 01-2

Comparison of Conventional Technique with Suture Fixation and Subperiostal Tight Pocket Technique on Revision Cochlear Implantation Rate

Mehmet Emrah CEYLAN[2], Mehmet Ekrem ZORLU[1], Onur CORAKCI[1], Ecem Sevim AKI[1], Gökçe Aksoy YILDIRIM[1], **Abdullah DALGIC[1]**

[1]Otolaryngology – Head and Neck Surgery, University of Health Sciences Turkey, Izmir Bozyaka Education and Research Hospital, Izmir, Türkiye
[2]Otolaryngology – Head and Neck Surgery, Private Ent Clinic, Türkiye

Objectives
Several fixation methods have been described to secure the receiver/stimulator during cochlear implantation, but the optimal stabilization technique is still being debated. The aim of this study was to compare the conventional technique with suture fixation to the subperiosteal tight pocket technique in terms of revision cochlear implantation rate and complications.
Methods
The medical records of 653 patients who had cochlear implantation were reviewed retrospectively. The patients who underwent subperiosteal tight pocket technique were named Group 1 (n=399), and the patients who underwent conventional technique were named Group 2 (n=254). The relationship between the fixation technique, revision rates, and the cause of revisions was investigated.
ResultsThe overall revision rate was 3.5% (23 out of 653). There were 17 (4.2%) and 6 (2.3%) revision implantations in the subperiostal tight pocket and conventional technique groups, respectively (p=0.276). The device failure rate was 2.7%, and it was the most common reason for revision surgery in both groups. Even though the patients in Group 1 had a much higher rate of device failure (3.7% and 1% respectively), there was no statistically significant difference between the groups (p = 0.345). In patients with hard failure (2.7%), revision was performed due to electrode dislocation in 5 of 11 patients in Group 1. In Group 2 (0.7%), revision was performed due to dislocation of the electrode in 1 patient. Recurrent hematoma was the reason for revision in 1 patient in Group 1 and in 2 patients in Group 2. There was no skin flap failure or infection causing revision surgery in either group.Conclusion
The conventional technique with suture fixation has a lower revision rate than the subperiostal tight pocket method without statistical significance. The conventional and subperiostal tight pocket techniques can both be safely preferred with low revision rates in patients undergoing cochlear implantation.

Keywords : Cochlear Implantation, Complications, Revision

Oral Presentation 01

OP 01-3

Insertion Considerations for Cochlear Slim Modiolar Electrode

Akinori KASHIO[1], Hibiki YABE[1], Hajime KOYAMA[1], Tatsuya YAMASOBA[1]

[1]Department of Otolaryngology and Head and Neck Surgery, The University of Tokyo, Japan

The Slim Modiolar (SM) electrode is a modilus hugging electrode developed by Cochlear that can be inserted through the round window (RW) approach. However, the SM electrode has some problems, such as difficulty in insertion via the RW approach and a certain rate of tip folding. In this study, we performed a retrospective analysis of SM electrode insertions performed in our department to investigate the rate of RW approach and the incidence of tip fold over. 70 out of 113 cases were successfully inserted using the RW approach the other needed extended RW approach. Tip fold over occurred in 7 cases and 6 were inserted through the RW approach. Tip fold over was classified into two patterns: fold over around 120 degrees, fold over near 270 degrees. In one of the cases of tip fold over around 120 degrees, video of the procedure showed that the electrode was trapped in the slit of the sheath. This was probably caused by the sheath being subjected to an external force, such as being hit against the wall, before entering the RW.
In our experience, there have been several cases where we have stopped insertion and checked the status of the lead because we suspected that an external force had been applied to the sheath during insertion. In one case, the electrode was trapped in the slit of the sheath, similar to the tip folding case. In another case, although the electrode did not appear to be trapped, when the electrode was ejected from the sheath, the angle at which it emerged from the sheath changed significantly.
Our findings suggest that the RW approach may not be possible in all cases for SM electrode and that it is important to minimize contact with the sheath during insertion to prevent tip fold over.

Keywords : Slim modiolar electrode, Tip fold over, Insertion approach

Oral Presentation 01

OP 01-4

Systematic Review of the Efficacy of Transimpedance Matrix (TIM) Recording to Confirm Optimal Intracochlear Electrode Placement

David SCHRAMM[1], Julian LITTLE[2], Lilia ANTONOVA[1]

[1]Department of Otolaryngology - Head and Neck Surgery, Faculty of Medicine, University of Ottawa, Canada
[2]School of Epidemiology and Public Health, Faculty of Medicine, University of Ottawa, Canada

Objective:
Electrode array tip foldover is a surgical complication that has occasionally been reported with precurved cochlear implant electrode arrays. Unrecognized electrode tip foldover may compromise functional outcomes. If electrode tip foldover could be accurately identified intraoperatively, there would be an opportunity to immediately reposition the electrode, potentially eliminating the need for postoperative radiologic imaging or revision surgery.
TransImpedance Matrix (TIM) recording has recently become commercially available and is aimed at intraoperatively assessing the final position of the electrode array. The purpose of this systematic review was to evaluate the predictive value of TIM in accurately assessing intracochlear electrode placement.
Methods
A systematic review of "TransImpedance Matrix" measurements and "Electrode Voltage Telemetry" and "tip +/- fold over" was performed. PubMed (Medline), Medline (Ovid), Cochrane Library (Wiley), Scopus, and CINAHL databases were searched. All publications, including conference abstracts were included. There was no restriction on study type, language, or year of publication.
The quality of the included studies was evaluated. Study results were synthesized to assess the predictive value of TIM recording to confirm optimal intracochlear electrode placement.
Results
Title and abstract screening yielded 13 articles for potential inclusion in the systematic review. Studies were included after full text review. Studies were primarily case series and case reports with variable study quality. Where possible, study results were synthesized. A pooled analysis of published results demonstrated that intraoperative TIM recording has a very high predictive value to evaluate possible electrode array tip foldover.
Conclusion
A pooled analysis of published results demonstrated that intraoperative TIM recording has both a very high positive and negative predictive value when used to evaluate possible intracochlear electrode array tip foldover.
In view of these findings, clinicians may wish to consider replacing postoperative modified Stenver's view X-ray with TIM for the purpose of confirming optimal intracochlear electrode placement.

Keywords : TransImpedance Matrix, Electrode Voltage Telemetry, Electrode array tip foldover

Oral Presentation 01

OP 01-5

Clinical Summary of Cochlear Implant (CI) in Patients with Middle Ear Infectious Diseases

Hui ZHAO[1], Zibo LI[1], Miao ZHANG[1]

[1]*College of Otolaryngology Head and Neck Surgery, Chinese Pla General Hospital, China*

Objective : To summarize the clinical experience of CI in patients with middle ear infectious diseases, and to provide appropriate treatment programs for patients who with infectious diseases of the middle ear requiring cochlear implantation. Method : Retrospectively analyze the clinical data of patients with middle ear infectious diseases undergoing cochlear implantation admitted to the First Medical Center of PLA General Hospital from 2000 to 2019 and the Sixth Medical Center of PLA General Hospital from 2020 to 2022. To summarize and analyze the nature, scope, surgical method, type of intraoperative tamponade, operative effect and postoperative complications of middle ear lesions in patients undergoing stage I or II surgery. Results: After 9 months to 10 years of follow-up, 19 patients were enrolled in the simultaneous stage implantation group, including 11 cases of chronic suppurative otitis media at static stage, 1 case of active stage. 7 cases of middle ear cholesteatoma (small area cholesteatoma or complete capsulation), among which 1 patient was middle ear cholesteatoma with ossifying labyrinthitis. In 8 cases of chronic suppurative otitis media, 6 cases were at active stage and 2 cases were at static stage. 2 cases of cholesteatoma in the middle ear (cholesteatoma was extensive or surrounded by normal tissue and could not be completely cleared). After 9 years of cochlear implantation, electrode migration occurred in 1 patient in the simultaneous stage implantation group. The remaining cases were treated with different surgical methods according to the characteristics of the cases. Conclusion : For patients with middle ear infectious diseases, cochlear implantation by stages is safer than that by simultaneous implantation. For stage I implantation, patients with mild lesions, limited lesions and easy to be completely cleaned should be selected as far as possible, and surgical methods should be selected as far as possible on the basis of complete removal of lesions.

Keywords : Cochlear Implant, Chronic Suppurative Otitis Media, Cholesteatoma

Oral Presentation 01

OP 01-7

Temporal swelling following cochlear implantation: Frequency, treatment, and outcomes

Mariko KASUGA[1], **Hidekane YOSHIMURA[1]**, Yutaka TAKUMI[1]

[1]Department of Otorhinolaryngology - Head and Neck Surgery, Shinshu University School of Medicine, Japan

Purpose: The aim of this study was to investigate the frequency, treatment, and outcomes of temporal swelling around cochlear implants after surgery.
Methods: We performed a retrospective chart review of 354 cases (516 ears) of cochlear implantation (CI) at Shinshu University Hospital from May 2009 to October 2022. Of these, 329 cases (472 ears) with follow up of more than 3 months were included in this study [138 pediatric cases (246 ears) and 191 adult cases (226 ears)]. Cases with swelling around the implant within 3 months were excluded.
Results: There were 22 cases (24 ears) with a history of temporal swelling around the implant body. In children (aged 0-19 years), this complication occurred in 22 ears (8.9%), while in adults (aged >20 years), this complication occurred in 2 ears (0.9%). The mean onset of swelling was 52 months following CI (range: 5.5–147 months). The cause was unknown in 13 ears, followed by head trauma in 9 ears and acute mastoiditis in 2 ears. Twenty-three ears were cured after treatment (antibiotics and/or strong magnetic compression), but revision CI surgery was required in one ear. Additionally, five ears relapsed.
Conclusion: The results suggest temporal swelling around the implant is much more frequent in children than in adults due to higher incidence rates of head trauma and middle ear infection in children. In most cases, conservative treatment was adequate; however, careful follow-up is needed. Our findings can serve as a reference for optimizing care and intervention options following CI.

Keywords : Cochlear implant, Surgery, Head trauma

Oral Presentation 01

OP 01-8

FDA Clinical Trial to Expand MED-EL Pediatric Cochlear Implant Indications in the United States

Nancy YOUNG[1,2]

[1]Otolaryngology, Lurie Children's Hospital of Chicago, USA
[2]Otolaryngology, Northwestern Feinberg School of Medicine, USA

Introduction: In the United States, approval from insurers for infant implantation is often challenging. Insurers may rely upon decades old, outdated Food and Drug Administration (FDA) indications. Given evidence that early implantation improves language outcome, this situation is an important public health issue. An FDA clinical trial sponsored by MED-EL is underway to expand indications to infants as young as 7 months. Data from the lead site for this multicenter clinical trial will be reported. If available, data from other participating sites will also be included.
Methods: Prospective study of safety and auditory outcomes of children implanted between 7 months and 5 years 11 months with the MED-EL Synchrony, followed post activation for 12 months. Primary outcome measures: 1. Device and surgical adverse events; 2. Little Ears Auditory Questionnaire (LEAQ) with score of 25 defined as clinical endpoint.
Results: Nine children with severe to profound sensorineural hearing loss were bilaterally implanted at mean age of 8.3 months (range 7 - 16): seven (78%) before 12 months; 4 (44%) before 9 months. No serious unanticipated surgical or device related adverse events occurred. The LEAQ study endpoint was reached in 7 (78%); 1 (13%) by 3 months, 3 (38%) by 6 months, and three (33%) by 12 months. All children achieving clinical endpoint were implanted before age 13 months. Two children completed the study without meeting the endpoint. Based on behaviors and progress, these children were suspected of having autism spectrum disorder. One has been evaluated and this diagnosis confirmed.
Conclusion: This study adds to literature demonstrating the safety of infant implantation. Expanding FDA approved age at implantation to 7 months will reduce barriers to early implantation. Lack of expected progress by children implanted during infancy may be evidence of another developmental disorder requiring evaluation and intervention.

Keywords : Infant implantation, Surgical safety, Auditory outcome

Oral Presentation 01

OP 01-9

A review of surgical and audiological outcomes of bonebridge at tertiary centres in Sarawak Malaysia

Asfa Najmi MOHAMAD YUSOF[1], Ing Ping TANG[2]

[1]*Otorinolaryngology, Sarawak General Hospital, Malaysia*
[2]*Otorhinolaryngology, University Malaysia Sarawak, Malaysia*

Introduction: Bonebridge (BB) is a bone conduction implant that is indicated in cases of conductive hearing loss and single sided deafness. It has lower complication as compared to percutaneous bone conduction implant.
Objective: To evaluate the surgical and audiological outcome of bonebridge at major hospitals in Sarawak from 2014 to 2022.
Methods: A retrospective analysis of twenty-six hearing-impaired patients who met the criteria for BB and responded well to a bone conduction hearing aid trial. With preoperative computer tomography planning, BB implantation was done under general anaesthesia. Air conduction, bone conduction and sound field at the frequencies 250 to 4000 Hz were measured preoperatively and after implantation at six months and one year follow up. Complications were observed post surgery. Hearing Device Satisfaction Scale (HDSS) questionnaire was used to evaluate patient's satisfaction.
Results: There was no major complication reported. Mean aided sound field threshold showed significant change in mean unaided air conduction for more than 40 dB gain from 500 to 4000 Hz ($p<0.05$). All of the patients expressed satisfaction (>80%) due to implant's promising functional results and acceptable aesthetic appearance.
Conclusion: BB implantation is safe, effective and showed excellent audiological gain in patients aged three and older with conductive or mixed hearing loss and single sided hearing loss.

Keywords : Bonebridge, Conductive hearing loss, Single sided deafness

Oral Presentation 01

OP 01-10

A New Objective-based Method for Measuring Cochlear Duct Length

Rabea AL SABILAH

Cochlear Implant Center, King Abdulaziz Specialist Hospital, Al-jouf, Moh, Saudi Arabia

The majority of current clinical practices utilize the cochlear duct length (CDL) as a main predictor of the proper electrode array length. There are many formulas that can be used to predict the CDL from the CT scan. However, the lumen of the Scala tympani ends before the bony boundary of the cochlear apex and the area of helicotrema includes no lumen where the electrode could be advanced. Furthermore, the diameter of the Scala tympani can affect the ability to advance the electrode inside the cochlea and since there is no correlation between the bony cochlear diameter and the Scala tympani diameter, it is not possible to predict this measure using CT in some cases. Therefore, inserting the cochlear electrode array completely into the cochlea is still challenging in some cases despite the pre-op calculation of CDL. This could be due to many reasons, such as the variability among the different CDL formulas, fibrosis, or the Scala tympani volume. For such cases with profound hearing loss, we propose an insertion test electrode for measuring the actual cochlear length and then select the electrode array length that best fits with each cochlea. After granting the ethical approval, we included the patients with; expected occlusion during insertion from pre-op imaging; difficult anatomy; profound with no residual hearing. Nine ears were included in this study and the results showed that eight cases had a full insertion with the same electrode length that resulted from the universal test electrode. As a conclusion, measuring the actual length of the challenging CI cases could help in assuring the proper electrode selection and minimize the intra-op complications, such as incomplete insertion, over insertion, fold over, and scalar deviation.

Keywords : Cochlear Implantation, Cochlear Duct Length, Cochlear Length

Oral Presentation 01

OP 01-11

Auditory Rehabilitation in Patients with Auditory Nerve Dysplasia.

Serafima SUGAROVA[1], Vladislav KUZOVKOV[1], Andrei LILENKO[1], Yulia KORNEVA1, Dmitrii LUPPOV[1]

[1]Hearing Restoration, Spb Ent Research Institute, Russia

Cochlear nerve dysplasia (CND), which includes aplasia and hypoplasia, is observed in 18% of children with sensorineural hearing loss (SNT). These patients are considered as candidates for a CI for the goal of hearing rehabilitation. Previously, CND was a contraindication for CI, so the method was proposed of direct stimulation of the cochlear nuclei using auditory brainstem implantation.
Study Objective. To conduct a retrospective research on the possibility of hearing rehabilitation after CI in children with CND.
Materials and Methods. The results of auditory-verbal rehabilitation of 18 children with CND after CI in the St. Petersburg Research Institute of ENT in the period from 2016 to 2022 were investigated.
Results. Patients with confirmed DSN are able to understand spoken language in 68% situations after CI.
The use of total communication after CI, combining spoken and sign language, was found in 55% of 22 children with CND.
Used electrophysiological methods can be to assess the generation of activity in the auditory nuclei of the brainstem through electrical stimulation. Therefore, evaluation of auditory nerve function using extracochlear and intracochlear electrical auditory brainstem response (eABR) is recommended .
After a CI, can be testing of children's auditory development should be conducted with speech perception tests, listening skills, and socialization tests age-appropriate.
Based on a retrospective research of patients with CND after CI, recognition of non-speech and speech sounds in children in the entire speech range was found in 70%. Absence of satisfactory auditory results was found in 30% of the children. A statistically significant improvement in the auditory development of children with CND after CI was found during testing.
Conclusion. CI and long-term hearing rehabilitation may be effective for children with CND. Before deciding whether to conduct a CI in children with CND are necessary preoperative examinations to identify the patient's auditory reactions.

Keywords : Cochlear Implantation, Cochlear Nerve Hypoplasia, Cochlear Nerve Aplasia

Oral Presentation 01

OP 01-12

Determining factors for outcomes of cochlear implantation in patients with congenital cytomegalovirus infection: a case-series study

Yen-Hui LEE[1], Pei-Hsuan LIN[1], Ting-Hua YANG[1], Chuan-Jen HSU[1,2], Tien-Chen LIU[1], **Chen-Chi WU[1,2]**

[1]Department of Otolaryngology, National Taiwan University Hospital, Taiwan
[2]Department of Otolaryngology, Buddhist Tzuchi General Hospital, Taichung Branch, Taiwan

Background:
Congenital CMV (cCMV) infection is an important cause of acquired sensorineural hearing impairment (SNHI) in children. The severity of SNHI varies remarkably among patients with cCMV infection, ranging from mild to profound SNHI unilaterally or bilaterally. For patients with profound SNHI, cochlear implantation is a viable option, yet the outcomes are highly variable. To facilitate clinical decision making, it is crucial to identify the prognostic determinants for CI outcomes in patients with cCMV infection.
Method:
We retrospectively reviewed all cases with cCMV infection receiving cochlear implantation at NTUH from 2013 to 2023 by a single surgeon. We ascertained pre-operative data including demographic data, audiological tests, radiological imaging, and neurological assessments. Auditory and speech performances were evaluated pre-operatively and post-operatively using categories of auditory performance (CAP), speech intelligibility ratings (SIR), and speech perception scores.
Result:
Cochlear implantation was performed in 8 patients (9 ears). No inner ear abnormality was found on imaging studies. All the 9 ears exhibited good response in evoked compound action potential during surgery and good aided thresholds in sound field audiometry postoperatively. However, the auditory and speech performances were highly variable. Factors associated with unfavorable auditory and speech performances included the presence of neurological disorders or sequelae, high CMV viral loads, presence of symptoms at birth, and poor preoperative auditory and speech performances.
Conclusion:
Cochlear implantation in patients with cCMV infection generally achieved good response to sound, but auditory and speech performances were highly variable. Careful counseling should be provided case by case.

Keywords : Cochlear implantation, Cytomegalovirus, Pediatric sensorineural hearing impairment

Oral Presentation 01

OP 01-13

Complications in Cochlear Implantation: Facing our fears and Learning from our Mistakes!

Vidhu SHARMA[1], **Amit GOYAL[1]**, Kapil SONI[1]

[1]Otorhinolaryngology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

Introduction – Cochlear implantation (CI) is labelled as one of the most sophisticated and technically demanding ENT surgeries. And with the 'tag', comes the 'baggage' of surgical complications. We are sharing our experience of dealing with a wide variety of complications of CI.
Methodology – A retrospective compilation of patient data was done for all CIs performed at our institute during 2017 to 2023. Details regarding patient demographics, surgical techniques and surgical complications were collected. The data is presented here along with the description of the management of some dreaded complications.
Results – A total of 150 ears underwent cochlear implantation by Veria technique during the said period. The age at implantation ranged from 9 months to 8 years among the pediatric patients while 2 post-lingually deaf adults (aged 32 and 39 years) underwent CI. The male: female ratio was 1.09:1. Electrode insertion was done via cochleostomy in 90 and round window in 60 cases. All surgeries were performed by a single senior CI surgeon. We faced our share of complications ranging from minor such as periorbital edema (4%), blisters around incision line (3%), posterior canal wall injury (5.3%), incudo-stapedial joint dislocation (2.67%), delayed onset tympanic membrane perforation (2%), chorda tympani injury (4%) to more serious ones like bleeding from high riding jugular bulb/sigmoid sinus (1.33%), CSF leak while drilling the implant bed or making tie down holes (1%), facial paresis (1.33%), meningitis (0.7%) and death (1.43%). We discuss the management of a few challenging complicated cases like biofilm associated wound complication and an unfortunate death due to Jervell and Lange-Nielsen syndrome.
Conclusion – An extensive pre-operative evaluation, meticulous peri-operative management with a skilled anesthetic team, proper surgical technique and dedicated post-operative care are mandatory to reduce the burden of complications associated with CI.

Keywords : Cochlear implantation, Complications, Management

Oral Presentation 01

OP 01-14

Revolutionizing Patient Care: A Decade of Global CI Indications Expanding Boundaries and Transforming Lives

Radesh NAJRAN

Med-el, Med-el Medical Electronics, Austria

The field of cochlear implantation has witnessed significant expanding advancements in surgical techniques and technology, enabling the safe and effective use of cochlear implants (CI) in various patient populations. However, the establishment of uniform candidacy criteria for cochlear implantation still remains elusive, with different regions adopting diverse sets of indication criteria. This abstract provides an overview of the current state of cochlear implant indication criteria globally and explores potential future indications for cochlear implantation.
The findings reveal significant heterogeneity in cochlear implantation indication criteria across the world's major markets. While certain criteria, such as SSD and AHL, have gained widespread acceptance, the inclusion of patients with moderate to severe cochlear hearing loss and/or ANSD has expanded the candidacy criteria. Furthermore, advancements in EAS and structural cochlear preservation techniques have contributed to transforming the criteria for cochlear implant candidacy in all age groups, accommodating the needs of both the elderly and the younger population. However, despite these developments, there remains a lack of consensus regarding measures, time frames, and guidelines for cochlear implant candidacy.
To gather insights into the international differences in cochlear implantation indication criteria, a questionnaire survey was conducted among professionals working in the field of cochlear implants. The survey aimed to collect data and ongoing updates on the prevailing indication criteria in different regions, as well as any proposed modifications or future directions in cochlear implantation candidacy. The data obtained from the survey formed the basis of analysis and discussion in this paper.
By exploring potential future indications, this study paves the way for advancements in cochlear implantation and improved patient care worldwide.

Keywords : Cochlear Implant Candidacy Criteria, Indications, Single Sided Deafness, Asymmetrical Hearing Loss, Auditory Neuropathy Spectrum Disorder, Electric Acoustic Stimulation

Oral Presentation 02

OP 02-1

Device selection between bone conduction and active middle ear implants – outcomes and experiences over a 10-year period

Dayse TAVORA-VIEIRA[1], Roberta MARINO[1], Jafri KUTHUBUTHEEN[1], Christopher BROADBENT[1], **Aanand ACHARYA**[1]

[1]*Department of Otolaryngology, Head & Neck Surgery, Fiona Stanley Hospital, Australia*

AIM
Patients with a conductive (CHL) or mixed hearing loss (MHL) are frequently considered for two types of hearing implant: bone-conduction implants (BCIs) and active middle-ear implants (aMEIs). Determining the most appropriate device to offer can be challenging, with some patients being candidates for either. The aim of this study is to present the decision-making paradigm that is implemented at our institution to determine the device to be offered and to compare this with hearing and quality of life outcomes over a 10-year period.
METHODOLOGY
With Ethics Committee approval and patient consent, a retrospective case-note analysis was undertaken of all patients that received a BCI or aMEI at a tertiary hearing implant centre between 2010-2020. Audiometry and speech discrimination in quiet testing were performed. Hearing-related quality of life was quantified using the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire. Statistical analysis using independent samples t-tests, Wilcoxon signed rank tests, analysis of co-variance (ANCOVA) and Tukey's test was undertaken.
RESULTS
Eighty-nine patients received either a BCI (n=54) or an aMEI (n=35). Aided hearing thresholds, effective gain and speech in quiet were similar between all 3 groups and remained stable over time. APHAB global scores measured 12 months post-surgery showed no difference between the groups. Bone conduction threshold, age at implantation and duration of hearing loss did not have any significant effect on aided hearing thresholds, speech in quiet or APHAB global scores.
CONCLUSION
Determining the most appropriate hearing implant for a patient with a CHL or MHL can be challenging. There is no "all-purpose" solution. We have found a decision-making paradigm that considers audiological, patient and surgical factors to be helpful in providing an individualized approach to each patient. This is reflected in the finding that hearing and quality of life outcomes were similar among the 3 groups studied.

Keywords : Bone conduction, Middle ear implant, Device

Oral Presentation 02

OP 02-2

Influence of adaptive digital modulation Roger technology on speech perception performance in Cochlear implant users in the real world scenario

Aninda Duti BANIK[1], Neevita NARAYAN[2], Sashidharan P[3], Amit ANAND[4]

[1]*Clinical & Research - Audiology, Advanced Bionics India Pvt Ltd, India*
[2]*Audiology & Speech Language Pathology, Sphear-speech & Hearing Clinic, India*
[3]*Audiology & Speech Language Pathology, Dr. Manoj's Ent Super Specialty Institute & Research Center Mesiarc, India*
[4]*Audiology & Speech Language Pathology, Apple Speech and Hearing Clinic, India*

Purpose
Perception of speech in noise is the biggest hinderance for any cochlear implant recipient and even a tier-3 city in India exhibits more than 75 dBA noise.
Methods
The multicentric Indian study in-progress aimed to evaluate in the real-world scenario, the effect of an adaptive digital modulation(DM) Roger technology on speech perception(SP) in noise & quiet on unilateral CI users (aged 13-58 yrs, Target 'n'=30). Speech recognition scores(SRS) were cross-compared in 13 different combinations of technology-program conditions and Roger wearing modes, in the Audiology room and a first of its kind testing in the real-world scenarios. In the Audiology-room, speech noise (65 dBHL) input was fixed at 90degree CI side and SRS using recorded-sentences was assessed at 0degree azimuth & 1.5m distance.
Results
Average ambience noise was calculated on a sound-level-app and utilizing monitored-live-voice, sentence scores were obtained in the waiting area (noise=58 dBSPL), cafeteria (68 dBSPL) & programming room (44 dBSPL) of the hospital. SRS were significantly better in all Roger conditions. Roger Select-IN used in a lanyard beamformer mode at 6 inches from the speaker resulted in SRS-50% at -21.3 dB(+/-2.06) as against -12.3 dB in SIN (UltraZoom+SNR Boost) mode[P=.0001)]. In the real-world scenarios, scores significantly improved the most using Roger in the lanyard mode by 38 (SD .98), 48 (SD 1.04) and 16 (SD .66) percentage points in the waiting area, cafeteria and programming room respectively.
Conclusion
The results strongly highlights the scope of an immediate boost of SP in noise in the real-world and recommends clinicians to select Roger to improve SNR. The study supports past reviews and has implications in the child's early learning stages, literacy, auditory fatigue, ANSD, CAPD, unilateral CI, I.E. malformations, challenging educational & office setups, behavioral and academic issues etc. and influences better quality of hearing.

Keywords : Auditory fatigue; ANSD, Digital Modulation wireless system; Roger Select-IN, Urbanization; Speech perception in Noise

Oral Presentation 02

OP 02-3

The novel active transcutaneous bone conduction implant Sentio: Preclinical output performance evaluation

Hannes MAIER[1,2], Stefan STENFELT[3], Patrick MAAS[4], Nils PRENZLER[1,2], Rolf SALCHER[1,2], Thomas LENARZ[1,2], Mohammad GHONCHEH[1]

[1]Dept. Otorhinolaryngology, Medical University Hannover, Germany
[2]Hearing4all, Cluster of Excellence, Germany
[3]Dept. of Biomedical and Clinical Sciences, Linköping University, Sweden
[4]R & D, Oticon Medical, Smoerum, Denmark

Objectives: The output performance of the novel transcutaneous bone conduction device Sentio (Oticon Medical) was compared to the percutaneous bone-anchored hearing device Ponto 3 (Oticon Medical) using fresh cadaver heads. The impact of actuator position, tissue growth below the actuator and the depth of the bone bed on performance was investigated.
Methods: Both devices were implanted sequentially at two different sites in 5 human cadaver heads: 55 mm superior-posterior to the ear canal opening (position A) and, 20 mm inferior-posterior behind the pinna on the mastoid (position B). The ipsi- and contralateral cochlear promontory (CP) velocity responses to BC stimulation were measured by laser Doppler velocimetry. Moreover, the CP vibration of the transcutaneous device placed directly on the skull surface was compared with placement in a 3 mm bone bed. Finally, the influence of placing a 0.3 mm silicone interposition below the implanted transducer was also explored. Results: The percutaneous device provided 11 dB higher CP vibration level than the transcutaneous device between 0.5 and 10 kHz. The ipsilateral CP vibration responses with stimulation at position B were 13 dB higher compared to stimulation at position A. The placement of the transcutaneous transducer at position B provided similar or higher average vibration magnitudes than the percutaneous transducer at position A. Neither the 3 mm bone bed nor placement of the silicone interposition had a significant effects on the output performance of the transcutaneous device.
Conclusions: Our results using the CP vibration responses show that at frequencies above 500 Hz the new transcutaneous device at position B provides similar output levels as the percutaneous device at position A. The results also indicated that neither a bone bed nor a simulated tissue growth below the actuator affect the output performance of the device.

Keywords : Transcutaneous Bone Conduction Device, Sentio, Output Performance

Oral Presentation 02

OP 02-4

Adhesive versus passive bone conduction implants

Javier GAVILAN[1], **Javier GAVILAN[1]**, Fernanda PEDRERO[1], Laura CAVALLE[2], Jose Manuel MORALES[1], Luis LASSALETTA[1]

[1]Otorhinolaryngology, La Paz University Hospital, Spain
[2]Otorhinolaryngology, La Fe University Hospital, Spain

Introduction: The first adhesive bone conduction device was introduced in 2017. We compare the auditory outcomes and patient satisfaction between adhesive and passive transcutaneous bone-conduction implants.
Methods: We include 16 pediatric patients with bone conduction threshold ≤ 25dB who were users of passive transcutaneous implants for at least one year, and gave them an adhesive system for one week. Pure tone thresholds and word recognition with bisyllables at 65dB with and without noise were measured for each of the two devices. A specific satisfaction questionnaire, SSQ life questionnaire and the Kinddle quality of life questionnaire adjusted to the patient's age were also passed.Results: The age of the patients was between 5 and 16 years. All of them had congenital aural atresia, 9 unilateral and 7 bilateral. The pure tone average in the studied ear recorded a mean threshold of 52 dB unaided. The mean passive transcutaneous-aided threshold was 27 dB and 29 dB with the adhesive-aided. The average word recognition score was 96% for the passive transcutaneous and 95% for the adhesive system in quiet. The word recognition score in noise at 5 dB SNR was 70% for the passive transcutaneous and 77% with the adhesive device and at 0 dB SNR 50% for the passive transcutaneous and 48% with adhesive implant.
Conclusion: The new adhesive bone conduction system provides comparable auditory results with passive transcutaneous bone conduction implants in free field, in word discrimination in quiet, and word recognition with background noise. The overall satisfaction of the new adhesive device is good.

Keywords : Adhesive bone conduction devices, Aural atresia, Passive transcutaneous bone conduction devices

Oral Presentation 02

OP 02-5

Results of the Osia II System in Patients with Mixed Hearing Loss After Middle Ear Surgery

Kyung-Seok PARK[1], Hong-Chan KIM[1],
Hyong-Ho CHO[1]

[1]Otolaryngology-head & Neck Surgery, Chonnam National University Medical School and Chonnam National University Hospital, Korea

Purpose: This study was aimed to evaluate the subjective and objective audiological benefits of the Osia II system compared to the previous Baha Attract system in patients with mixed or conductive hearing loss after mastoidectomy.
Methods: The study involved 10 patients (2 men and 8 women) with mixed or conductive hearing loss after mastoidectomy who were implanted with the Osia II system. Their audiological outcomes and user satisfaction were compared with 7 patients (all women) who had previously been implanted with the subcutaneous Baha system. The subjective satisfaction was assessed using APHAB questionnaire and K-IOI-HA questionnaire.
Results: After Osia II surgery, the mean scores for the ease of communication, reverberation, and background noise subscales of the APHAB questionnaire significantly decreased at 3 and 6 months compared to preoperative scores. The mean K-IOI-HA scores were also significantly higher after Osia II surgery. The postoperative aided thresholds with Osia II or Baha were significantly lower than the preoperative unaided thresholds, and the maximal compatible level (MCL) was also significantly lower after surgery. However, there was no significant difference in maximum phonetically balanced word-recognition scores between preoperative unaided and postoperative Osia II or Baha-aided conditions. The effective gain of the Osia II system was better than the Baha system at 500 Hz, 2 kHz, and 4 kHz. The functional gain of both systems was similar at all frequencies.
Conclusion: The Osia II system and the Baha system showed improved satisfaction and audiological test results in patients with mixed hearing loss after mastoidectomy. The Osia II system provided greater audiological gain than the Baha Attract devices, particularly at frequencies of 0.5 kHz, 2 kHz, and 4 kHz, resulting in higher compliance. Therefore, the Osia II system could be considered as a good option for patients with mixed hearing loss with higher bone conduction thresholds.

Keywords : Osia II, Mixed Hearing Loss, Implanted device

Oral Presentation 02

OP 02-6

Different approaches in active transcutaneous bone conduction implant

Mario Emilio ZERNOTTI[1],
Jose Manuel MORALES-PUEBLA[2], Maximo ZERNOTTI[1],
Javier GAVILAN-BOUZAS[2]

[1]Otrhinolaryngology, Sanatorio Allende, Argentina
[2]Otorhinolaryngology, Hospital La Paz, Spain

Introduction: Bone conduction prosthesis are useful devices designed to improve conductive hearing loss (CHL). From percutaneous up to active transcutaneous devices, a long journey was travelled. Active implants proved to have the best results, while transcutaneous showing the lowest complications rate. These are nowadays the gold standard for the treatment of aural atresia or chronic otitis media with severe CHL. The pioneer since 2012 is Bonebridge (BB), electromagnetic prosthesis with excellent audiological results (functional gain over 35 dB).
Objective: To describe the most recommendable approach according to middle ear and mastoid conditions. The special design with a transition bridge allows the possibility of surgery in different positions. Besides, a new nomenclature for these approaches is proposed to avoid the negative implications associated with conventional "neurosurgical" approaches.
Material and Methods: 98 patients were implanted in 3 different positions in 2 tertiary centers. In Mastoid approach (called MARA -Mastoid Regular Approach-) the device is implanted in the sinodural angle. It is a good option for patients with normal mastoid and patients with unsuccessful previous ossiculoplasty or with middle ear malformations. The Posterior Inferior Approach (PIA), formerly retrosigmoid approach, is a very good alternative for patients with radical cavities or patients with congenital aural atresia thinking in aesthetic reconstruction surgeries. Finally, STELA (Supra Temporal Line Approach), misnamed as middle fossa, is an interesting position for patients with canal wall down surgery and microtia malformations, including future reconstructive surgeries of pinna.
Results: The most important indications were microtia, chronic otitis media and unilateral hearing loss. No statistically significant audiological differences could be found between different positions. The 3 approaches allowed the best audiological results with the lowest rate of complications.
Conclusion: Depending on the anatomy of the patients, BB may be implanted in different anatomical positions improving audiological results increasing patient comfort and usability.

Keywords : Bone conduction device, Aural atresia, Chronic otitis media

Oral Presentation 02

OP 02-7

Intraoperative Auditory BrainStem Responses with Vibrant Sound Bridge

Medhat YOUSEF[1], Asma ALAHMADI[1], Farid ALZHRANI[1]

[1]King Abdullah Ear Specialist Center, King Saud University, Saudi Arabia

Background: Objective intraoperative monitoring methods have been suggested for the assessment of coupling and outcomes of Vibrant Soundbridge (VSB). Although several techniques were proposed, they have not been widely adopted due to their complexity and invasiveness. Recent studies proposed Auditory Brainstem Response (ABR) for objective assessment of VSB outcomes.
Objectives: This study investigated the intraoperative ABR threshold measurement using AcoustiAP.Methods: The medical records of 11 patients who received a VSB device and had an intraoperative objective assessment of coupling efficiency were retrieved. AcoustiAP was used to evaluate intraoperative ABR thresholds, which were assessed before and directly after the FMT placement using acoustic CE-Chirps signals. The Vibrogram was used for the postoperative audiological evaluation.
Results: The median age of the included patients was 7 (range 4 -50) years, and 91% of the patients had conductive hearing loss. The median preoperative bone conduction (BC) pure tone audiometry (PTA3) and PTA4 were 15 (-6.7 – 51.7) and 11.3 (-7.5 – 48.8) dB, respectively. While the median postoperative VSB PTA3 and PTA4 were 30 (5 - 81.7) and 30 (5 -80), respectively. The median intraoperative ARB threshold at good coupling was 45 (40 – 70) dB, which was significantly different from the measurement at loose coupling (median 60 [40 – 100]), $p < 0.001$. The results showed a statistically significant positive correlation between intraoperative ARB threshold with postoperative VSB PTA3 ($r = 0.69$, $p = 0.02$) and PTA4 ($r = 0.63$, $p = 0.04$). However, there were no significant correlations between intraoperative ARB threshold and preoperative measurements.
Conclusion: These results provide novel insights into the potential of intraoperative ABR monitoring as a predictive tool for postoperative auditory performance in patients fitted with a VSB. Further studies are warranted to validate these findings in a larger sample size and to explore the underlying mechanisms of this correlation.

Keywords : Vibrant Sound Bridge, Auditory Brainstem Response, Middle ear Implant

Oral Presentation 02

OP 02-8

Long-term Result of Bonebridge in Aural Atresia

Paninee CHARUSRIPAN

Otolaryngology, Chualongkorn University, Thailand

Objective: To evaluate long-term result of Bonebridge implantation
Method: Seven patients who underwent Bonebridge implantation during year 2017 to 2018 were reviewed. Audiogram, compliance and patient satisfaction are evaluated.
Result: Six of seven patients continue using Bonebridge. One patient stopped using Bonbridge due to hyperacusis and cosmetic reason. Sound-field threshold between unaided and Bonebridge showed statistically significant difference at frequency 0.5,1,2,4,8, Hz at the first year of implantation and also 5 years later. Speech Reception threshold also improve after implantation in all patients. Two patients had to change sound processor due to accident.
Conclusions: Bonebridge show a good long-term hearing outcome both pure tone average and speech recognition threshold

Keywords : Bonebridge, Long-term, Aural atresia

Oral Presentation 02

OP 02-9

A Totally Implantable Cochlear Implant shows potential benefits for adults with hearing loss

Philippe LEFEBVRE[1], Joachim MÜLLER[2], John-Martin HEMPEL[2], Gerhard MARK[3], Ingeborg HOCHMAIR[3]

[1]Otorhinolaryngology, Liège University, Belgium
[2]Klinik Und Poliklinik Für Hals-nasen-ohren-heilkunde,, Munich University, Germany
[3]Head Quarter, Med-el Elektromedizinische Geräte Gmbh, Austria

People with hearing impairment have several specific expectations: advanced technology providing superior outcomes, aesthetics, and reliability. The newly developed totally implantable cochlear implant (TICI) was designed to provide these. Advanced technology considers now and the future. Users experience benefits in speech understanding in quiet, speech understanding in noise, using the telephone, and listening to music. Aesthetics means having no visible audio processor, while still allowing a person to hear when they are in the shower, swimming, or when sleeping. Therefore, an increasing number of individuals with hearing loss might decide for cochlear implantation and enjoy the benefits thereof. A TICI comprises the housing and electrode of a conventional cochlear implant, while incorporating the microphone, the signal processing and the batteries previously contained in the external audio processor. A first-in-human clinical investigation using the MED-EL TICI system in six post-lingually deafened adults (21.3-73.2y) collected data over 52 weeks. The surgical procedure for the TICI is similar to the one used to implant currently marketed cochlear implants, except for the microphone positioning under the skin. Self-reported overall satisfaction improveme from first fitting to 20 weeks. Monosyllable scores with the TICI improved from 6.3% pre-operatively to an average of 63.8% at 3-months post-operatively, further increasing to 70.3% at one year. The OLSA sentence test in noise determines the signal-noise ratio where 50% of sentences can be understood. At 3-months post-operative, mean SRT with the TICI was -1.2 dB SNR. These scores were similar when comparing the TICI with the SONNET audio processor.The evaluation of the TICI in a first-in-human study, showed that expectations of users can be met. Speech-scores matched scores using an external audio processor. User satisfaction showed increasing satisfaction with the TICI over time. No unexpected safety events were recorded. The TICI shows the new way forward for cochlear implants.

Keywords : Cochlear implant, Fully implantable, Microphone

Oral Presentation 02

OP 02-10

Long-term outcomes and its relationship with objective measures in children with Auditory Brainstem Implant

Ranjith RAJESWARAN[1,2], Mohan KAMESWARAN[2]

[1]Audiology and Speech Language Pathology, Merf Institute of Speech and Hearing, India
[2]Audiology, Madras Ent Research Foundation, India

PURPOSE:
The purpose of the study is to document the trend in development of communication skills in children with Auditory Brainstem Implant (ABI) and to correlate the long-term outcome with Electrically Evoked Auditory Brainstem Response(EABR) and Electrically evoked compound action potential of cochlear nucleus (CN eCAP) to predict outcomes.
MATERIALS AND METHODS USED:
Fifty children with ABI were studied retrospectively with mean implant age of 44 months. The subjective outcomes were measured during pre-activation and post activation at 12 months, 24 months, 36 months and 48 months using CAP,SIR, MAIS, MUSS and LEAQ performance scales and measures. EABR and CN eCAP were measured post-operatively using a novel method. Measures of auditory and non-auditory sensations were performed behaviorally.
RESULTS:
Scores improved gradually till 24 months post switch-on, scores plateued after 24 months. By 48 months, a maximum of 6 participants showed median score of 5 in CAP, 10 participants with median score 4 in SIR and 4 children were comparable to children with cochlear implants in LEAQ. Outcomes were better in children, where more than 75% of electrodes elicited good eABR, positive correlation was found between the subjective scores and number of electrodes with good eABR. Behavioural responses for non-auditory sensation correlated with eABR, differentiating auditory and non-auditory sensation for each electrode stimulated. CN eCAP could be measured in few electrodes across subjects, since it is very preliminary data the morphology and its relationship will be discussed during presentation.
CONCLUSION:
Outcomes with ABI in children are variable, however speech production is very poor compared to auditory comprehension. In few children auditory performance are comparable to CI users. eABR is a reliable tool, and a good predictor of outcomes. Children with ABI require a longer period of rehabilitation and some children need to be dependent on visual cues for communication.

Keywords : Auditory Brainstem Implant, EABR, Outcomes

Oral Presentation 02

OP 02-11

Hearing Outcomes Following Cochlear Implantation with Anatomic or Default Frequency Mapping in Postlingual Deafness Adults

Xinmiao FAN[1], **Xiaowei CHEN[1]**

[1]Otolaryngology, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, China

Purposes: The aim of this study was to compare the outcomes of different mapping procedures based on anatomic or default frequency distribution in postlingual deafness adults who underwent cochlear implantation (CI).
Methods: Forty-eight adults with postlingual deafness who underwent CI (MED-EL) from January 2021 to May 2022 in our hospital were prospectively recruited. The participants were randomly assigned to two groups (the anatomic group and the default group). Postoperative computerized tomography (CT) scans were evaluated with Otoplan® to determine the angular insertion depth (AID) and the specific locations of the intracochlear electrodes. Anatomic maps were imported into MAESTRO 9.0 software (MED-EL) for anatomy-based fitting for anatomic group while default mapping program was set up for the default group. Hearing thresholds, Speech Recognition Scores (SRS) and Subjects' auditory and musical abilities were evaluated one year after using the CI. Differences were determined in two groups using Stata statistical software, with significance defined as $p < 0.05$.
Results: SRS under noisy conditions was significantly greater for anatomic group than the default group ($p=0.02$). Under quiet conditions, however, mean hearing thresholds (0.5, 1, 2, and 4 kHz) and SRS did not differ significantly between the two groups ($p=0.07$). Modified questionnaires showed that auditory ($p=0.02$) and musical ($p=0.01$) quality were significantly better following the anatomic mapping than the default procedure.
Conclusion: CI program based on the anatomic distribution may bring better SRS under noise conditions as well as better auditory and musical qualities than based on the default frequency distribution.

Keywords : postlingual deafness, Cochlear implantation, Anatomical mapping

Oral Presentation 02

OP 02-12

Cochlear implantation versus auditory brainstem implantation in children with auditory nerve deficiencies

Zhihua ZHANG[1,2,3], Jianqing CHEN[1,2,3], Yun LI[1,2,3], Zhaoyan WANG[1,2,3], Hao WU[1,2,3]

[1]Department of Otolaryngology, Shanghai Ninth Hospital Affilated To Shanghai Jiaotong University, China
[2]Ear Institute, Shanghai Jiaotong University, China
[3]Shanghai Key Laboratory of Translational Medicine On Ear and Nose Diseases, Shanghai, China

Objective: To review the outcomes of cochlear implantation(CI) versus that of auditory brainstem implantation(ABI) in children with cochlear nerve deficiency
Methods: Thirty-six children with cochlear nerve deficiency and bilateral prelingual profound sensorineural hearing loss were included in this study. Inner ear and internal auditory canal structures were evaluated using magnetic resonance imaging and temporal bone computed tomography scans. Meaningful auditory integration scales, categories of auditory performance scores, speech intelligibility ratings and pure tone average threshold were measured for evaluation of hearing and speech performance.
Results: Twenty-three children received CI, 13 children received ABI. In 13 ABI patients, 8 patients received CI and failed. In CI patients, after 12 months, average IT-MAIS was 26.5±11.2, CAP was 3.3±1.1, MUSS was 10.5±5.7, SIR was 2.0±0.2, average pure tone audiogram was 49.8±6.9dBHL. In ABI patients, average IT-MAIS was 31.5±17.1, CAP was 4.3±0.8, MUSS was 14.5±3.7, SIR was 2.3±0.3, average pure tone audiogram was 38.8±5.9 dBHL.
Conclusions: The decision to perform CI or ABI in children with cochlear nerve deficiency is difficult. The hearing and speech outcome were variable and uncertain. For CI patients who failed, it is recommended to perform ABI early.

Keywords : Cochlear implant, Auditory brainstem implant, Cochlear nerve deficiencies

Oral Presentation 02

OP 02-13

Exploring the impact of Active Transcutaneous Bone Conduction Implant on Tinnitus in Patient with Asymmetric Hearing Loss or Single-Sided Deafness

Ji Hyung LIM[1], Young Jun SEO[1], Jae Sang HAN[1], Jae Hyun SEO[1], **Shi Nae PARK[1]**

[1]Department of Otolaryngology-head and Neck Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea, Korea

Objectives: The aim of this study is to evaluate the impact of a Bonebridge™ (Med-El Corporation, Innsbruck, Austria), the active transcutaneous bone conduction implant, on tinnitus in the patients with asymmetric hearing loss(AHL) or single-sided deafness (SSD).
Methods: This retrospective analysis included the medical records and tinnitus questionnaires of the patients with either AHL or SSD who underwent Bonebridge surgery by a single surgeon at Seoul St. Mary's hospital between 2017 and 2022. Both audiologic assessments and tinnitus questionnaires were administered to the patients before and after surgery.
Results: Total of 21 patients, 11 with AHL and 10 with SSD, were enrolled in this study. Prior to the surgery, 80.9% (17) of the patients reported experiencing tinnitus, while 4 did not. There was no newly developed tinnitus after surgery. After implantation, 5 patients (23.8%) showed a complete cure of tinnitus at average of 9 months postoperatively. All patients showed significant improvement in hearing level after surgery. The mean tinnitus handicap inventory (THI) score and the four visual analogue scale (VAS) scores (loudness, awareness, annoyance, effect on life) demonstrated significant decreases after surgery, from 48.35±23.1 to 28.64±23.1, 5.41±1.7 to 3.70±2.2, 78.82±26.8 to 40.00±34.4, 5.47±2.1 to 2.94±2.6, 5.64±2.1 to 2.64±2.5, respectively. In subgroup analysis, both the AHL and SSD groups showed significant improvements across all tinnitus measures, except for the annoyance VAS score in the SSD group.
Conclusion: The use of BCI appears to be an effective approach not only for hearing rehabilitation but also for alleviating or even cure of tinnitus symptoms in the patients with AHL or SSD.

Keywords : Tinnitus, Bone conduction implant, Bonebridge

Oral Presentation 02

OP 02-14

Relationship between vestibular function and hearing in children with cochlear implantation

Ruijie WANG[1], Jianfen LUO[1], Xiuhua CHAO[1], Fangxia HU[1], **Haibo WANG[1], Lei XU[1]**

[1]Department of Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital, Shandong University, Jinan, China

Objective: This prospective cohort study aimed to investigate the vestibular function (VF) and hearing preservation (HP) and their relationship in pediatric recipients before and after a minimally invasive cochlear implantation (CI).
Methods: Forty-five pediatric patients with preoperative low frequency residual hearing (LFRH) (250 or 500 Hz ≤80 dB HL) who underwent minimally invasive CI were enrolled. Pure-tone thresholds were assessed before and at 1 and 12 months after surgery on the implanted side in all patients, including at the longest time-points in a group of 23 patients. The cervical/ocular vestibular-evoked myogenic potential (cVEMP/oVEMP), and video head impulse test (vHIT) were all evaluated in a second group of 24 patients with preoperative normal VF before and at 1 and 12 months after surgery.
Results: Before surgery, a significant correlation between 500 Hz and cVEMP-amplitude ratio (AR) was found (r=0.44, p=0.03); however, there were no other significant correlations between hearing and VF (p>0.05). There were nosignificant differences on VF preservation between 1 and 12 months post-CI, as well as HP (p>0.05). At 1 month post-CI, the correlations of the changes in horizontal semicircular canal (HSC) and posterior semicircular canal (PSC) and the change in 250 Hz threshold are correlated (r=-0.41, p=0.04 and r=-0.43, p=0.04, respectively). At 12 months post-CI, the change in 250 Hz threshold correlated to change in superior semicircular canal (SSC) (r=-0.43, p=0.04); the HP correlated to change inoVEMP-AR (r=0.41, p=0.04).
Conclusions: Minimally invasive techniques for HP are successful and effective for the preservation of VF in pediatric patients both in the short- and long-terms.
Key Words: Cochlear implant, pediatric patient, residual hearing, vestibular function

Keywords : Cochlear implant, Hearing preservation, Vestibular function

Oral Presentation 03

OP 03-1

Cochlear Implant Electrode Impedance Subcomponents as Biomarker for Residual Hearing

Stephan SCHRAIVOGEL[1], Philipp AEBISCHER[1], Stefan WEDER[1], Marco CAVERSACCIO[1], **Wilhelm WIMMER[1,2]**

[1]Department of Ent, Head and Neck Surgery, Bern University Hospital, University of Bern, Switzerland
[2]Klinikum Rechts Der Isar, Department of Otorhinolaryngology, Technical University of Munich, Germany

For patients undergoing cochlear implantation, maintaining the integrity of the cochlea and preserving residual hearing is crucial, especially for those who will undergo electric-acoustic stimulation. Impedances may reflect trauma due to electrode array insertion and could, therefore, serve as a biomarker for residual hearing. The aim of this study was to investigate the association between residual hearing and estimated impedance subcomponents.
Forty-two patients with lateral wall electrode arrays were included in the study. Residual hearing was computed for each patient based on audiological measurements, impedance telemetry recordings were used to estimate near and far-field impedances using an approximation model, and computed tomography scans were used to extract anatomical information about the cochlea. Linear mixed-effects models were used to assess the association between residual hearing and impedance subcomponent data.
Far-field impedance was found to be stable over time compared to near-field impedance, which showed progression. Low-frequency residual hearing demonstrated the progressive nature of hearing loss, with 48% of patients showing full or partial hearing preservation after 6 months of follow-up. Analysis revealed a statistically significant negative effect of near-field impedance on residual hearing (-3.81 dB HL per kΩ; p <.001). No significant effect of far-field impedance was found.
This study suggests that near-field impedance may offer higher specificity for residual hearing monitoring, while far-field impedance was not significantly associated with residual hearing. These results highlight the potential of impedance subcomponents as objective biomarkers for outcome monitoring in cochlear implantation.

Keywords : Hearing preservation monitoring, Objective measure, Electrode-tissue interface

Oral Presentation 03

OP 03-2

Anatomical Features of Children with Mondini Dysplasia: Influence on Cochlear Implantation Performance

Hye Ah JOO[1], **Hong Ju PARK[1]**, Woo Seok KANG[1], Joong Ho AHN[1], Jong Woo CHUNG[1]

[1]departments of Otorhinolaryngology-head and Neck Surgery, asan Medical Center, University of Ulsan College of Medicine, Korea

Objective: To analyze the long-term auditory performance after cochlear implantation (CI), and identify anatomical features of Mondini dysplasia associated with post-CI outcomes.
Study Design: Retrospective study.
Setting: Tertiary care academic center.
Patients: We enrolled 49 ears with Mondini dysplasia who underwent CI with >7 years of follow-up and age at CI- and sex-matched control group with radiologically normal inner ears.
Main outcomes and Measures: The development of auditory skills after CI was evaluated using word recognition scores (WRS). The anatomical features were measured based on temporal bone computed tomography (CT) and magnetic resonance imaging (MRI), involving the width of the bony cochlear nerve canal (BCNC), cochlear basal turn, enlarged vestibular aqueduct, cochlear height, and diameter of the cochlear nerve (CN).
Results: CI in ears with Mondini dysplasia showed comparable benefits and improvement of auditory performance to controls over 7 years follow-up. In Mondini dysplasia, four (8.2%) ears showed narrow BCNC (<1.4 mm) with poorer WRS (58±17%) than those with normal-sized BCNC, which had WRS (79±10%) comparable to that of the control group (77±14%). In Mondini dysplasia, the maximum ($r = 0.513$, $p < 0.001$) and minimum ($r = 0.328$, $p = 0.021$) CN diameters had positive correlations with post-CI WRS. The maximum CN diameter ($\beta = 48.347$, $p < 0.001$) and BCNC width ($\beta = 12.411$, $p = 0.041$) were significant factors which influence the post-CI WRS in multiple regression analysis.
Conclusions: Preoperative anatomical evaluation, especially BCNC status and cochlear neve integrity, may serve as predictive markers for post-CI performance.

Keywords : Cochlear implantation, Mondini dysplasia, Speech perception

Oral Presentation 03

OP 03-3

Objective measurements of the central auditory system in cochlear implant children with malformation: EABR and fNIRS testing

Hiroshi YAMAZAKI[1,2], Saburo MOROTO[1], Tomoko YAMAZAKI[1], Rinko TAMAYA[1], Naoko FUJII[1], Keizo FUJIWARA[1], Norio YAMAMOTO[1], Yasushi NAITO[1]

[1]Department of Otolaryngology, Kobe City Medical Center General Hospital, Japan
[2]Department of Otolaryngology-head and Neck Surgery, Kyoto University, Japan

Cochlear implant (CI) users with inner ear malformation and/or cochlear nerve deficiency (CND) often require larger intensities of CI stimulation to obtain adequate hearing. However, the excess electrical stimuli from CI often induce non-auditory facial nerve stimulation (FNS), one of the most common complications in malformation cases. Hence, properly setting the maximum CI stimuli is essential to obtain adequate hearing without FNS in the malformation population. Considering the increasing number of malformation ears undergoing cochlear implantation and the recent decreasing age of CI surgery, conventional behavioral-based CI programming may not be enough for appropriate CI programming for young children with severe malformations. In the present study, we retrospectively evaluated postoperative long-term changes in CI map parameters in 119 ears with malformation and 63 control ears without malformation and demonstrated that the results of intraoperative electrically evoked auditory brainstem response (EABR) testing would predict the maximum CI stimuli optimized by the behavioral-based CI programming after long-term CI use in malformation ears. Furthermore, we postoperatively performed both EABR and functional near infra-red spectroscopy (fNIRS) in 40 children with malformation who had used their CI for over one year to show both the fNIRS and EABR testing results were significantly correlated with the maximum CI stimuli determined by the behavioral-based CI programming. These study results suggest that objective measurements of the central auditory system, including the EABR and fNIRS tests are helpful for CI programming in pediatric CI users with malformation.

Keywords : Malformation, EABR, NIRS

Oral Presentation 03

OP 03-4

Cochlear implantation in common cavity malformation

Jamal KASSOUMA[1,2]

[1]Cochlear Implant Unit, Dubai Hospital, United Arab Emirates
[2]Faculty of Medicine, Damascus University, Syrian Arab Republic

The cochlear implantation procedure has been increasing all around the world, and initial guidelines was to avoid doing implantation in congenital anomalies, but this has changed with time.
I am going to demonstrate the Cochlear Implantation in the presence of common cavity malformation, showing the outcome in 11 cases using Med El custom-made devise and medium electrode, with comparison of the results of CI in normal cochlea.

Keywords : Cochlear implantation, Common cavity, Outcomes

Oral Presentation 03

OP 03-5

Cochlear Implantation in Advanced Otosclerosis: Utility of Preoperative Radiological Assessment in Predicting Intraoperative Difficulty and Final Electrode Position

Jean-Marc GERARD[1], Daniel WONG[1], Fiona HILL[1], Jamie LEIGH[1], Richard DOWELL[1], Robert BRIGGS[1]

[1]*Victorian Cochlear Implant Program, Royal Victorian Eye and Ear Hospital, Australia*

Purpose: To determine if preoperative radiological scoring can predict intraoperative difficulty and final cochlear electrode position in patients with advanced otosclerosis (AO). To investigate if radiological features and non-scala tympani insertions are correlated with postoperative speech outcomes.
Methods: A retrospective cohort study of AO patients who underwent cochlear implantation from 2014 to 2020. Speech perception outcomes in AO (N=48, 52 ears) were compared to a larger cohort of post-lingually deaf adult patients implanted from 2000 to 2020 (N=1414) with bilateral hearing loss and normal cochlear anatomy. Preoperative imaging for AO patients and final electrode position were scored and correlated with intraoperative difficulty. Radiology and electrode position were correlated with speech outcomes.
Results: AO with severe-to-profound sensorineural hearing loss benefit significantly from cochlear implantation (3-month phoneme score 39.7% versus preop score 10.9%, p <0.001). Mean duration of deafness was longer in the AO group (19.5 versus 14.3 years, p<0.05). AO group had no facial nerve stimulation post-implantation. Abnormality of the round window on preoperative radiological assessment predicts intraoperative difficulty in electrode insertion. Preoperative radiological evidence of signal change in the scalae has a higher correlation with final electrode position in a non-scala tympani position. Final electrode position (scala tympani or vestibuli) was not correlated with differences in audiological outcomes at 12 months.
Conclusions: Anatomical changes of the otic capsule in otosclerosis can result in increased difficulty of surgery. Evidence of preoperative cochlear luminal changes is associated with intraoperative difficult insertion and final non-scala tympani position. Perimodiolar implants are recommended to reduce incidence of facial nerve stimulation. AO patients derive benefit from cochlear implantation, with no difference in speech outcomes with scala vestibuli insertions. These patients may be considered for earlier implantation.

Keywords : Advanced otosclerosis, Imagery, Hearing outcomes

Oral Presentation 03

OP 03-6

Outcome prediction of cochlear implantation in children with inner ear anomalies without modiolus

Sung Wook JEONG[1], Lee-Suk KIM[1]

[1]*Department of Otolaryngology, College of Medicine, Dong-a University, Korea*

Objective: Given that cochlear implant stimulates spiral ganglion cells in modiolus, inner ear anomalies without modiolus (IEAw/oM) can result in poor speech perception after cochlear implantation (CI). This study was performed to assess the outcome of CI in children with IEAw/oM.Methods: A retrospective review of medical record of pediatric CI during last 30 years were reviewed. The speech perception outcomes after CI in IEAw/oM cases were assessed and the factors to determine the outcome were analyzed using correlation analysis.
Results: There were 936 pediatric CI cases. IEAw/oM cases were 33 among them. IEA accounted for 24 % of pediatric CI cases. IEAw/oM accounted for 14.6 % of IEA cases and 3.5% of pediatric CI cases. IEAw/oM group consisted of incomplete partition (IP) type 1 in 11 ears and IP type 3 in 3 ears, cochlear hypoplasia type 4 in 8 ears, common cavity (CC) in 9 ears, cochlear aplasia in 2 ears.
All the children with IEAw/oM achieved useful open-set speech perception abilities after CI. IP 1 and 3 were associated the best outcome and CC cases showed worst outcome. Age at CI and bony cochlear canal width were significant factors to influence speech perception after CI.
Conclusion: children with IEAw/oM can achieve good speech perception if they receive CI at younger age and have patent cochlear nerve canal.

Keywords : Inner ear anomaly, Modiolus, Cochlear implant

Oral Presentation 03

OP 03-7

Application of Multiplanar Volume Reconstruction Technique for the Assessment of Electrode Location and Analysis of the Correlation to Cochlear Programming and Performance in Common Cavity Deformit

Xingmei WEI[1], Simeng LU[1], Ying KONG[1], **Yongxin LI[1]**, Huaiyu ZHANG[2]

[1]Department of Otorhinolaryngology Head and Neck Surgery, Capital Medical University, China
[2]Department of Radiology, Capital Medical University, China

Purpose: Owing to the characteristic anatomy, cochlear implantation (CI) for common cavity deformity (CCD) has resulted in varied outcomes and frequent facial and vestibular nerve stimulation. The current study analyzed the correlation among the distance between each electrode and cavity wall (abbreviation, D), programming parameters, and performances outcomes.
Materials and Methods: The current, retrospective study included 25 patients (27 ears) with CCD underwent CI. The multiplanar volume reconstruction (MPVR) techniques were employed to reconstruct and evaluate the postoperative temporal bone CT. The D and maximum comfortable level (MCL) 6 months after CI, facial and vestibular nerve stimulation, and outcomes 1, 2, and 3 years after CI pertaining to the questionnaires were documented and analyzed.
Results: The patients were divided into symptomatic (10, 37%) and asymptomatic (17, 63%) groups according to with or without facial and vestibular nerve stimulation. The MCL pertaining to the symptomatic group was significantly lower than asymptomatic group, but Categories of Auditory Performance (CAP) scores 1 year after surgery was better ($p < 0.05$). The subjects were divided into flat (12, 14.4%) and curved (15, 55.6%) groups based on the contour of MCL map. The MCL and D were lower and shorter in the curved group than the flat group, and CAP score 1 year after surgery and Speech Intelligibility Rating (SIR) 3 years after surgery were better ($p < 0.05$).
Conclusion: Although abnormal reactions such as facial and vestibular nerve stimulation were observed to be more frequent, lower MCL and better outcomes were observed in relation to the shorter D.

Keywords : Cochlear implantation, Common cavity deformity, Maximum comfortable level

Oral Presentation 03

OP 03-9

Implementation of the International Classification of Functioning, Disability and Health model in Cochlear Implant recipients

Dayse TAVORA-VIEIRA[1,2,3], Ellen ANDRIES[4,5], Artur LORENS[6], Miryam CALVINO[7,8], Anja KURZ[9], Ilona ANDERSON[10], Edda AMANN[10], Griet MERTENS[4,5]

[1]Audiology, Fiona Stanley Fremantle Hospital Group, Australia
[2]Medical School, University of Western Australia, Australia
[3]School of Population Health, Curtin University, Australia
[4]4department of Otorhinolaryngology, Head and Neck Surgery,, Antwerp University Hospital, Belgium
[5]5experimental Laboratory of Translational Neurosciences and Dento-otolaryngology, University of Antwerp, Belgium
[6]Institute of Physiology and Pathology of Hearing, World Hearing Center, Poland
[7]Department of Otolaryngology, La Paz University Hospital,, Spain
[8]8biomedical Research Networking Centre On Rare Diseases, Institute of Health Carlos Iii, Spain
[9]9department of Otolaryngology, University Clinic of Würzburg, Germany
[10]Clinical Research Department, Med-el Gmbh, Austria

Background: Cochlear implantation has emerged as a highly effective intervention for individuals with severe to profound hearing loss, offering the potential to restore or significantly improve auditory perception and speech understanding. However, outcomes are measured differently across clinics and countries, creating a lack of standardized reporting for the effect of cochlear implants.
Objectives: The aim of this study was to define an International Classification of Functioning, Disability and Health (ICF) core set specifically for CI users. Additionally, we sought to assign a valid assessment tool to each ICF category included in this core set and apply it in clinical routine with a wide range of CI users.
Methods: An international multidisciplinary core group of CI experts was assembled to select the most relevant ICF categories and codes for CI users from the existing ICF core set for hearing loss. Subsequently, a commonly used validated instrument or method was identified and assigned to each ICF category, accompanied by quantified ICF qualifiers. The resulting ICF-based CI outcome assessment protocol was then implemented in a prospective longitudinal multicenter study, involving 63 adult CI candidates who were assessed before and 6 months after implantation.
Results: The study encompassed a diverse range of participants, including adult unilateral CI users, bilateral CI users, bimodal CI users (combining a CI with a hearing aid), and individuals with single-sided deafness. Overall, the CI users in our study exhibited either improvements or stable ICF qualifiers after cochlear implantation across all ICF domains. Notably, categories related to auditory perception and communication showed the most significant improvements following implantation.
Conclusion: The ICF Core set for CI and its assigned measurement tools provide a common language and comprehensive assessment protocol for the description and measurement of CI outcomes worldwide.

Keywords : ICF, Cochlear implant, Outcomes

Oral Presentation 03

OP 03-10

Patient preferences for Remote Cochlear Implant Assessment: A Discrete Choice Experiment

Cathy SUCHER[1,2], Richard NORMAN[3], Emma CHAFFEY[1,2], Rebecca BENNETT[1,2,4,5], Melanie FERGUSON[1,5]

[1]Brain and Hearing, Ear Science Institute Australia, Australia
[2]School of Medicine, University of Western Australia, Australia
[3]Curtin School of Population Science, Curtin University, Australia
[4]National Acoustic Laboratories, Nal, Australia
[5]Curtin Medical School, Curtin University, Australia

Objectives: Consideration of patient preferences for delivery of remote services is crucial for successful implementation. Remote Check (Cochlear Ltd) facilitates asynchronous remote review of CI users and their CI function. We employed discrete choice experiment techniques to understand the key factors promoting client uptake and continued use of Remote Check in a busy implant clinic.
Study Design: Discrete Choice Experiment
Methods: A discrete choice experiment consisting of 5 attributes related to a Remote Check review service; 1.Who reviews the test, 2. What outcome information is provided, 3.How results are delivered, 4. How soon results are received, and 5.Willingness to pay, was constructed following focus groups with CI recipients, clinicians and administrators. Experienced CI recipients, were invited to complete the D-efficient experiment, designed using Ngene software and administered with Qualtrics software, as an online survey. Recipients from three Australian implant clinics were approached to participate, regardless of their experience with Remote Check. Respondents were presented with 12 choice pairs, varying across attributes, across 3 clinical scenarios (4 pairs per scenario). A conditional logit model and latent class analysis was used to identify mean preferences and differing opinions. Results: A total of 131 respondents (median age 65 years, range 26-89) completed the survey.
Respondents strongest preferences were for Remote Check review by their regular audiologist rather than trained administration staff ($p<0.001$), with results received the next day rather than in two weeks $p<0.001$) at the cheapest cost possible (AUD10 per review most preferred compared to all other options including annual subscriptions of AUD40 or AUD120 $p=0.035$; $p<0.001$ respectively) or single cost AUD30 ($p<0.001$).
Conclusion: Our model showed that cost, client-clinician relationship and prompt review are the most important factors to patients when considering implementation of Remote Check services.

Keywords : Telehealth, Cochlear implant, Service delivery

Oral Presentation 03

OP 03-11

Investigating Facial Nerve Stimulation After Cochlear Implantation

Farid ALZHRANI

king Abdullah Ear Specialist Center (kaesc), king Saud University, Saudi Arabia

Objectives/Hypothesis: Facial nerve stimulation (FNS) can occur after cochlear implantation for a small number of recipients. This study aimed to investigate if a correlation exists between the variables involved in FNS.
Study Design: Retrospective cohort review.
Methods: There were 32 out of 1,100 cochlear implant recipients who experienced FNS in our clinic between 2010 and 2019. The following variables were recorded from a retrospective chart review: grade of FNS, onset of FNS, the number of channels stimulating FNS, and radiological findings of abnormalities in the inner ear. Statistical analyses were performed to identify a correlation between any of the variables involved. The techniques used to reduce FNS were analyzed.
Results: Eleven adult ears had progressive hearing loss, three had idiopathic sudden sensorineural hearing loss (SNHL), and one congenital SNHL. All pediatric ears were diagnosed with congenital SNHL, except for one ear with idiopathic sudden SNHL. The grade of FNS ranged from mild stimulation or slight motion in the eye, mouth, nasolabial, or forehead regions ($n = 8$) to total severe stimulation of the facial musculature and/or severe pain ($n = 3$). The onset of FNS occurred immediately after activation for nine ears, and up to 16 months later for the other subjects. A significant correlation was observed between the number of channels stimulating FNS, the grade of FNS, and the radiological findings of the inner ear. FNS was completely resolved for 30 ears and partially resolved for two ears.
Conclusions: FNS can occur any time after cochlear implantation and can affect both adult and pediatric. However, it can be effectively resolved using specific fitting techniques.

Keywords : Facial Nerve Stimulation, Cochlear Implantation, hearing loss

Oral Presentation 03

OP 03-12

Cochlear Implantation for Auditory Neuropathy Spectrum Disorder: An Updated Systematic Review

Maryam SAHWAN[1], Yassin ABDELSAMAD[2], Fatema ALASFOOR[1], Fatema ALFAYEZ[1], Jaya NICHANI[3], **Ghada BINKHAMIS[4,5]**

[1]Ent Department, Governmental Hospitals, Bahrain
[2]Research Department, Medel, Saudi Arabia
[3]Ent Department, Royal Manchester Children's Hospital, University of Manchester, UK
[4]Communication and Swallowing Disorders Department, King Fahad Medical City, Saudi Arabia
[5]Manchester Center For Audiology and Deafness (mancad), University of Manchester, UK

Background: The goal of treating auditory neuropathy spectrum disorder (ANSD) is to restore the children's ability to discriminate auditory information. Children who are not making sufficient progress in speech comprehension and speech and language development after receiving adequate auditory re/habilitation and/or acoustic amplification may be candidates for cochlear implantation (CI). Despite the growing number of published literature on CI outcomes in children with ANSD, current evidence is primarily based on case reports or retrospective chart reviews some of which with a limited number of children. Also, the outcomes of CI seem to vary between children with ANSD. Thus, compelling evidence is lacking. This updated systematic review evaluated the speech perception, language, and speech intelligibility outcomes of children with ANSD post CI.
Methods: An online bibliographic search was conducted in PubMed, Scopus, Web of Science, and CENTRAL databases. We included both interventional and observational studies that assessed the outcomes of the CI for children with ANSD.
Results: Thirty-three studies were included in this systematic review. Several tests were used to assess speech perception following CI in children with ANSD. Children with ANSD had mean Categories of Auditory Performance scores ranging from 4.3 to 7 post-operatively, this result was better to the preoperative scores which ranged between 0.4 to 2.5. Likewise, the Infant-Toddler Meaningful Auditory Integration Scale, Phonetically Balanced Kindergarten, and multisyllabic lexical neighborhood test showed clinically relevant improvement after the CI. The same findings were reported for language and speech intelligibility scores. One study investigated the quality of life/child satisfaction after CI and showed overall good satisfaction with CI outcomes.
Conclusion: The present systematic review suggests that CI is a feasible and effective hearing re/habilitation modality for children with ANSD.

Keywords : Cochlear implant, Auditory neuropathy spectrum disorder, Cochlear nerve aplasia

Oral Presentation 03

OP 03-13

The clinical trial of cochlear implantation in single-sided deafness in Japan

Masahiro TAKAHASHI[1], Shogo OYAMADA[1], **Satoshi IWASAKI[1]**

[1]Department of Othorhinolaryngology, International University of Health and Welfare, Mita Hospital, Japan

Purpose
Single-sided deafness (SSD) is characterized by severe-to-profound sensorineural hearing loss in one ear and normal hearing or only mild hearing loss in the better hearing side. SSD has been estimated to be one case per 300 people. SSD patients often experience difficulties in hearing, particularly in noisy environments, as well as in sound localization.
The cochlear implantation as a treatment option for SSD had received CE mark in 2013, and approved by FDA in 2019. It is not yet approved and covered by insurance in Japan. At last, the clinical trial of cochlear implantation for SSD patients started at our hospital in 2021 (jRCTs032200430). The purpose of this study is to present the results of the clinical trial.
Methods
Eligible participants were the age 6 years or older who experienced unilateral sensorineural hearing loss of at least 70 dB, and functional acoustic hearing (<40dB) in the better hearing ear. Eligibility criteria also included a duration of deafness of 6 months.The evaluation for SSD before and after cochlear implantation is performed by speech perception ability in quiet and noise, sound localization ability and tinnitus distress were assessed presurgically and at 1, 3, 6, and 12 months after CI activation. The speech perception test is on the Japanese monosyllable test (67-S). All patients were implanted with a fully inserted MED-EL Synchrony FLEX28 implant (MED-EL, Innsbruck, Austria).
Results
37 cases were included in this study. The average speech perception ability in noise, sound localization ability and tinnitus distress were significant improvement after 1 year surgery. Conclusion
Cochlear implantation for Japanese, single-sided deafness patients resulted in improved speech perception, increased sound localization accuracy, and reduced tinnitus distress.

Keywords : Single-sided deafness, Speech perception in noise, Sound localization

Oral Presentation 03

OP 03-14

Sequential Bilateral Implantation in Older Children: inter-implant map differences and their effects in functional outcomes

Mohamed ALSHEHABI[1], Laura VIANI[2], Peter WALSHE[2]

[1]*Ent, Royal Medical Services, Bahrain*
[2]*Cochlear Implant and Hearing, Beaumont Hospital, Ireland*

Objective
How do inter-implant delay and map differences between two implants affect spatial and speech in noise discrimination, in sequentially implanted
Methodology
Children divided into two groups, according to their Inter-Implant Delay (IID):
Short IID (12, mean IID = 4.1 yrs; range: 1-7 yrs)
Long IID (11, mean IID = 12.6 yrs; range: 8-16 yrs)
Outcome Measures•
Speech Testing in noise •
Spatial Discrimination
ResultThe Dynamic Range for CI2 was 25% smaller than DR for CI1 for Long IID group.
This difference arises from lower C-levels.
Children with Short IID and balanced DRs exhibit improvement of ~ 24% in CI1+2 mode.Children with Long IID show similar speech discrimination in CI1 and CI1+2 modes.
Children with Short IID and balanced DRs show smaller localisation errors in CI1+2 condition compared with CI1 alone condition. Children with Long IID exhibit similar performance errors in CI1+2 and CI1 conditions.
Children with Short IID show asymmetric distribution of localisation errors in CI1 condition with significantly larger errors when localising sounds from the side contralateral to the implant
Conclusion
Older children show some functional benefits from sequential implantation. Benefits ardependent onInter-implant delayInter-implant programming differences, in particular DR. Differences in DRs between first and second implants can lead to asymmetric sound perception.Finally, this novel VR-based spatial discrimination tool has been shown to be viable clinical alternative to assess spatial discrimination in users with bilateral implants.

Keywords : Bilateral, Sequential, Outcome

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Abstract Book

Plenary Lecture 02

PL 02

Next generation concept to treat severe hearing loss – Advanced cochlear implantation

Thomas LENARZ

Otolaryngology, Hannover Medical School, Germany

Recent advances in the field of auditory implants have opened a wide range of possibilities to treat all types and grades of hearing loss. Patients with severe to profound hearing loss are mainly served by cochlear implants, which restore the function of the inner ear partially. Recipients can understand speech in quiet but still show deficits in speech and noise understanding and music listening. The main reasons are the reduced information transfer at the electrode nerve interface and the non-physiological coding of auditory information within the auditory system. In addition, multi module stimulation for the optimal use of residual hearing is not provided in integrated systems.

Recent developments focus on improvement in all of these three areas. The electrode nerve interface can be improved by different approaches with either regeneration of auditory nerve fibers growing on to the electrode, the direct insertion of the electrode into the auditory nerve (ANR auditory nerve implant) or by more focused stimulation of the auditory nerve. All three approaches are leading to an increased number of information channels. These efforts combine both technological and biological approaches, which will lead to advanced auditory implants.

In order to improve the central auditory processing recordings out of the central auditory system become important to analyze the underlying processing mechanisms. Closed-loop-systems will allow to use this information for the optimization of the peripheral stimulation in a feedback process. In addition, neuro modulation through electric stimulation will induce plasticity to improve hearing and understanding in different listening situations.

In summary these developments are leading towards integrated auditory systems that combine peripheral and central processing stimulation and processing processes which will lead to improved auditory performance.

Featured Talk 09

FT 09

Cochlear Implant Revisions – What have we learned?

Joachim MüLLER

Department of Otorhinolaryngology, Head & Neck Surgery, Munich University Hospital, Germany

Cochlear implantation is considered to have a low incidence of complications. As the indications for cochlear implantation have expanded, both the number of implantations and the number of implanting centers have increased (currently > 150 in Germany), which can potentially also have an impact on revision rates. In addition, newer technologies pose new risks, such as electrode migration, magnet dislocations and "tip fold over", which will also be discussed in the lecture in comparison to the literature.

We report our results and revision rates for our consecutive primary CI surgeries that required revision due to device-related problems, trauma, surgical, or other medical complications. include short- and long-term complications. Particular attention is paid to revisions after long-term use of the device.

We report our results on revision rates due to device related problem, surgical complications and revisions caused by trauma. Medical Complications rates include short and long term complications. Our Data are comparable with the lower range of those mentioned in the literature. However failure specification may vary among authors, leading to difficult to compare given revision rates.

In addition, recent technologies have increased the risk of appearence of new problems, like electrode migration, magnet displacements, electrode tip fold over which are also discussed in comparison with the literature.

It is suggested that both, revision surgery and reimplantation require extra care and should be carried out by experienced surgeons. Based on case demonstrations , the surgical procedure is discussed, especially reg re-implantation. Some conclusions for the primary intervention are given and solutions to prevent complications are presented for discussion, also with the aim to create awareness for caution in an expanding surgical field.

Featured Talk 10

FT 10

Remote care - putting the patient in charge

Helen CULLINGTON

Auditory Implant Service, University of Southampton, UK

People with cochlear implants need lifelong care to achieve their best outcomes. The COVID-19 pandemic facilitated a widespread rapid introduction of remote care in most healthcare settings. Technology also improved considerably e.g., online consultations and groups, Zoom, Teams, and enhanced autocaptioning. Some cochlear implant companies introduced new tools to facilitate caring for patients remotely. Almost all aspects of cochlear implant care for adults and children can now be done remotely: tuning, rehabilitation and lifelong care (not the surgery … yet!). Many cochlear implant centres now offer a blended service: some appointments are in person and some are offered remotely. Cochlear implant companies now also offer apps to allow the patient to manage their own care at home, for example adjusting programs, finding a lost processor, testing hearing and speech perception, checking equipment, and uploading photos of the implant site. However some aspects of care can be missed when done remotely, for example equipment issues, extra headpiece magnets added, wellbeing or safeguarding concerns, non verbal cues, or cochlear implant microphone issues (if testing is done using streaming).

Sometimes the people who need remote care the most cannot access it, for example a patient with mobility issues, living alone many hours from the implant centre … with no computer or smartphone. In the United Kingdom (UK), around a third of the public feel that increased use of technology made sense during COVID-19, but was 'not for the long term' [1], with barriers including digital skills, connectivity, accessibility, confidence and motivation. Some sectors of the population are more likely to be digitally excluded than others, for example people who are older, in lower income groups, without a job, in social housing, homeless, those with disabilities, people with fewer educational qualifications, people living in rural areas, and those whose first language is not English. More than 11 million people lack basic digital skills to use the internet effectively in the UK [2].

Just because it is technically possible to do something remotely does not mean it is the right thing for the patient. We need to always put the patient in charge of their care, and use shared decision making between the patient and their family and clinician to decide what is the best option. We need to codesign, implement and evaluate care with patients for patients – ensuring we continue to provide high quality, sustainable, accessible, flexible cochlear implant services. We need to explore patient preferences for how they receive their care, and ensure they are empowered to make the right decision for them at that time.

1. The Health Foundation, Securing a positive health care technology legacy from COVID-19. 2021.
2. NHS Digital, Digital inclusion for health and social care. 2019.

Featured Talk 11

FT 11

The TEMPORAL project: Optimizing Speech Coding Strategies by Using Models and Machine Learning

Johan FRIJNS[1,2]

[1]*Otorhinolaryngology and Head and Neck Surgery, Leiden University Medical Centre, The Netherlands*
[2]*Leiden Institute of Advanced Computer Science (LIACS), Leiden University, The Netherlands*

The multidisciplinary TEMPORAL project involves three Ph.D. students and aims to enhance speech coding strategies, specifically focusing on temporal fine structure, using computational models of normal and electrical hearing via artificial intelligence. The Bruce et al. (Hear Res 2018) model is employed to simulate normal hearing, while in-house biophysical models [Kalkman et al., Hear Res 2022] and a phenomenological model [van Gendt et al., Hear Res 2020] are used to simulate electrical hearing. This pipeline generates simulated spike trains in response to pulse trains from a speech coding strategy, implemented on a highly flexible speech processor model. By optimizing the characteristics of the speech coding strategy in silico, we want to minimize the differences in the spiking patterns produced by the normal hearing model and the model of electrical hearing when presented with the same sound input. The optimized speech coding strategies will be validated through patient testing.

A first step within this project has been to make the pipeline computationally less expensive, such that it can be used in large-scale optimization experiments. In De Nobel et al. [Hear Res 2023], a surrogate was developed to replace the costly active nerve fiber model, which reduced simulation duration by five orders of magnitude. The surrogate was able to emulate the behavior of the biophysical model with near-perfect precision (R^2> .99). It was used to optimize the shape of the stimulus waveform for energy efficiency, which indicated potential energy savings of 8%–45% compared to a square wave. Results were validated with the original active nerve model, which demonstrates the robustness of the approximation by the surrogate to new waveform types.

To reduce the computational complexity of the phenomenological model, the original implementation, which uses a power law to compute the neural properties of accommodation and adaptation, has been replaced with a double exponential smoothing function, which only requires a single operation per time step. The parameters for this exponential smoothing function have been optimized to match the temporal behavior of the power law implementation closely, and the model has been re-validated on several experimental data sets.
In parallel, we analyzed the neurograms of the two models with two implementations of the spectrally modulated ripple test (SMRT; Aronoff & Landsberger, JASA 2013). The original SMRT was created with a carrier density of 33/octave, but these stimuli give a distorted view of the spectral resolution threshold of listeners, as Resnick et al. (JASA 2020) showed that spectral aliasing occurred around 16 ripples-per-octave (RPO). From neurograms created with the normal hearing model of Bruce et al. (2018), we could indeed infer that aliasing happened around 16 RPO. In addition, we could gather from neurograms created with the electric hearing pipeline that spectral resolution is severely limited for a cochlear implant user when compared to normal hearing.

We conclude that our models can successfully reproduce spiking behavior in normal and electric hearing for complex sounds, thereby forming a foundation for using computational models to create an optimized speech coding strategy. We have developed a computational pipeline to expedite the optimization process and started aligning the output of the two computational models. Going forward, our work will concentrate on optimizing known speech coding strategies and designing novel ones through this framework.

Featured Talk 12

FT 12

Elderly CI and cognition

Shakeel SAEED

Department of Otology/Neuro-otology, University College London Ear Institute, UK

Featured Talk 13

FT 13

Managing Far Advanced Otosclerosis – Stapes surgery, Hearing aids or CI?

Mohan KAMESWARAN

ENT, Madras ENT Research Foundation, India

Background: Advanced otosclerosis affects approximately 10% of patients with otosclerosis. Ossification of the cochlea increases with the course of the disease and may cause sensori-neural or mixed hearing loss. Hearing aids, stapedotomy and cochlear implants are management options for hearing loss associated with advanced otosclerosis.

Methods: A retrospective study of 153 patients with advanced otosclerosis was done in a tertiary ENT centre. 110 patients with advanced otosclerosis underwent stapedotomy followed by hearing aid fitting and 43 patients with advanced otosclerosis underwent cochlear implantation (CI) from 1997 till date. Exclusion criteria included patients with profound hearing loss from causes other than otosclerosis. The aim was to study the indications, selection criteria, as well as surgical issues of stapedotomy and cochlear implantation in patients with advanced otosclerosis.

Results: Stapedotomy followed by use of hearing aid was found to give good outcomes in advanced otosclerosis. Patients with advanced otosclerosis who had poor pre-operative speech discrimination underwent CI. Complete insertion was possible in 39 patients and partial insertion was done in 4 patients. The outcomes of cochlear implantation were found to be satisfactory. Facial nerve stimulation was seen in 5 patients who underwent CI; however this was successfully managed by reprogramming or switching off the concerned electrodes.

Conclusion: In our experience, stapedotomy followed by hearing aids or CI in advanced otosclerosis have proven successful. The selection criteria for hearing aids versus stapedotomy versus CI have to be stringent for optimal outcomes.

Keywords: Advanced otosclerosis, Stapedotomy, hearing aids, CI

Featured Talk 14

FT 14

Predicting speech and language outcomes in 9-year-old children with hearing loss who use cochlear implants

Teresa CHING[1,2,3]

[1]Macquarie School of Education, Macquarie University, Australia
[2]NextSense Institute, NextSense, Australia
[3]School of Rehabilitation Sciences, University of Queensland, Australia

Predicting speech and language outcomes in 9-year-old children with hearing loss who use cochlear implants.
Teresa YC Ching, Linda Cupples, Greg Leigh

This study examined speech and language outcomes in a population-based cohort of 9-year-old children with hearing loss who use cochlear implants. Assessments of speech and language abilities were administered at 5- and 9-years of age, along with collection of a diverse set of cognitive, demographic and audiological variables using direct assessment and caregiver report. Multiple regression analyses were used to address two questions: 1) Does speech perception at age 5 years predict language outcomes at 9 years after controlling for the effect of early language? 2) Does language at 5 years of age predict speech perception at 9 years of age after controlling for the effect of early speech perception? The results are interpreted in light of current research and past findings. Implications for clinical management will be discussed.

Featured Talk 15

FT 15

Development and translation of a new auditory nerve implant

Hubert LIM

Otolaryngology and Biomedical Engineering, University of Minnesota, USA

Over the past decade, there have been rapid developments in novel neural technologies for treating a wide range of neurological and health disorders, catalyzed by the large increase in funding provided through NIH BRAIN Initiative, DARPA, and other funding mechanisms across the United States and worldwide. Invasive and noninvasive technologies have been pursued by multiple groups, in addition to different energy modalities including electrical, magnetic, optical and ultrasound stimulation. One major goal of my lab has been to treat hearing loss and enhance communication capabilities with new implantable stimulation technologies. For hearing restoration, cochlear implants have enabled hundreds of thousands of deaf individuals to hear and better integrate into mainstream society. The cochlear implant is considered one of the most successful neural prostheses. However, there are deaf individuals who cannot sufficiently benefit from a cochlear implant, which requires implantation into the bony cochlea and electrical activation of the auditory nerve through the bony structure. One key bottleneck for greatly improving the performance of cochlear implants is associated with the limited number of frequency channels of information possible with cochlear implants, since the electrode sites are distant from the auditory nerve with current having to travel through a bony cochlear wall to reach the nerve (i.e., large current spread of neural activation). A major opportunity in this field is to implant electrode sites directly into the auditory nerve to achieve a higher density of channels of auditory information to the brain, in what is called the auditory nerve implant (ANI). Through a large collaborative NIH BRAIN Initiative grant, an ANI system is being developed that leverages the well-known Blackrock electrode array technology connected with a MED-EL cochlear implant stimulator for implantation in three deaf patients. In my talk, I will present on the ongoing efforts for translating the ANI to patients that spans device development, pre-clinical device validation testing, animal studies, stimulation algorithm development, surgical approach development in cadaver experiments, and regulatory processes to then initiate a pilot clinical trial by Fall of 2024.

Featured Talk 16

FT 16

Current Issues with Pediatric Cochlear Implantation: Patient Evaluation, Candidacy Guidelines, Vaccine Requirements, Age at Implantation, Surgical Considerations and Speech Perception Outcomes

Kenneth H LEE

Otolaryngology - Head & Neck Surgery, University of Texas Southwestern Medical Center at Dallas, USA

Cochlear Implants (CIs) have enabled children with severe to profound sensorineureal hearing loss to gain meaningful sound sufficient to functionally demonstrate a clear benefit. As a result, CIs have gained wide acceptance as an ideal treatment option for deafness in the pediatric population. As with many issues related to the medical and surgical care of young children, cochlear implantation in a child has various nuances that require special attention beyond the standard considerations for evaluation and surgery in adults with hearing loss. Resulting from improvements specifically related to CIs and post implant rehabilitation, as well as general technological advances, such as better imaging resolution and greater understanding of the significance of genetic testing, various aspects of cochlear implantation in children remain a moving target. There has been an evolution in the approach to patient evaluation, changes in candidacy guidelines and vaccine requirements as well as a lowering of the age requirement for surgery. In addition, there are special considerations to account for in children due to differences in the anatomy and physiology of infants. Current criteria and guidelines of cochlear implantation in children will be presented. Furthermore, special surgical considerations and the outcomes of CI surgery in children will be discussed.

Featured Talk 17

FT 17

"Neural interphase as important factor in "long term" results in cochlear implantation"

Angel RAMOS-MACIAS

Department of Otolaryngology Head Neck Surgery, University of Las Palmas de Gran Canaria, Spain

In this presentation we analyze the Improvement in Neural interphase in cochlear implant when using a slim and geometric slim electrode array. The main factors to be analyze in this lecture are : a)Improve stimulation b)Improve Discrimination and c)Improve Listening effort . Acccording to our data , "Cochlear Health" as main concept including : best surgical approach, residual hearing monitoring, better preop and postop knowledge of the Cochlea anatomy , is essential for CI results, so improving the neural interphase, mainly providing a symmetrical peri-modiolar position, will provide better stimulation and better long term results Modiolar electrodes recipients have better ECAPs responses if compare with similar lateral Wall electrodes in the same neurophysiological and anatomical condition . Also a 65% success rate on electrode discrimination was observed, while lateral electrodes recipients has a 21% success rate. These results shows that modiolar electrode position may provide better electrode discrimination and stimulation with a lowest cognitive workload compared with lateral electrodes according to pupil variation (pupillometry).

Featured Talk 18

FT 18

Clinical features of cochlear implants in children with additional needs

Jong Woo CHUNG

Otorhinolaryngology-Head and Neck Surgery, ASAN MEDICAL CENTER, UNIVERSITY OF ULSAN COLLEGE OF MEDICINE, Korea

Objectives
Additional needs mean the specific requirements or supports that individuals with disabilities or syndromes. Intellectual ability is an important factor, estimating the outcome of a cochlear implantation (CI). Social maturity score (SMS) is an indirect predictor of intellectual capacity and social skills. We aimed to evaluate the clinical characteristics and performance of CI of congenital deaf patients with additional needs, including the effect of SMS on CI.
Methods
The medical records of patients who were diagnosed with severe to profound SNHL and underwent CI from January 2001 to December 2021 at our tertiary institution were retrospectively reviewed. The study focused on infants who had developmental delay, chromosomal abnormalities, or other syndromes accompanying prelingual deaf. We included the patients who underwent CI prior to the age of seven. Preoperative Social Quotient (SQ) from the SMS was used to evaluate the presence of developmental delay, and the language development was assessed including Categories of Auditory Performance (CAP) and Infant- Toddler Meaningful Auditory Integration Scale (MAIS) for over 2 years.
Results
A total of 80 patients diagnosed with developmental delays (preoperative SMS scores below 70) or other syndromes (20 CHARGE syndrome, 6 Waadenburg syndrome, 7 Down syndome, 5 Noonan syndrome and 42 others) were included. On average, the surgery was performed at 2.36 years of age, with 52 (65%) were male, and 44 (55%) were accompanying inner ear anomalies. The study involved a follow-up observation period averaging 95 months.
Low SMS group children were categorized into 3 groups (mild, moderate, and severe to profound) based on their SQ scores. When observed for more than 5 years after surgery, the group with higher SQ scores exhibited a statistically significant increase in CAP and MAIS scores compared to the group with lower SQ scores.
Children with Waardenburg syndrome do not exhibit developmental delay, and on average, their CAP and MAIS scores reach their peak within 20 months after surgery. Otherwise, in children with CHARGE syndrome, the average achievement for CAP was 4.8 and for MAIS was 86 points, although there was significant variability among individual patients. The correlation between preoperative SQ scores and CI performance showed a positive relationship, but it did not reach statistical significance.

Conclusion
In developmental delay and syndromes preoperative SMS score correlated with CI performance. Patients with additional needs can achieve auditory benefits from CI surgery, even in the presence of comorbidities. Comprehensive analysis of the preoperative social skills and adaptive behavior including their individual genetic profiles including structural defects are recommended for accurate prediction of CI outcomes in patients with additional needs.

Keynote Lecture 05

KL 05

Effects of congenital CMV infection on executive functioning, pragmatic skills and mental health in children with cochlear implants

Ulrika LÖFKVIST[1,2]

[1]*Department of Public Health and Caring Sciences, Uppsala university, Sweden*
[2]*Department of CLINTEC, Karolinska Institute, Sweden*

Previous studies have shown that comorbidity is common in children with congenital Cytomegalovirus (cCMV) infection, which is a very heterogeneous population. Congenital CMV infection is a common cause of acquired progressive hearing loss or deafness, and/or neurodevelopmental disorders. We have shown that it is common for children with cCMV infection who use cochlear implants (CI) to have severely damaged balance function (Karltorp et al., 2014; Lazar et al., 2021). Children with cCMV infection who have hearing loss may also have vision impairment, intellectual disability, eating problems, and can in parallell be diagnosed with Autism and/or ADHD. Clinical observations during our previous studies have indicated that children with cCMV infection and hearing loss have specific problems with executive functioning (EF). Therefore, the aim of the current study was to explore EF, pragmatic skills, and mental ill health in children with cCMV infection with CI, and in comparison to well-matched controls who were deafened due to genetic non-syndromic deafness.

Methods and material:
Ten children with a cCMV infection and CI (4.8-12:9 years) and seven matched controls who were deafened due to Cx26 mutations (4:8-12:8 years) participated in the study. Children with cCMV had been tested with an MR investigation before they were implanted with CI, and they all had results that indicated slightly atypical patterns (white substance), mainly in the frontal regions of the brain (level 1 of three levels, where a higher level indicates more injuries). All parents, in both groups, reported that there were no close family members with ADHD, Autism or Developmental Language Disorder. No children had known additional diagnoses (Autism, ADHD or Developmental Language Disorder). The two groups were matched on age, hearing, vocabulary level and non-verbal cognitive ability.

The study participants were all followed-up at the Hearing Implant Center, Karolinska university hospital, Stockholm, Sweden. They came for an extended clinical visit and were randomly scheduled to meet a multidisciplinary research team for around 4 hours. The participants then met a medical doctor, educational audiologist, speech-language pathologist, social worker, and in addition a blinded psychologist who had no previous knowledge about the participants, or knew which group each participant belonged to (cCMV or Cx26 mutations). Parents and teachers had filled out questionnaires before the occasion.

Executive functions were assessed with formal tests targeting phonological working memory (SIPS) and attention level (TEA-Ch), and with questionnaires for parents and teachers (BRIEF). Pragmatic skills and mental health were investigated with standardized parent and teacher reports (CCC-2 respectively SDQ). Expressive vocabulary (Boston Naming Test), non-verbal cognitive ability (Ravens matrices) and speech recognition (in quiet and noise) were also assessed. Furthermore, participants' early spoken language outcome after initial cochlear implantation was retrieved from medical records (Reynell, SIR-2, Expressive Grammar Scale) and investigated in relation to outcomes from the follow-up visit (EF, pragmatic skills, and mental ill health) with non-parametric correlation analysis. Early spoken language outcome data was retrieved from the clinical 1- and 3-year follow-up after CI.

Results: Children with cCMV infection had statistically significant worse pragmatic outcome and phonological working memory (EF ability) than controls with Cx26 mutations, despite that the groups had similar non-verbal cognitive ability, expressive vocabulary and speech recognition level (quiet and noise). However, there were no statistical differences between the two groups regarding their EF in everyday settings or their mental ill health status. There were associations between language outcomes at the 3-year follow-up after 1st CI, and later EF and pragmatic skills in the whole sample.

Conclusion: Some children with a cCMV infection who use cochlear implants are at risk of developing learning difficulties in school and experience problems with social interactions due to difficulties with phonological working memory and pragmatic skills, despite adequate vocabulary and non-verbal cognitive ability. The current results indicate that it is important to identify children with cCMV as early as possible and support them and their families with preventive actions related to hearing, cognition and communication.

Keynote Lecture 06

KL 06

Hearing and Balance for Healthy Aging

Manuel MANRIQUE RODRIGUEZ

Otorhinolaryngology, Clínica Universidad De Navarra, Spain

Introduction
A healthy aging is one that allows to maintain the functional capacity and the well-being at the old age.

Purpose of the study
Eassess the impact of hearing loss and balance disorders on healthy aging, evaluate the impact of early intervention on these pathologies, analyze their relationship with various epidemiological features and test the applied work methodology.

Material and Methods
In a population of 700 subjects, they compare the evaluations carried out to three groups: Group A: subjects without hearing and/or balance disorder. Group B: Subjects with an untreated hearing and/or balance disorder. Group C: subjects with hearing and/or balance disorder who have been treated.
It is an observational, prospective and longitudinal study during 6 years with repeated measurements over time to evaluate the effects of aging on the following aspects and corresponding tests: Hearing ,Balance; Depression; Cognition; Dependency (Lawton Instrumental Activities of Daily Living Scale, Jong Loneliness Scale); Nutritional Status; Physical Activity and General State of Health.

Results
The first analyses of this sample show that different factors are epidemiological trait associated with hearing loss. An increased risk of falls, worse cognition and poorer overall health is observed in people with hearing loss and/or balance disorders. Preliminary results show that early treatment with hearing devices improves the quality of life of older people.

Conclusions
It is estimated that an early detection and a complete diagnosis of hearing loss and / or balance disorders in older people and their epidemiological factors will allow both prevention and early intervention, which will be very useful to maintain the communicative, cognitive, mental and autonomy skills of the elderly, that will ultimately improve their quality of life and reduce the negative impact of their dependence on their caregivers and on the economic sustainability of health systems.

Keynote Lecture 07

KL 07

Overview of US FDA regulation of medical device for start-up companies developing class II and class III hearing devices

Jongho Philip WON

Hyman, Phelps & McNamara, P.C., Hyman, Phelps & McNamara, P.C., USA

The landscape of the U.S. medical device regulation, particularly in the realm of hearing devices, is a complex and vital aspect for companies seeking to navigate the U.S. market. This presentation will explain the framework of the U.S. Food and Drug Administration (FDA) regulations, specifically focusing on Class II and Class III hearing devices.

This presentation will begin with the concept of device classification, which determines the regulatory pathway. The discussion will cover the nuances of intended use and labeling – the pivotal elements in aligning product functionalities with regulatory classification, regulatory pathway, and data requirements. Central to this presentation will be discussions of premarket strategy and pathways, including the pre-submission program, 510(k) Premarket Notification, De Novo request, and Premarket Approval (PMA), and their impact on product marketing and claims. This presentation is designed to help start-up companies embark on their medical device development journey with a better understanding of the key elements of US FDA regulation.

Keynote Lecture 08

KL 08

Cortical development features in congenital deafness children after auditory brainstem implant

Hao WU[1,2]

[1]Department of Otolaryngology-Head & Neck Surgery and Auditory Implant Center, Ninth People's Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China
[2]Ear Institute, Shanghai Jiaotong University School of Medicine, Shanghai, China

Objectives: The aim of this study is to present our experience and results of auditory brainstem implantation in children with congenital non-tumor deafness and to investigate the cortical developmental and functional connection features after ABI in children, and their relations to behavioral outcomes.

Materials and Methods: Retro-sigmoid or retro-labyrinthine approach was applied for ABI surgery. EABRs was intraoperatively performed to find out optimizing position of electrode paddle on the cochlear nucleus, and was postoperatively applied during activation and following fitting to determine the objective function of each electrode. The pure tone listening test (PTA), categories of auditory performance (CAP), infant-toddler meaningful auditory integration Scale (IT-MAIS), the meaningful use of speech scale (MUSS), speech intelligibility rate (SIR) and charge level of threshold of electrically evoked auditory brainstem responses (eABRs) were assessed in participants. The electroencephalogram (EEG) and functional near-infrared spectroscopy (fNIRS) were used to record cortical neural responses to auditory mismatch negativity (MMN) paradigm.

Results: ABI was successfully performed in all cases without intra-operative and post-operative major complications. The average active electrode ratio was 83% ±19% at first activation (n=49) and 76% ±15% at 12 months after 1st fitting (n=21). At 24 months after 1st fitting, 61.5% reached CAP-II≥5; 69.2% reached IT-MAIS/MAIS≥35 and 38.5% reached IT-MAIS/MAIS 40; 46.2% reached MUSS≥25; 92.3% children presented improvement on SIR and 30.8% reached SIR≥3. The fNIRS oxygen concentration analyses revealed more efficient functional-connections between the left auditory cortex and other cortices with longer implantation duration. The functional coherence of left auditory and frontal cortex was positively correlated to CAP (Spearman r=0.67 P=0.0019), IT-MAIS (Spearman r=0.69 P=0.0020) and SIR (Spearman r=0. 47 P=0.017) scores.

Conclusion: Cortical plasticity in congenital deafness children after ABI may contribute to the auditory and speech behavioral development, especially the connection between left temporal and frontal lobe. Auditory brainstem implantation has been a safe and feasible technique in young children who are contra-indicated to cochlear implantation, to restore the hearing and promote speech development.

Instructional Course 01

IC 01

Complications of cochlear implant

Abdulrahman HAGR

President of Saudi ORL Society, President of Arab Academy of Otology and Cochlear Implant, Professor King Saud University, Saudi Arabia

The number of cochlear implant (CI) recipients is increasing so there needs to be greater awareness of possible CI complications. We were able to lower the complications in our center over 10 years and we would like to share this with everyone in the conference.

Instructional Course 02

IC 02

Case Discussion: Cochlear Implantation in Abnormal Inner Ears

Ing Ping TANG

Professor & Senior Consultant ORLHNS, Universiti Malaysia Sarawak & Sarawak General Hospital, Sarawak, Malaysia

Cochlear implantation (CI) has proven to be an effective treatment for severe to profound bilateral sensorineural hearing loss (SHNL) in abnormal inner ears except for those with complete labyrinthine and cochlear aplasia. Twenty percent of cases with congenital SNHL have inner ear malformations. Another common aetiology of abnormal inner ear related post lingual SNHL is cochlear ossification secondary to bacterial meningitis.

Pre-implantation radiological assessment is crucial to identify the abnormalities of inner ear and other associated anomalies, in order to anticipate the potential complications that may occur during surgery. Furthermore, those cases with severe malformation may require different surgical approaches or modification of surgical techniques in order to implant the electrode successfully. Custom-made implant with specific cochlear duct length may be needed for certain inner ear abnormalities. Decision making between CI and auditory brainstem implant (ABI) may also be challenging in some of these cases too.

The management of the above mentioned clinical issues will be illustrated through discussion of different cases with inner ear abnormalities.

Instructional Course 03

IC 03

Patient Delight Factor in the Trial of Bone Conduction Hearing Devices

Sumit Kumar GAUR

ENT and Head & Neck Surgery, Apollo International Hospitals, India

Introduction: Bone Conduction Devices (BCDs) are the most reliable methods of auditory rehabilitation in patients with conductive hearing loss/mixed hearing loss or single-sided deafness who otherwise do not benefit from conventional hearing aids. The common indications for BCDs include microtia with congenital aural atresia, bilateral mastoidectomies, failed stapedotomies, and single-sided deafness (SSD). The present study is on patient satisfaction during a trial of BCD.

Methods: 246 BCD trials for four groups of indications were given in our experience from the year 2006 to 2023. Indications include bilateral microtia with aural atresia, unilateral microtia, mastoidectomies/chronic otitis media/failed stapedotomies and single-sided deafness. Of these, 198 were Baha Soft band/SoundArc system and 48 were ADHEAR. The parameters assessed during the trial were sound quality/fidelity, loudness, speech in quiet, speech in noise, wearing comfort and cosmesis. The patient satisfaction with these parameters was recorded on a 10-point Visual Analog Scale (VAS). Resultant data has been represented as percentages obtained from the mean VAS scores.

Results: Maximum benefit with the trial of BCD was obtained in patients with bilateral microtia and aural atresia (92.2%) whereas in patients with unilateral microtia and mastoidectomies/failed stapedotomies, the benefit was 78.8% and 83.6% respectively. In SSD, the benefit was only 61.2% without simulated conductive hearing loss in the opposite ear. With simulated conductive loss, the benefit improved to 75.8%. Patients with SSD were given a home trial for 1 week, after which their satisfaction scores increased to 79%.

Conclusion: BCDs are effective means of rehabilitation for hearing loss where conventional hearing aids are not effective. Maximum subjective benefits are obtained in bilateral microtia and aural atresia, followed by failed surgeries/chronic otitis media, unilateral microtia and single-sided deafness.

Instructional Course 04

IC 04

Hearing implants and MRI: From bonebridge to CI

Georg SPRINZL

Department of Otorhinolaryngology, St. Pölten University Hospital, Austria

Instructional Course 05

IC 05

The test electrode: A useful tool to decide between CI and ABI in vestibular schwannoma patients

Javier GAVILAN

Otorhinolaryngology, La Paz Univrsity Hosptial, Spain

INTRODUCTION
The functional status of the auditory nerve is the key point when deciding between a cochlear implant and an auditory brainstem implant after resection of a vestibular schwannoma. Intra-surgical stimulation of the round window or directly the cochlear nerve has been performed with varying degrees of success. Electrical auditory brainstem responses (eABR) with intracochlear stimulation via the cochlear implant (CI) may determine the integrity of the auditory pathway. However, no method have been reveal to predict the cochlear nerve status consistently.
OBJECTIVE
The goal of this study was to assess the integrity and the functionality of the auditory nerve in standard cochlear implantees by using an intracochlear test electrode and to compare eABR responses via the test electrode with the eABR responses with the cochlear implant.
METHODS
Ten subjects (age at implantation 55 years, range 19 - 72) were selected from the CI patient pool. All subjects were diagnosed with bilateral sensorineural hearing loss and were subsequently implanted with MED-EL Concerto cochlear implant on the no useful residual hearing side. Following identification of the round window, the test electrode was inserted in the cochlea previous to cochlear implantation. To assess the quality of an eABR waveform, scoring criteria from Gibson et al. were chosen. The speech performance was evaluated with monosyllables, disyllables and sentence recognition tests.
RESULTS
In all 10 patients responses to electrical stimulation could be evoked. In all cases both the intra-cochlear test electrode and the cochlear implant elicited responses and there were no statistical differences in latencies or amplitudes after stimulation with the test electrode or CI.
All patients in this study obtained useful hearing by their implants and are using their implants daily. Auditory performance three months after the initial stimulation of the CI showed open-set speech recognition in all tested patients (74% - 100% sentence recognition in silence).
CONCLUSIONS
Our results suggest that the intra-cochlear testing electrode may be a suitable method to test the integrity of the VIIIth cranial nerve by recording eABR signals. This allows for future development on the status of the auditory nerve after tumour removal and correlations with auditory performance.

Instructional Course 06

IC 06

Clinical Implication of Hearing Loss & Cognitive Function

Kyoung Ho PARK

Otolaryngology Head & Neck Surery, The Catholic University Of Korea, Seoul St. Mary's Hospital, Korea

There has been increasing research interest in the correlation between hearing loss and cognitive function that are strongly associated. Hearing loss appears as a risk factor for cognitive impairment, especially in elderly. Both the prevalence of hearing loss and cognitive impairment will increase substantially due to the aging of the population.
But hearing loss has been identified as a modifiable age-related condition linked to dementia, especially in midlife hearing loss.
Several pathophysiological mechanisms of cognitive impairment and hearing loss are proposed until now. They include increased cognitive load, changes in brain structure and function, common genetic and pathologic causes, and social disengagement.
Hearing rehabilitative treatments may potentially alter or delay the progression of cognitive impairment and maintain a good cerebral function. With the treatment of hearing loss in people with cognitive impairment may help improving communication, increasing quality of life, and reducing behavioral symptoms of cognitive decline. It is believed that these positive effects are achieved that hearing enhancement can reduce the effort required for auditory processing, redirecting it to cognitive tasks and then reducing the progression of brain atrophy
As for the use of hearing aid in cognitive decline, many studies reported that the positive results in long time user and many participants are included. But the precise effect of hearing aids on cognitive function is debatable. Hearing amplification devices and cochlear implant have similar effects on cognition, and are still mainly underexplored.
In this lecture, we review the association of the hearing loss with cognitive function and its clinical implication in hearing rehabilitative treatment.

Instructional Course 07

IC 07

Introducing the new eardrum hearing aid: Earlens

Chi Kyou LEE

Department of Otolaryngology-HNS Soonchunhyang Seoul Hospital, The Soonchunhyang University College of Medicine, Korea

Ear lens is a new direct contact hearing aid conventional air conduction hearing aid. There are various hearing aid devices depend on operation modes, conventional air conduction, implantable hearing aids and cochlear implant. Many hearing aid users complaint such different factors as low fidelity, sound distortion, discomfort, occlusion effect, feedback problem. The cause of this inconvenience is mainly due to the receiver. So, there is need to develop implantable hearing aid without receiver. Some of implantable hearing aids work as mechanical vibration, Med-el Vibrant Sound bridge, Envoy Esteem, Ototronix Maxum, and Cochlear Carina. Many papers support better preference of implantable hearing aids than conventional hearing aids. But implantable hearing aids need surgery. This is a matter of elderly hearing aid users. Earlens is very similar hearing aid with implatable hearing aids, not need surgery and is very good alternate for these patients.

Earlens has similar characteristic of implantable hearing aids, using direct vibration of ossicles. 1st generation Earlens was dirven by light power, but new generation Earlens was inducted by electromagnetic power. It has open-canal hearing device designed to have a frequency range of 0.1 to 10 kHz. It is mainly composed of three parts: mini BTE-type sound processor, ear tip and earlens wireless actuator. The function of BTE stimulator is sound processor and signal transmission. The actuator has six sub-parts: peritympanic platform and chassis, microactuator, umbo platform, electromagnetic detector, support springs, grasping tab.
Earlens provide 120dB SPL of output and 60 dB insertional gain through 10 kHz. It covers wide frequency range from 100 Hz to 10000 Hz. So, it has very good sound fidelity and many patients satisfy at this point. It is using mechanical vibration with wide vent, so it has no occlusion and feedback. Earlens also is good for low frequency hearing loss patient.

Earlens can prescribe by only physician because of dangerous positioning of lens on eardrum and delicate maintenance. It is impossible to remove the lens on your own and must be used continuously. It is both a weakness and a strength of earlens.

Symposium 13

Post COVID & Telerehabilitation
SP 13-1

Advantages and utilizatin of telemedicine for cochlear implant users

Kenichi TAKANO

Otolaryngology - Head and Neck Surgery, Sapporo Medical University, Japan

Proper post-operative care for patients is crucial in enhancing hearing outcomes following cochlear implantation surgery. A pivotal aspect of this procedure involves achieving an optimal fit for the cochlear implant (CI), making it one of the primary objectives. A specialized fitting program serves as a guide throughout this process, necessitating multiple sessions that are arranged with the patient at the CI center. For the majority of CI recipients, particularly those residing at a considerable distance from the CI center, these recurring sessions demand extensive travel, leading to longer travel distances, increased expenses, and potential disruptions to schooling or employment commitments. Consequently, this scenario can compromise the reliability of test results and the effectiveness of the overall treatment.

Notably, Hokkaido, encompassing approximately one-fourth of Japan's total land area, presents a unique challenge due to its vastness, making procedure management even more complex. Recent advancements in telemedicine have facilitated the provision of healthcare services and medical information through telecommunication technologies. This approach emerges as a valid and valuable means of extending care to patients situated in remote and underserved regions. To address this, we have introduced telefitting in conjunction with the Custom Sound Pro (developed by Cochlear Ltd.) and a telecare system for CI recipients residing far from the Sapporo CI center.

Our clinical trial findings strongly indicate that telefitting was positively embraced by CI recipients and offers a feasible alternative to in-person fittings. This holds true even for young children with cochlear implants. While some limitations pertaining to adaptability exist, telefitting possesses the potential to be a effective avenue for delivering CI services to geographically isolated locations. This is particularly relevant during natural disasters such as earthquakes and typhoons, or in situations involving the spread of pathogens like SARS-CoV-2.

Symposium 13

Post COVID & Telerehabilitation
SP 13-2

Using a web-based experiment builder to replicate in-clinic sentence tests at home

Neil DONNELLY

Cambridge Hearing Implant Centre, Cambridge University Hospitals, UK

Background
Cochlear implant centres no longer have the capacity to complete in-person annual performance reviews. Remote monitoring applications are available but are device specific and do not replicate in-person tests. We aimed to replicate in-clinic tests at home using a web-based experiment builder.
Method
All unilaterally implanted adult CI recipients receiving an upgrade to the Marvel CI sound processor from Advanced Bionics were invited to take part in an at home listening experiment. The Gorilla experiment builder was used to complete a sound device questionnaire, sound quality ratings, and Bamford-Kowal-Bench (BKB) sentence testing both in quiet and noise (+10 dB signal-to-noise) from home. All sounds were accessed using a bluetooth connection in a quiet room. Each participant completed the listening activities twice, once with the direct streaming Marvel processor and once using the Q70 processor plus compilot.
Results
Remote BKB sentence testing was successfully completed using the Gorilla experiment builder for all 11 participants. Remotely tested sentence scores in quiet were similar between the Marvel and Q70 devices and similar to clinic-based testing. Remotely tested sentences in noise showed a slightly poorer median scores, of 70% and 80% for the Q70 and Marvel CI processors respectively (n=11) compared to some 88% (n=8) for in-clinic results. Those tested in-clinic were better performing implant recipients, while all participants were tested in noise when home testing. Participants felt reassured by their at home listening tests and clinicians were able to offer programming appointments when responses to listening activities deviated from previous results.
Conclusion
In-clinic speech tests could be replicated remotely using Gorilla. Results were sufficiently reliable to report on progress and advise programming changes when baseline in-clinic scores were available. Further testing with a larger patient group is required to determine reliability of remote sentence testing.

Symposium 13

Post COVID & Telerehabilitation
SP 13-3

The use of smartphone applications in the aftercare of cochlear implant patients

Andreas BUECHNER[1], Sven KLIESCH[1], Thomas LENARZ[1]

[1]*Hearing Center, Medical University of Hannover, Germany*

The number of cochlear implant (CI) patients receiving regular aftercare continues to rise. As this trend persists, it will become increasingly difficult for implanting centers to accommodate annual routine check-ups for all patients. Concurrently, health insurers are exerting cost pressure, necessitating more efficient treatments without compromising the quality of care. One solution is to utilize cutting-edge smartphone apps that actively involve patients in the therapy process. This approach, known as "patient empowerment," has already proven successful in diabetes and cardiovascular disease management, and CI aftercare could similarly benefit from comparable concepts and apps.

In a chronic feasibility study that began in November 2022, 20 CI patients using the Advanced Bionics Naida-M system are provided with a smartphone app that enables the measurement of parameters such as electrode impedances, microphone condition, and skin thickness between the external coil and the implant to assess system integrity. Moreover, patients can adjust their hearing programs using two different user interfaces that have been evaluated in a previous study. This functionality allows patients to tailor their hearing programs for various listening situations and recall them as needed. The app also enables patients to conduct a hearing test, such as the Oldenburg sentence test (OlSa) in noise, and track their hearing progress. All collected data are transmitted to a central server and made accessible to the treating CI center.

To date, 12 patients have been included in the study and regularly employ the app in their daily lives. As a result, 2000 impedance measurements, 10,000 skin thickness measurements, 80 aided thresholds, and 70 OlSa measurements have been collected. Additionally, it has been observed that patients actively utilize program customization options and recall self-generated programs for specific listening situations. The latest findings and evaluations will be presented at the conference.

Keywords : Remote Care, Patient Empowerment, Self-Fitting

Symposium 13

Post COVID & Telerehabilitation
SP 13-4

Parent Coaching in Telepractice: The Lessons to Learn from Malaysia

Basyariatul Fathi OTHMAN[1], Cho Kai Shuo[2]

[1]*Centre of Ear, Hearing and Speech, Faculty of Health Sciences, The National University of Malaysia;*
[2]*Hospital Tunku Ampuan Besar Tuanku Aishah Rohani, National University of Malaysia,*

Parent involvement is the known prognostic factor to habilitation and development of listening and spoken language in children with hearing loss. However, for parent involvement to be impactful on their child's outcomes, therapists need to provide effective coaching to parents, which include specific coaching strategies and asking constructive coaching questions. In the Malaysian context, there is scant information on parent coaching — either in the scope of deaf/hard-of-hearing, or early intervention in general. However, Covid-19 and the ensuing lockdown had forced therapy sessions to move from physical sessions to telepractice. This pivot provided an opportunity for scrutiny of the telepractice recordings. Therefore, this study aims to describe parent coaching that occurred during telepractice for children with hearing loss. This restrospective study analysed 10 recorded video clips of telepractice sessions conducted by a therapist. A total of five coders viewed and coded the telepractice video clips. This is followed by a qualitative and quantitative description of the parent coaching strategies and coaching questions, adopting Rush (2014) metrics on parent coaching and questioning as the framework. The profile of parent coaching as gleaned from these 10 video clips are described. Overall, the video analyses found some parent coaching strategies and coaching questions more frequently adopted by the therapist, while other strategies and questions are much less frequent. This is potentially problematic, given how crucial parent coaching is in telepractice and in early intervention as a whole. The implications of these findings, and the recommended future studies for therapist-family collaboration in early intervention for children with hearing loss are discussed.

Keywords: parent coaching, telepractice, parent-professional interaction

Symposium 13

Post COVID & Telerehabilitation
SP 13-5

The impact of the COVID-19 pandemic on rehabilitation services provided for cochlear implant recipients in Saudi Arabia

Rihab H ALKHALIL[1,2]

[1]*King Abdullah Specialized Children's Hospital, Ministry of National Guard Health Affairs, Saudi Arabia*
[2]*King Abdullah International Medical Research Center (kaimrc), Ministry of National Guard Health Affairs, Saudi Arabia*

Objective: This study examines the impact of the COVID-19 pandemic on cochlear implantation (CI) recipients in Saudi Arabia. The impact was measured using the results of an online survey that investigated challenges related to access to re/habilitation and programming services, increased dependence on virtual interaction, and emotional impact.
Methods: The cross-sectional online survey reached 353 pediatric and adult CI recipients between April 21st and May 3rd 2020, during the first weeks of implementing the lockdown strategy and the transitioning to virtual settings.
Results: It was revealed that overall access to aural re/habilitation was considerably affected during the pandemic, and that the impact of this disruption was significantly greater for pediatric recipients than for adults. On the other hand, overall access to programming services was not affected. Results also revealed that CI recipients' performance at school or work was negatively impacted by the transition to a virtual communication. In addition, participants noticed a decline in their auditory performance, language skills, and speech understanding. They also registered feelings of anxiety, social isolation, and fear related to sudden changes in their CI function.
Finally, the study revealed a gap between CI clinical/non-clinical support provided during the pandemic and the expectations of CI recipients.
Conclusion: Collectively, outcomes from this study highlight the importance of shifting towards a more patient -centered model that offers empowerment and self-advocacy. In addition, the outcomes also emphasize the importance of developing and adapting emergency protocols. This will ensure continuation of services provided to CI recipients during scenario disasters like a pandemic.

Keywords : COVID-19, Aural rehabilitation, Cochlear implant

Symposium 14

Auditory Neuropathy Spectrum Disorder
SP 14-1

COCHLEAR IMPLANTATION IN PATIENTS WITH AUDITORY NEUROPATHY SPECTRUM DISORDER

Armagan INCESULU

Department of Otolaryngology-Head and Neck Surgery, Eskisehir Osmangazi University, Türkiye

Auditory neuropathy spectrum disorder (ANSD) is a pathology with many unknowns and challenges in the diagnosis and treatment for both ENT physicians and audiologists. Dysfunction in the cochlear inner hair cells and spiral ganglion cells, while preservation of the function of the outer hair cells is a possible mechanism in the pathogenesis. Varied etiologies as well as clinical profiles have been reported.
Diagnosis and management of patients with ANSD is still challenging. Severity of the problem, additional disabilities, age and the etiology may affect the outcome of the treatment.
Out of 14 patients with ANSD, two had hereditary motor and sensory neuropathy, most probably Charcot–Marie–Tooth disease. Even though they had vision impairment, they refused to any management about hearing loss. None of the patients had milder form of disease in which maximize signal-to-noise ratio is indicated. Hearing aids are indicated in the patients with moderate hearing loss. If these patients are children, their language development and hearing thresholds should be followed closely and the training program should be supervised. Cochlear implantation is the first choice in case of severe to profound hearing loss, especially in presynaptic disorders, and in case of poor speech perception and communication outcomes with conventional hearing aids. However, in some cases, the decision to move from hearing aids to cochlear implants is difficult.

Multidisciplinary approach, and intensive hearing and speech therapy and close follow-up are essential for adequate rehabilitation.

Symposium 14

Auditory Neuropathy Spectrum Disorder
SP 14-2

Possibility of stem cell therapy to increase the performance the of CI in ANSD patients

Min Young LEE

Otorhinolaryngology and Head & Neck Surgery, Dankook University, Korea

Background:
Our goal is to develop a regenerative therapy for sensorineural hearing loss by targeted delivery of encapsulated progenitor cells and differentiation factors into the modiolus which can then be triggered to release and differentiate using light irradiation. Among the goals of targeted delivery for any regenerative therapy, the most important is to ensure that the delivered package is to function as intended. In this part of the study, we will demonstrate the capability of the encapsulated materials, namely the neural progenitor cells (NPC) and the chosen growth factors, to differentiate into functional spiral ganglion neurons.

Materials and Methods:
3D neurospheres were formed using NPCs (ATCC, ACS-5004) and induced to further differentiate into mature neurons with the supplementation of either BDNF or NT-3 or a combination of BDNF and NT-3. The neurospheres were observed until 4 weeks and evaluated for immunofluorescence (IF), RNA sequencing and electrophysiological analyses.

Results:
The resulting neurospheres from BNDF only and BDNF+NT3 were able to generate cells with visible neurite protrusions. IF staining confirmed the presence of TUJ1 and MAP2 expression indicating mature neurons. Voltage-gated sodium channels were also observed using NaV1.2 and NaV1.6 staining and supported by electrophysiological recordings. RNA sequencing analysis showed the upregulation of several DEGs associated with neuronal development as well as auditory cell fate specification.

Conclusions:
The confirmation of NPCs ability to successfully differentiate into functional neurons in now ready for succeeding encapsulation and targeted delivery to regenerate the damaged structure and function of spiral ganglion neurons.

Symposium 14

Auditory Neuropathy Spectrum Disorder
SP 14-3

Therapeutic effect of FAM19A5 antibody on noise-induced hearing loss in mice

Jinwoong BOK[1,2]

[1]*Department of Anatomy, Yonsei University College of Medicine, Korea*
[2]*Department of Otorhinolaryngology, Yonsei University College of Medicine, Korea*

Acquired sensorineural hearing loss (aSNHL) is a pathological condition with limited therapeutic options. Cochlear synaptopathy, also known as hidden hearing loss, is a well-known pathophysiological factor in SNHL. NS101 is a monoclonal antibody targeting FAM19A5, a protein involved in synaptic disorganization. NS101 promotes synapse assembly by binding to FAM19A5 and disrupting the FAM19A5-LRRC4B complex. In this study, we determined the feasibility of NS101 in the treatment of SNHL using a mouse model of noise-induced temporary threshold shift (TTS). Mice treated with 30 mg/kg NS101 intravenously once a week for two weeks did not show ototoxicity as evidenced by the absence of ABR threshold changes. Immunohistochemical analysis of the cochlear region showed that noise exposure reduced the number of synapses in hair cells compared to the baseline (before noise exposure, BN), but treatment with NS101 restored the number of synapses to the baseline levels, suggesting that NS101 may be effective in restoring the number of synapses in the auditory nervous system. In addition, NS101 was effective in restoring hearing ability impaired by noise exposure, as evidenced by changes in ABR thresholds after noise exposure. NS101 also restored hearing ability as measured by ABR wave I amplitude and DPOAE amplitude. Taken together, the improvement in hearing function with NS101 in TTS models provides insight into the potential efficacy of NS101 in SNHL.

Symposium 14

Auditory Neuropathy Spectrum Disorder
SP 14-4

Etiology and CI outcome in postlingual ANSD

Byung Yoon CHOI

Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

Symposium 15

Better Spectral and Temporal Resolution
SP 15-1

Anatomic vs physiologic mapping

Oliver F ADUNKA

Otolaryngology, Head & Neck Surgery, Ohio State University, USA

Cochlear implant mapping has developed into a routine clinical process for clinician. The underlying frequency allocation tables (FAT) have remained essentially unchanged over the past few decades. Mostly, the FATs are based on anatomic information derived from Greenwood's map depicting frequency representation within the cochlea.

More recently, alternative frequency allocation methods have been described. One of these methods is to use patient specific cochlear measurements to map-out the position of individual electrode contacts within the cochlea and to align FATs with these. Alternatively, electrophysiologic data from electrocochleography recordings have been used. This presentation will review the underlying physiologic principles and the potential clinical utility of each method for assigning frequency spectra for cochlear implant electrode mapping.

Symposium 15

Better Spectral and Temporal Resolution
SP 15-2

Spectral and temporal resolution over time for school-aged children with cochlear implants

René Headrick GIFFORD

Hearing and Speech Sciences, Vanderbilt University Medical Center, USA

Cochlear implants (CIs) have provided significant improvement in auditory function, speech perception, speech production, language, reading, and overall quality of life for the majority of recipients. Despite these advances, children with CIs exhibit significant variability in speech and language development with too many children demonstrating suboptimal outcomes. The source of variability as well as auditory, speech, and language delay is partially attributed to a period of auditory deprivation prior to implantation; however, it is also likely that the spectrally degraded signal plays a role. Several studies have observed poor spectral resolution for children with CIs—poorer than even that exhibited by adult CI users. Indeed, the literature is mixed on the relationship between behavioral spectral and temporal resolution and speech perception in children with CI. Thus, the aim of this study was to investigate the relationships between spectral resolution, temporal resolution, and speech perception in prelingually deafened children with cochlear implants (CIs). To account for maturation effects, we collected data at two time points separated by 1 year. Our primary hypothesis was that there would be no significant relationship between speech perception and either spectral or temporal resolution at baseline, but that this relationship would emerge over time with chronological age and CI experience. Thus, our secondary hypothesis was that a relationship between change in speech perception and changes in spectral and/or temporal resolution would emerge at 12 months.

Data were collected from 47 children with CIs with a mean age of 8.3 years (range 4-13 years). Children were followed longitudinally over a 2-year period; however, because the study is ongoing, we will present data for the first year. At both study visits children were assessed on tasks of spectral modulation detection (0.5 & 1.0 cyc/oct), temporal modulation detection (sinusoidal amplitude modulation rates of 4, 32, and 128 Hz), and speech perception (CNC word recognition, pediatric AzBio sentence recognition at +5 and/or 0 dB SNR, vowel recognition, BKB-SIN, and adaptive HINT. Data for the first year of study participation revealed that all children had either stable performance on all speech perception tasks or significantly improved scores. Between the baseline and 12-month visits, both spectral modulation detection and temporal modulation detection significantly improved. We did not observe a significant relationship between either spectral or temporal resolution and any of the speech recognition measures. However, changes in spectral resolution over a 1-year period demonstrated a large, but not statistically significant, effect on vowel ($r(13) = -.546$) and word recognition ($r(13) = -.706$). In summary, when studied over a 12-month period, spectral resolution, temporal resolution, and speech recognition all improved but there was no significant relationship between either spectral or temporal resolution and speech perception. This study is ongoing and given the emerging, but not significant relationship between improvement in spectral resolution and speech perception for vowel and word recognition may uncover developing spectral resolution as an underlying mechanism of speech perception in children with CIs.

Symposium 15

Better Spectral and Temporal Resolution
SP 15-3

Novel Cochlear Stimulation with an apical electrode

J. Thomas ROLAND JR.

Department of Otolaryngology-Head and Neck Surgery, NYU Langone Medical Center, USA

The standard cochlear implant (CI) electrode array is designed to be inserted only into the first cochlear turn which in the normal ear represents frequencies above approximately 785 Hz (Stakhovskaya, 2007). There is evidence that electrical stimulation in regions deeper in the cochlea that can be provided by a standard CI electrode array can improve speech in noise understanding (e.g. Buchman et al., 2014; Beuchner et al., 2017) and sound quality (Landsberger et al., 2016). However, there are negative attributes to longer electrodes. Most importantly, increasing the electrode length increases the potential for cochlear damage (e.g. Annirudah and Jolly, 2017). Additionally, there are a number of manufacturing and anatomical limitations to using longer electrode arrays.

In the experiments, a modification to the surgical approach will be used to provide electrical stimulation into the cochlear apex while still using a standard electrode array which is only inserted approximately to 360 degrees into the cochlea. In the CI system from Cochlear Limited, stimulation from one of the intracochear electrodes is grounded via one of two (or both) extra cochlear electrodes in the device. One of the two electrodes that are typically placed extracochlearly will be placed via cochleostomy in the apex of the cochlea. This allows stimulation to be grounded to either an extra cochlear ground electrode (providing a stimulation pattern used in the standard clinical intervention) or grounded to the apical ground electrode. Participants will be fit clinically using the extra cochlear electrode as a ground providing a standard stimulation profile. Acutely in our translational cochlear implant laboratory, we will verify that current flows more apically and produces a lower pitch using the apical ground than when the extra cochlear ground is used. Additionally, an acute fitting using the apical ground will be evaluated. If participants prefer the map using the apical stimulation, then they will be allowed to keep the modified fitting.

This presentation will review the cadaver work that documented pushing current to the cochlear apex and outcomes with many of our first patients.

Symposium 15

Better Spectral and Temporal Resolution
SP 15-4

Spread of electric field, neural excitation, and speech perception in CI patients after resection of intralabyrinthine schwannoma

Stefan K. PLONTKE

Dept. of Otorhinolaryngology, Head and Neck Surgery, Martin Luther University Halle-Wittenberg, Germany

Objective

Cochlear implants (CIs) can restore hearing not only in patients with profound hearing loss and deafness, but also in patients following tumour removal of schwannomas in the inner ear. In such cases, surgical trauma and electrode placement placement differ from conventional "atraumatic" electrode insertions, in which the cochlear capsule remains intact, and the cochlea is filled with fluid. Despite these technical and surgical differences, previous studies have tended to show above average (above benchmark) results in speech perception in these patients. We retrospectively evaluated the ability to predict speech recognition outcomes using individual electric field distributions based on different electrode designs and investigate special tumor cases.

Study design

In a retrospective analysis in a single academic university center, trans-impedance, electrically evoked compound action potentials, and word recognition were measured. Relative impedance was computed as a function of distance between the stimulation and recording electrode. Electric field distributions were also compared between different groups of electrode designs and indications for cochlear implant surgery. Voltage gradients were then correlated with speech recognition results.

Results

Trans-impedance was smaller and more homogeneous in patients with partial or subtotal cochleoectomy than in the control group. Differences in electrical field distributions were found between lateral wall electrodes and perimodiolar electrodes. A significant correlation to scores in speech recognition could be demonstrated.

Conclusion

We conclude that the surgical technique used for cochlear implantation with subtotal cochleoectomy reduces the spread of the electric field and overcomes the potential drawbacks of a significantly reduction in structure preservation. Prediction of speech recognition outcome based solely on electric field propagation results seems not feasible, although significant differences in field distribution between electrode arrays can be clearly demonstrated. These observations and their relevance should therefore be further investigated in future studies.

Symposium 15

Better Spectral and Temporal Resolution
SP 15-5

Clinical-effectiveness and cost-effectiveness of upgrading cochlear implant sound processors in older adults.

Paola INCERTI[1,2]

[1]*Audiological Sciences, National Acoustic Laboratories, Australia*
[2]*Macquarie University Centre for the Health Economy, Macquarie University, Australia*

Aim: Many older Australian adults with cochlear implants (CI) lack funding for replacement sound processors, risking complete device failure and reduced quality of life. The overarching aim is to investigate the clinical- and cost-effectiveness of upgrading obsolete CI sound processors in adults aged 65 years or over.

Methods: The research study examined the impacts of upgrading cochlear implant sound processors in an older adult population. It was embedded in a clinical upgrade program for sound processors manufactured by Cochlear Ltd funded by the Australian Government Department of Health and conducted by the National Acoustic Laboratories (NAL). The study recruited a cohort of older adults whose processors were obsolete or had entered the final stages of the product lifecycle in the Australian market, and who did not have access to any funding for replacement sound processors. Existing sound processors were replaced with the most current commercially available sound processors approved by the Therapeutic Goods Administration. Primary outcome measures included speech perception in noise, the lived experience and cost-effectiveness between upgraded and obsolete sound processors after 1 and 6 months. Secondary outcome measures included comparing self-report measures such as cognition, listening effort, fatigue, device benefit, mental well-being, participation, empowerment, and important changes in older adults using upgraded versus obsolete processors.

Results: The study start date was May 20, 2021, and it closed on April 21, 2023. Recruitment ran from June 2021 to May 2022 across 15 clinical sites. A total of 358 adults were screened for eligibility, 320 recruited and 304 progressed to enrolment. A total of 340 sound processors were upgraded in 304 participants across 15 collaborating sites across Australia (NSW, QLD, SA, TAS, VIC, WA). The cohort had a mean age of 77·4 years (SD 6.6), 147 (48.5%) were female, 157 (51.5%) were male. The age of onset of hearing loss was 30.0 (SD 21.0) years and the duration of CI use was 12.0 (SD 6.2) years. Primary outcome measures showed a significant improvement in participant's ability to understand speech in noise. For those who were unable to complete the study assessments, their significant others (e.g. family members) reported reduced communication difficulties. Secondary outcome measures demonstrated that participants experienced significant reductions in listening effort, fatigue and listening difficulties. Semi-structured interviews with 22 upgrade recipients and their family members were conducted. Upgrades addressed fears and anxiety about how the users of obsolete CI technology would deal with a total failure of their processor(s). A health economic analysis from the Australian health system perspective found that cost-effectiveness of upgrading sound processors came from avoiding scenarios of total failure of devices, in which the user experienced a significant decrease in health-related quality of life from no longer being able to use the hearing technology on which they rely upon.

Conclusion: This study represented an opportunity to conduct research with a large cohort of older Australians who use CIs to examine the impact of upgrading sound processors. Overall, this study provides evidence that upgrading sound processors offers significant benefits for the individual and is economically sound in cases where it avoids someone losing access to sound completely due to a total device failure. The study also provides new insights into client-focused benefits of CI technology in domains beyond traditional clinical measures of benefit. The evidence collected in this study can be used to inform policy around CI processor upgrades in older adults.

Symposium 16

Elderly CI and Cognition
SP 16-1

Hearing Loss & Dementia: Understanding & Addressing Hearing Loss among Persons Living with Dementia

Carrie NIEMAN[1,2]

[1]Otolaryngology-Head & Neck Surgery, Johns Hopkins School of Medicine, USA
[2]Johns Hopkins Cochlear Center for Hearing & Public Health, Johns Hopkins Bloomberg School of Public Health, USA

Sensory health and cognitive impairment, including dementia, stand at the intersection of two major public health challenges. Sensory impairments are among the most common and disabling comorbidities among individuals aging with cognitive impairment yet frequently go unrecognized and unaddressed. Among sensory impairments, hearing loss is one of the most common comorbidities among persons with dementia. Prevalence estimates, based on audiometric data, range from 60 to over 90% in specialized memory clinics and approximately 70-80% among community-dwelling cohorts of older adults. As age-related conditions, the prevalence of hearing loss increases with age and is higher among those with greater severity of cognitive impairment. Proxy-rated hearing loss by care partners and healthcare providers underestimate hearing loss among older adults with cognitive impairment. Sensory impairment among individuals with cognitive impairment is associated with increased neuropsychiatric symptoms, yet persons with dementia have low rates of hearing aid use, around 20%, and face barriers to traditional clinic-based hearing care. This presentation will review current epidemiological understanding of hearing loss and its impact on persons with dementia. Furthermore, to meet the unique needs of persons with dementia, this presentation will share opportunities to provide hearing care through novel, community-delivered approaches.

Symposium 16

Elderly CI and Cognition
SP 16-2

Evaluation of the Cognitive Function in the Cochlear Implanted Adults

Shi Nae PARK

Department of Otolaryngology-Head and Neck Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

Hearing loss is one of the most important risk factors of cognitive dysfunction in older adults. Recent studies have suggested a correlation between severity of hearing loss and cognition. Given that the management of profound hearing loss with cochlear implantation has been world widely accepted even in very old adults, it is time for us to focus on the cognitive function of the elderly adults with cochlear implantation as well as the ones with untreated profound hearing loss who may suffer from potentially preventable cognitive impairment. However, there is a lack of direct evidence showing the effect of cochlear implantation on the cognitive function in the elderly and it seems to be caused by the difficulty in performing cognitive function tests in our clinic.
Here, I would like to briefly introduce different evaluation test tools for cognitive function in the elderly with the demonstration of my recent study results using these test materials. Moreover, simple standardized questionnaire for screening cognitive impairment, Korean Dementia Screening Questionnaire- Cognition (KDSQ-C), which can be used to monitor the cognitive function of the cochlear implanted adults will be introduced. In our pilot study using this questionnaire, adult patients with cochlear implantation showed the improved condition of cognitive function compared to the preoperative status. More studies to provide guidance for managing both hearing loss and cognitive impairment using practical and efficient test tools in the cochlear implanted elderly patients seem to be needed.

Symposium 16

Elderly CI and Cognition
SP 16-3

Cochlear implantation and cognition in elderly patients

Huan JIA[1,2,3]

[1]*Unit of Otology, Auditory implants et and Skull Base Surgery, Neurosensory surgical Department, GH Pitié-Salpêtrière, Sorbonne APHP, France*
[2]*UMR-S 1159 Inserm, Sorbonne University, France*
[3]*Otorhinolaryngology Head Neck Surgery, Shanghai Ninth People's Hospital, China*

A prospective multi-center study on the cognitive benefits of cochlear implantation was initially conducted in 10 tertiary referral centers in France. The study aimed to explore the relationship between cognitive function and cochlear implantation. This study involved 94 elderly patients, aged 65 to 85 years (with a mean age at implantation of 72 years), who had profound postlingual hearing loss.

The short-term results (1 year after implantation) revealed that cochlear implantation significantly improved speech perception in these patients. Notable enhancements in speech perception were observed in both quiet and noisy environments. Additionally, cochlear implantation had a positive impact on the quality of life for these elderly patients. They reported improved communication in their daily lives, contributing to an overall improvement in their quality of life. The study also found that cochlear implantation helped reduce depressive symptoms in these patients. One year after the surgery, a significant proportion of patients experienced a reduction in depressive symptoms, indicating an improvement in their mental well-being. Most notably, among patients who exhibited cognitive impairments before implantation, an impressive 81% showed substantial improvements in global cognitive function one year post-implantation. This suggests that cochlear implantation not only aids in hearing restoration but also has a positive impact on cognitive function.

Furthermore, at 7 years after cochlear implantation, long-term cognitive outcomes were evaluated in 70 cases among the initial 94 recipients, with the loss of follow-up in some cases attributed to the patients' passing away. Before cochlear implantation, 71% of profoundly deaf elderly patients exhibited alterations in cognitive abilities, particularly in executive function and attention. The prevalence of Mild Cognitive Impairment (MCI) had been significantly higher in this group than in the normal population (50% vs. less than 20%). Seven years after cochlear implant use, there was no decline in communication abilities or deterioration in the quality of life among elderly patients aged 72 to 92 years. Cognitive stabilization or improvement was observed in 83% of cochlear implant recipients, with a low incidence of dementia (3%, compared to an estimated 24% in this population).

In conclusion, the restoration of hearing through cochlear implantation in motivated elderly patients with profound hearing loss can be considered as a preventive strategy against cognitive decline and dementia. The study underscores the multifaceted benefits of cochlear implantation, not only for hearing improvement but also for cognitive and overall well-being in the elderly population.

Symposium 16

Elderly CI and Cognition
SP 16-4

Cognitive Improvement After Cochlear Implantation in Older Adults With Severe or Profound Hearing Impairment: A Prospective, Longitudinal, Controlled, Multicenter Study

Griet MERTENS[1,2], **Ellen ANDRIES**[1,2], Annes CLAES[1,2], Vedat TOPSAKAL[1,2], Vincent VAN ROMPAEY[1,2], Miryam CALVINO[3], Isabel SANCHEZ CUADRADO[3], Elena MUÑOZ[3], Javier GAVILÁN[3], Piotr Henryk SKARŻYŃSKI[4,5,6], Henryk SKARŻYŃSKI[4], Lynne TAPPER[7], Catherine KILLAN[7,8,9], Jillian RIDGWELL[7], Janet MCGOWAN[7], Christopher RAINE[7], Dayse TAVORA-VIEIRA[10,11], Roberta MARINO[10,11], Aanand ACHARYA[10,11], Luis LASSALETTA[3,12]

[1]Department of Otorhinolaryngology, Head and Neck Surgery,, Antwerp University Hospital, Belgium
[2]Experimental Laboratory of Translational Neurosciences and Dento-otolaryngology, Faculty of Medicine and Health Sciences, University of Antwerp, Belgium
[3]Department of Otolaryngology, Hospital Universitario La Paz, Spain
[4]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[5]Heart Failure and Cardiac Rehabilitation Department, Medical University of Warsaw, Poland
[6]Department of Sensory Organs, Institute of Sensory Organs, Poland
[7]Yorkshire Auditory Implant Service, Bradford Royal Infirmary, UK
[8]National Institute For Health Research, Nottingham Biomedical Research Centre, UK
[9]Hearing Sciences, Division of Clinical Neuroscience, University of Nottingham, UK
[10]Otolaryngology, Head & Neck Surgery, Medical School, The University of Western Australia, Australia
[11]Department of Otolaryngology, Fiona Stanley Hospital, Australia
[12]Biomedical Research Networking Centre On Rare Diseases (ciberer), Institute of Health Carlos Iii, Spain

Objective: To compare the cognitive evolution of older adults with severe or profound hearing impairment after cochlear implantation with that of a matched group of older adults with severe hearing impairment who do not receive a cochlear implant (CI).

Design: In this prospective, longitudinal, controlled, multicenter study, 24 older CI users were included in the intervention group and 24 adults without CI in the control group. The control group matched the intervention group in terms of gender, age, formal education, cognitive functioning, and residual hearing. Assessments were made at baseline and 14 months later. Primary outcome measurements included the change in total score on the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing impaired individuals score and on its subdomain score to assess cognitive evolution in both groups.
Secondary outcome measurements included self-reported changes in sound quality (Hearing Implant Sound Quality Index), self-perceived hearing disability (Speech, Spatial, and Qualities of Hearing Scale), states of anxiety and depression (Hospital Anxiety and Depression Scale), and level of negative affectivity and social inhibition (Type D questionnaire).

Results: Improvements of the overall cognitive functioning ($p = 0.05$) and the subdomain "Attention" ($p = 0.02$) were observed after cochlear implantation in the intervention group; their scores were compared to the corresponding scores in the control group. Significant positive effects of cochlear implantation on sound quality and self-perceived hearing outcomes were found in the intervention group.

Conclusion: Intervention with a CI improved cognitive functioning in older adults with severe hearing impairment compared to that of the matched controls with hearing impairment without a CI. However, older CI users did not, in terms of cognition, bridge the performance gap with adults with normal hearing after 1 year of CI use, which may highlight the need for additional cognitive rehabilitation in the long term after implantation.

Keywords : Cochlear Implant, Cognition, Older adults

Symposium 16

Elderly CI and Cognition
SP 16-5

Improving Cognitive Health of Middle-Aged and Elderly Patients (70+) with Cochlear Implantation

Heidi OLZE

Otorhinolaryngology, Head and Neck Surgery, Charité-Universitätsmedizin Berlin, Germany

Introduction
Several studies demonstrated the association of hearing disorders with neurocognitive deficits, but little is known about the effects of auditory rehabilitation with CI on cognitive performance. For middle-aged patients, hearing loss is the most significant controllable risk factor (9%) for the development of dementia in old age. The present work aimed to describe changes in the cognitive performance of patients over 70 and under 65 who underwent auditory rehabilitation with a unilateral CI.
Materials and methods
This longitudinal prospective study included fifty-three patients split into two age groups: over 70 (n=21) and below 65 (n=32). The measuring points were before implantation and 12 months after the first CI fitting. The working memory (WMI) and processing speed (PSI) were evaluated using the Wechsler Adult Intelligence Scale 4th edition (WAIS-IV). The audiological assessment included speech perception (SP) in quiet, noise and self-assessment inventory.
Results
Twelve months after the first CI fitting, the auditory parameters and the working memory and processing speed improved significantly in the elderly and the middle-aged cohort. In detail, the elderly group reported significant improvement of SP and OI, resulting in FMT of 57.4 ± 22.0%; OLSA (65dB SPL) 2.1 ± 2.4 dB S/N and total OI of 3.02 ± 0.63. Importantly, also the WMI (pre 92.7 ± 15.2; post 98.1 ± 15.3 pts) and PSI (pre 97.2 ± 16.2; post 101.9 ± 15.8) improved significantly ($p<0.05$). Similarly, in the middle-aged group, speech understanding in quiet improved ($p \leq 0,0001$) whereas WMI improved from 84.1 ± 16.7 to 91.0 ± 17.1 ($p \leq 0.0001$) and PSI increased from 91.6 ± 12.8 to 95.4 ± 13.8 ($p=0.011$).
Conclusion
The presented results suggest that CI positively impacts the cognitive abilities of elderly and middle-aged bilaterally hearing-impaired patients, thus, supporting the notion about preventing cognitive decline by rehabilitating auditory deficits.

Keywords : Cognitive health, Elderly, Cognition test

Symposium 17

Recent Issues in Rehabilitation
SP 17-1

Speech and lexical tone perception outcomes in Cantonese Chinese with cochlear implants

Iris H.-Y. NG[1,2]

[1]Department of Otorhinolaryngology, Head and Neck Surgery, The Chinese University of Hong Kong, Hong Kong SAR
[2]Institute of Human Communicative Research, The Chinese University of Hong Kong, Hong Kong SAR

Cantonese Chinese is a tone language spoken by over 86 million people worldwide as their native language. As a tone language, lexical tone plays a crucial role, as it is characterised by variations in the speaker's fundamental frequency pattern. The change in tone corresponds to a change in meaning, making it essential for tonal language speakers to accurately understand and produce tones.

A cohort of over 180 paediatric cochlear implant users has undergone regular evaluations for five years following their implant activation. Long-term data indicate that the mean percent correct scores for word recognition tests were approximately 65%, significantly lower than the close to 100% scores achieved by their counterparts with typical hearing. Furthermore, children using cochlear implants reached mean percent correct scores of around 60% for the lexical tone identification test, while children with typical hearing at the age of 7 years or above are generally expected to achieve 100% accuracy in this test.

Although cochlear implant speech coding strategies have been well-developed for various populations, it appears that specific speech understanding difficulties still affect Cantonese Chinese speakers. Consequently, researchers and clinicians in the cochlear implant field have contemplated whether modified speech coding strategies, an enhanced aural rehabilitation protocol, or a revised test battery for speech perception outcome measurements are needed to better serve this population.

The results of the longer-term follow-up of this paediatric cohort provide further evidence that children using cochlear implants do not perform as well as their typically hearing peers in perceiving Cantonese tones. The ability to identify lexical tones, however, presents as a crucial outcome indicator for children who speak tonal languages. The question of how Cantonese Chinese speakers can reach their full potential with cochlear implants remains unanswered and poses a challenge to the field.

Symposium 17

Recent Issues in Rehabilitation
SP 17-2

American Cochlear Implant Alliance Guidelines for Implantation of Children with Single-sided Deafness

Nancy YOUNG[1,2,3]

[1]*Otolaryngology Head and Neck Surgery, Northwestern University Feinberg School of Medicine, USA*
[2]*Surgery, Ann & Robert H Lurie Children's Hospital of Chicago, USA*
[3]*Communication Sciences and Disorders, Knowles Hearing Center of Northwestern University, USA*

More children with severe to profound unilateral sensorineural hearing loss, often referred to as single-sided deafness (SSD) are receiving cochlear implants in the United States. This change was driven by 2019 approval of MEDEL Corporation's implant for this indication followed by approval in 2022 of Cochlear Corporation's device. The goal of implantation for SSD is to provide bilateral input to enable development of binaural hearing. The American Cochlear Implant Alliance (ACIA) created a task force to develop guidelines to review current evidence and to provide guidance on candidacy and management. In 2022 the task force guidelines with references to published studies relevant to SSD was published open access in Ear and Hearing (DOI: 10.1097/AUD.0000000000001204). This presentation will summarize the ACIA guidelines.

Background: There is growing evidence of the disadvantages of unilateral hearing loss and its impact on understanding speech in noise, increased risk for speech and language problems, behavior and cognitive problems and negative impact on quality of life. Amplification is not effective in addressing all degrees of unilateral hearing loss. Alternative technologies for SSD included contralateral-routing-of-signal hearing aids and bone conduction devices. Each of these routing devices have advantages and disadvantage and are typically not treatment options for young children. Routing technology also does not impact changes in the auditory cortex that occur due to lack of auditory input. Published outcomes in children with SSD+CI are limited, although positive trends have emerged in terms of subjective benefits, speech understanding in noise, length of device use, tinnitus suppression and enhancement of localization.

Guidelines Summary
Guideline 1: At present, cochlear implantation (CI) is contra-indicated in children with nerve aplasia/hypoplasia, also referred to as cochlear nerve deficiency. It is estimated that almost half of children with congenital SSD have cochlear nerve deficiency. MRI, the most sensitive modality to identify a deficient cochlear nerve, is therefore an essential part of the pre-implant evaluation.
Guideline 2: CI should be a priority for children at risk for hearing loss in the contralateral ear. Prompt implantation of SSD due to bacterial meningitis is important due risk of progressive cochlear ossification.
Guideline 3: Young age at CI is advantageous. Children with longer lengths of deafness may experience fewer benefits and the child and family should be counselled appropriately.
Guideline 4: CI evaluation is recommended for children with unilateral three frequency pure tone average 3FPTA > 60 dB HL and/or an aided Speech Intelligibility Index (SII) < 0.65 because this population of children may not benefit from traditional amplification.
Guideline 5: Trials with re-routing devices are not recommended if binaural benefits are the goal of the child/family because these devices do not provide bilateral input.
Guideline 6: Counselling for families considering CI to address SSD should include information on known developmental risks of SSD, role of bilateral input for spatial hearing, importance of neural plasticity, reasonable expectations, and importance of full-time device use.
Guideline 7: Candidacy evaluation should include 1. age-appropriate behavioral assessment and cross-check; 2. spatial hearing assessment in child's every day listening condition; 3. relevant subjective questionnaires; 4. recorded aided word recognition testing with contralateral masking if child may benefit from amplification.
Guideline 8: Post-activation measures completed at regular intervals should include 1. subjective questionnaires; 2. assessment of unaided hearing; 3. isolated single word recognition using direct audio-input; 4. validation of CI audibility; 5. spatial hearing assessment with and without CI
Guideline 9: Evaluation of audibility in sound field completed while using plug-and-muff technique and screening in plug-and-muff alone condition, without the processor to evaluate whether thresholds are reflective of the occluded contralateral ear.
Guideline 10: Prioritize spatial hearing assessments in SSD children. Speech-in-noise testing with three target-to-masker configurations.
Guideline 11: Device programming considerations include plugging of the contralateral ear during mapping, use of electrically evoked stapedial reflex threshold (eSRT), and considerations for rapid adaption.
Guidelines 12: Habilitation with listening therapy based on hierarchy of auditory skills and development of binaural integration is recommended.
Guideline 13: Clinicians working with SSD+CI children need to follow rapidly evolving research and best practices.

Symposium 17

Recent Issues in Rehabilitation
SP 17-3

Educational and occupational status in prelingually deaf young people with cochlear implants

Woo Seok KANG

Department of Otorhinolaryngology Head & Neck Surgery, Asan Medical Center, University Of Ulsan College Of Medicine, Korea

A cochlear implant(CI) is recommended for auditory rehabilitation and the development of oral communication skills in children with profound hearing loss. Cochlear implants in deaf patients improve hearing, speech, and language skills and help build an educational and professional career. Although there have been many prior reports on the cost, effectiveness, and safety of cochlear implantation, relatively few studies have evaluated the educational and occupational outcomes of patients who have received cochlear implantation.

Therefore, in Asan Medical Center, the study was performed to investigate the educational and occupational status of prelingually deaf children who received a CI before the age of 7 and to identify factors that influence these outcomes. In this study, 71 prelingually bilateral deaf young children were enrolled. Primary outcomes included the latest education, occupation status, and word recognition score(WRS). All the study subjects had graduated from high school or obtained an equivalent educational qualification. General high school graduates (n=54) showed a higher WRS than those who attended a special education high school (n=7). The college entrance rate of the CI patients (74.6 %) was comparable to that of the general population (70.4 % in 2019 and 72.5 % in 2020), and the subjects who went to college had a significantly better WRS than those who did not (51.4% vs 19.3%). Intuitively, a sufficient speech perception ability through auditory rehabilitation would be essential to complete a proper education, and present findings have indicated that good speech perception is closely related to successfully completing general high school and entering college. Excluding the 30 subjects currently enrolled in college, 26 (62%) of the remaining 41 were currently employed and engaged in various vocational activities, of which most (21 out of 26, 81%) were employed through vocational training institutes, or via special recruitment policy for people with disabilities.

In Korea, as of 2020, the college entrance rate for all high school graduates in Korea was 70.4%. The above study demonstrated that 74.6% of hearing-impaired students went to college, which is comparable to the proportion of the general population. Moreover, the employment rate of those who graduate college in the general population (65.1%) was similar to that found for the hearing-impaired subjects in the current study series (62%). This indicated that the use of CI in prelingual deaf children enables speech perception and produces comparable levels of education and employment to those of the general population.

South Korea is implementing a special college admission process for students with disabilities. As of 2020, 993 persons have been admitted to 118 different universities via these special procedures. It is demonstrated that the special admission process can be advantageous to persons with disabilities. It can thus be assumed that this special screening for selecting college students played some role in helping our hearing-impaired subjects to enter college. In the job market, 81% of our hearing impaired study subjects obtained employment through bespoke processes introduced for disabled jobseekers, including those attending vocational training centers, suggesting that government policy support is needed to ensure positive employment outcomes for people with disabilities. Therefore, supportive policy is necessary and highly related to these successful outcomes.

Symposium 17

Recent Issues in Rehabilitation
SP 17-4

Depression, anxiety, and quality of life in patients with cochlear implant

Mahmut Tayyar KALCIOGLU[1,2]

[1]Department of Otorhinolaryngology, Istanbul Medeniyet University, Istanbul, Türkiye
[2]ENT Clinic, Goztepe Prof. Dr. Suleyman Yalcin City Hospital, Istanbul, Türkiye

Rümeysa YENİ ELBAY[1 2], Burcu BAKICI BALCI[3 4], M. Tayyar KALCIOGLU[3 4]

[1]Department of Psychiatry, Istanbul Medeniyet University, Istanbul, Türkiye
[2]Psychiatry Clinic, Goztepe Prof. Dr. Suleyman Yalcin City Hospital, Istanbul, Türkiye
[3]Department of Otorhinolaryngology, Istanbul Medeniyet University, Istanbul, Türkiye
[4]ENT Clinic, Goztepe Prof. Dr. Suleyman Yalcin City Hospital, Istanbul, Türkiye

The relationship between hearing loss, a major cause of disability, psychological distress and reduced quality of life is well established. The aim of this study was to assess the levels of anxiety, depression and quality of life in adults with postlingual hearing loss who have received cochlear implants and to compare them with individuals who have never experienced hearing loss.

This prospective, controlled clinical study included 53 people with cochlear implants and 52 hearing healthy controls. The Hospital Anxiety and Depression Scale was used to assess depression and anxiety, and the Short Form 36 was used to assess quality of life.

The mean age of the participants was 42.88±18.04 years and 44% (23) were female. There were no significant differences in scores on the Hospital Anxiety and Depression Scale between the study and control groups. However, when assessing quality of life, the study group scored statistically significantly higher than the control group on the Short Form 36 Physical Role (P=. 018) and SF-36 General Health (P=. 014) subscores. No significant associations were found between time since surgery and Hospital Anxiety and Depression Scale and Short Form 36 scores.

The results show that patients assessed after cochlear implant surgery had similar levels of depression and anxiety to controls. In addition, their quality of life, particularly physical role and general health, was significantly better than that of the control group. This underlines the importance of hearing restoration.

Symposium 17

Recent Issues in Rehabilitation
SP 17-5

Predictive factors for long-term speech perception and quality of life outcomes in Mandarin speaking adults with cochlear implant

Hung-Ching LIN[1,2]

[1]Department of Otolaryngology and Head Neck Surgery, Mackay Memorial Hospital, Taiwan
[2]Department of Audiology and Speech Language Pathology, Mackay Medical College, Taiwan

Objective:
Despite the rapid development of Cochlear implant (CI) technology, post-CI speech perception in adult users has high individual variability, and some unexplained factors remain unexplored. Most people in Taiwan speak Mandarin-Chinese. However, Mandarin is a tonal language and it is challenging for CI recipients to recognize tone or lip-reading due to the limitations of CI technology. Therefore, we should be valuable for comparison between Mandarin and other intonation language subjects.

Methods:
The study was performed at the single medical center, a total of 53 adult CI recipients (55 implanted ears) were enrolled in this study. Post-CI outcomes were evaluated after long-term (at least 24 months) follow-ups using speech perception tests (vowels, consonants, disyllable words, and Mandarin monosyllable recognition test) and quality of life questionnaire. Firstly, we examine the relationship between related factors, such as age at identification, age at HA fitting, age at intervention, hearing years in life and long-term speech perception outcomes. Secondly, we analyzed the speech perception affecting subjective quality of life.

Results:
The shorter duration of profound deafness and a higher percentage of hearing years in life were significant predictive factors for better post-CI speech perception. Profound deafness less than 30 years indicated promising improvements in post-CI quality of life. Better performance of monosyllable word scores was predictive of better subjective improvements in social and emotional life.

Conclusion:
Duration of profound deafness is one of the most important factors affecting long-term post-CI outcomes. Profound deafness of less than 30 years and MMRT monosyllable words score of over 56% could help improve psychosocial life benefits. These results provide pre-CI consultation guidelines for Mandarin-speaking adult who are considering cochlear implantation.

Symposium 18

Future Technology & Robotics
SP 18-1

Robotic cochlea implantation

Marco Domenico CAVERSACCIO[1,2]

[1]ENT, Head and Neck Surgery, University Hospital Bern, Switzerland
[2]ARTORGcenter for Biomedical Engineering Research, University of Bern, Switzerland

Robotics has recently gained popularity in otology as an effective tool to overcome the surgeon's limitations such as tremor, drift and accurate force control feedback. Several products are on the market.
Robotic cochlear assisted implantation as tunnel procedure is a minimally invasive approach for CI surgery. The prototype of our developed robot and the procedure was created and evaluated in a clinical trial as a translational project at the University ARTORG Center and the Hospital in Bern, Switzerland.
The clinical study was approved by the local IRB and regulatory body. Access to the middle ear was drilled using a previously developed task specific image-guided robotic system. Sufficient clearance of the drill trajectory from the facial nerve was confirmed using intraoperative cone beam CT imaging. The electrode array was manually inserted in the round window using a specifically manufactured insertion tube. Correct placement and nominal function of the implant was verified by telemetry and postoperative CT imaging. We have demonstrated that a CI electrode can be successfully inserted into the cochlea through a 1.8 mm keyhole created by a surgical robot. The crucial key point remains the size of the facial-chorda angle.
During the last years the development of our prototype to a commercial robot system has been reinforced by the industry. The inner ear approach with the robot seems possible for the future. 2020 the prototype received the CE-mark.
Since 2021 we include robotic cochlear implantation with the commercialized system (Hearo™) and the planning system (Otoplan™) to evaluate the performance. It's an ongoing study (ClinicalTrials.gov) J Vis Exp 2022, 16(184).
Additionally in a multicenter study the robot will be tested by the University hospitals of Antwerp, Brussels, Vienna, Düsseldorf and Montpellier. Before the robot can become the standard approach for CI, several points still need to be addressed, primarily imaging, accuracy, cost and duration of the procedure.

Symposium 18

Future Technology & Robotics
SP 18-2

The role of robotic assistance in Cochlear Implantation: Comparisons between traditional and surgically assisted cochlear implantation in In-Vitro models.

William CROHAN

Otorhinolaryngology, University of Western Australia, Australia

Aim: To investigate and compare the relative forces of cochlear implantation in robotically assisted and traditional cochlear implantation surgery.
Methodology: Using a similar In-Vitro model of the Scala Tympani previously reported in the literature for operative factors of Hearing Preservation Cochlear Implantation,(1) intra-cochlear pressure rise, variation and time were measured as surrogate markers for trauma to the cochlea during surgery, against different methods of handling the cochlear implant electrode.
The model was a plastic mould of the Scala Tympani, with a mechano-optical fibre optic pressure installed at the apex of the Cochlea that measured pressure changes along the fluid column.
As a simple form of robotically-assisted surgery, a cochlear implant electrode was mounted onto a basic syringe driver with human guidance. Using a slow insertion, soft surgery technique, this was gently inserted into the plastic model. The measurements using this methodology were contrasted against a traditional, instrument-held soft surgery technique.
Results: The experiment demonstrated a significant disparity between robotically assisted and traditional cochlear implantation.
As predicted, robotically assisted surgery led to a significant reduction in the variation in intracochlear pressure. This effected was particularly pronounced during longer insertion times.
Conclusion: Robotically assisted surgery has the potential to greatly reduce the force and trauma transferred to the cochlea during cochlear implantation.

Symposium 18

Future Technology & Robotics
SP 18-3

Robotic insertion of cochlear implant electrodes: Technique and interest

Christophe VINCENT

Otology and Neurotology Department, University Hospital of Lille, France

Quality of the manual insertion of the cochlear implant electrode is dependent to the experience and the dexterity of the surgeon. However, even with experienced surgeons, some factors associated with the surgical insertion (such as incomplete or traumatic insertions, translocations, destruction of residual hearing) could be due to the speed of a manual insertion. The RobOtol® is an innovative robotic assistance system dedicated to ear surgery, designed and built in France. This is a compact serial robot with 7 degrees of freedom and high resolution, allowing a controlled speed of insertion. The surgeon can use the robot during the surgery, directing it with a spacemouse, to insert the cochlear implant. The technique, interests and limits will be presented as well as future evolution of the concept of preservation of the cochlear structures after cochlear implantation.

Symposium 18

Future Technology & Robotics
SP 18-4

Cochlear implantation in post irradiation ears

Wai Tsz CHANG[1,2]

[1]Department of Otorhinolaryngology, Head and Neck Surgery, The Chinese University of Hong Kong, Hong Kong SAR
[2]nstitute of Human Communicative Research, The Chinese University of Hong Kong, Hong Kong SAR

Aim: To address and review the problems and complications of cochlear implantation in post irradiated ears and review the clinical outcomes in comparison to adults with cochlear implant but no irradiation. And to propose surgical alternatives in the era of endoscopic assisted cochlear implantation.

Material and Methods: This is a retrospective case controlled study of adult patients underwent cochlear implantations from 1994 – 2021. Explantation rate and cause was reviewed and compared. Surgical outcomes were measured with Speech perception tests, including Hong Kong Speech Perception Test Manual (HKSPTM) and Cantonese Hearing-in-Noise Test (CHINT) pre-operatively, and then at 6 months, 12 months and 24 months post-operatively.

Results: Total of 329 ears has been implanted, 51 with prior irradiation and 278 without. Among them, 6 (11%) CI require explantation is post irradiation group and 6 (2%) in non-irradiated group. The relative risk is 5.5 higher in the post irradiation group. But the outcome measure is promising. NPC group did significantly better at the 12 month and 24 month post-operatively on sentence recognition. The two groups performed similarly in the other two measurement, namely the word recognition and tone perception within the two-year period.

Conclusion: Cochlear implantation is a promising intervention for the management of hearing impairment with NPC. The high rate of explantation might be due to the poor soft tissue and bone condition leading to easier infection, extrusion and mispositioning. Peri-operative care and counselling of expectation were stressed but not inhibiting them from implantation. Endoscopic assisted implantation with blind sac closure can be considered in special cases.

Symposium 18

Future Technology & Robotics
SP 18-5

The development and first clinical results of a partial ossicular replacement prosthesis with a concentric microsphere joint in the headplate

Dirk BEUTNER

Dept. Otorhinolaryngology, Head and Neck Surgery, University of Göttingen, Germany

In passive middle ear prosthetics, rigid implants have proven successful in reconstructing the ossicular chain. However, these cannot fully replicate the physiology of the ossicular chain. Pressure fluctuations cause high stresses in rigid passive prostheses, which can result in dislocation, extrusion and unsatisfactory hearing results.
In collaboration with MED-EL, we developed a new passive middle ear prosthesis (PORP) that features a balanced, centered microsphere joint between the headplate and prosthesis shaft. Before clinical application we performed temporal bone experiments and compared the sound transmission properties of this new prosthesis with those of a rigid prosthesis. Using Laser-Doppler-Vibrometry (LDV), we measured the sound-induced velocity of the stapes footplate relative to a given acoustic stimulus.
The new prosthesis showed equivalent sound transmission characteristics compared to the rigid prosthesis, while retaining the ability to compensate for pressure fluctuations due to its microsphere joint. Thus ensuring good transmission properties even in different positions of the tympanic membrane.
First experience in clinical use demonstrated the straightforward application of the prosthesis and excellent hearing outcomes.
This development is a further step towards the physiological reconstruction of the ossicular chain.

Symposium 19

Pediatric CI Issues
SP 19-1

Bilateral cochlear implants

Joachim MüLLER

Department of Otorhinolaryngology, Head & Neck Surgery, Munich University Hospital, Germany

Cochlear implants (CI) are standard for the hearing rehabilitation of severe to profound deafness. Since 1996, if bilaterally indicated, bilateral implantation is done and it is usually recommended (in accordance with German guidelines) for adults and children. Bilateral implantation enables better speech discrimination in quiet and in noise and restores directional and spatial hearing. Children with bilateral CI are able to undergo their hearing and speech development based on „hearing“. Within the scope of their individual possibilities, bilaterally implanted children develop faster than children with unilateral CI and attain, a larger vocabulary within a certain time interval, i.e. until the age of 8y. Only bilateral implantation allows true "binaural hearing," with all the benefits that people with normal hearing benefit from, namely: better speech discrimination in quiet and in noise, as well as directional and spatial hearing. Naturally, the developments take time.
Binaural CI users benefit from the same psychoacoustic effects as normal hearing persons: head shadow effect, squelch effect, and summation and redundancy effects. Sequential CI fitting is not necessarily disadvantageous - both simultaneously and sequentially fitted patients benefit in a similar way. For children, earliest possible fitting and shortest possible interval between the two surgeries seems to positively influence the outcome if bilateral CI are indicated. Thus as a logical consequence from 2005 onwards patients , adults and children, with single sided deafness are treated with cochlear implants.
In addition, preliminary data on quality of life in bilateral CI users are presented. The data show that both, CI users implanted early at younger age (4 months to 2.5 years), who are now in the age of 14-20 years are, as well as older CI users (36-76 years of age), very satisfied with their living condition according to German norms. However interestingly, the younger CI users are shown to report better subjective hearing quality than the older CI users. Quality of life self assessment of early implanted children compare equal to self assesssment of normal hearing pairs.

Symposium 19

Pediatric CI Issues
SP 19-2

Importance of age at 2nd implantation and inter-implant interval to the outcome of bilateral prelingually deafened pediatric cochlear implantation

Che-Ming WU[1,2]

[1]*Department of Otorhinolaryngology & Head and Neck Surgery, New Taipei Municipal Tucheng Hospital (Built and Operated by Chang Gung Medical Foundation), New Taipei city,, Taiwan*
[2]*Department of Otorhinolaryngology & Head and Neck Surgery, Chang Gung Memorial Hospital, Linkou,School of Medicine, Chang Gung University, Taoyuan, Taiwan*

Background:
In Taiwan, the number of sequential bilateral pediatric cochlear implantation cases is increasing, but there is insufficient data on its effectiveness and the reimbursement policy. This study examines speech perception and quality of life in bilateral prelingually deafened children who underwent sequential cochlear implantation, considering age at the second implantation and inter-implant interval.
Methods:
We studied 124 Mandarin-speaking participants who received their initial cochlear implant (CI1) between 2001 and 2019 and a second cochlear implant (CI2) between 2015 and 2020. Patients were monitored for a minimum of 2 years. Recipients were divided into groups based on age at the second implantation (<3.5, 3.6-7, 7.1-10, 10.1-13, and 13.1-18 years) and inter-implant interval (0.5-3, 3.1-5, 5.1-7, 7.1-10, and >10 years). We measured speech perception outcomes, device usage rates, and assessed quality of life using subjective questionnaires (SSQ and CCIQ). Data were analyzed within each group.
Results:
Speech perception scores of second implant showed a negative correlation with factors such as age at first implantation, age at second implantation, and inter-implant interval. Older age and longer intervals resulted in higher rates of non-use of the second implant and poorer auditory performance and quality of life. Among individuals over 13 with intervals over ten years, up to 44% did not wear their second ear. The 7.1-10 age group performed better in speech perception and questionnaires compared to the 10.1-13 and 13.1-18 age groups. The 10.1-13 years age group had a lower rate of continuous usage of the second implant compared to the 7.1-10 years age group.
Conclusion:
Optimal outcomes are linked to the timely implantation of the second ear. This pertains particularly to sequentially implanted recipients who have experienced long-term deafness in their second ear, where hearing aids have proven ineffective since the initial ear implantation. To optimize results, it has been recommended to consider an upper age limit of ten and a suggested interval of seven years for the second implant to prevent suboptimal outcomes. These local data can be provided as a reference to implant recipients, their families, and relevant medical and audiological professionals, enabling a clearer understanding of the benefits and potential impacts of the timing of second ear implantation.

Symposium 19

Pediatric CI Issues
SP 19-3

Electric acoustic stimulation in children

Lisa PARK

Otolaryngology Head and Neck Surgery, The University of North Carolina at Chapel Hill, USA

Introduction: Children with preoperative normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss with poor speech recognition can be considered for a cochlear implant (CI). Electric-acoustic stimulation (EAS) is an option for pediatric CI recipients who retain residual hearing, while full-electric stimulation (FES) is utilized when residual hearing is lost. Recent research utilizing standard speech perception assessments has indicated improved performance in pediatric CI recipients with pre-operative residual hearing. This study examines speech recognition and prosodic identification outcomes in children with maintained residual hearing using EAS and those who experience residual hearing loss and are fitted with FES.

Methods: This prospective clinical trial included pediatric CI recipients with a preoperative low-frequency pure-tone average (LFPTA; 125, 250, and 500 Hz) of 75 dB HL or better. Participants with functional hearing preservation were fit with EAS, while those exceeding the 75 dB HL threshold were fit with FES. A total of 26 children (EAS: n= 13, FES: n= 13) were monitored for 12 months post-activation. Performance was evaluated using recorded speech recognition materials (CNC words and BKB-SIN) and a prosodic perception task. The latter task involved repeating a semantically neutral sentence with pitch variation indicating a question or a statement. Blinded reviewers rated participant repetitions for accuracy in discerning questions versus statements.

Results: After 12 months of device use, no significant difference in speech recognition performance was found between the EAS and FES groups for CNC words or BKB-SIN. Notably, the EAS group exhibited superior performance in prosodic identification compared to the FES group. A strong inverse correlation emerged between post-activation low-frequency hearing level and accuracy in prosodic identification.

Conclusion: Children with normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss may achieve comparable word recognition and sentence recognition in noise, regardless of preserved or lost hearing. Children using EAS exhibit enhanced ability to differentiate between questions and statements compared to those with FES. The level of residual hearing post-activation significantly impacts prosodic identification task performance. Preserved hearing in children plays an important role in accessing auditory cues crucial for spoken language development.

Symposium 19

Pediatric CI Issues
SP 19-4

COCHLEAR IMPLANT IN YOUNG CHILDREN: CHALLENGES AND OUTCOME

Bee See GOH

Department of Otorhinolaryngology Head & Neck Surgery, Faculty of Medicine, Universiti Kebangsaan Malaysia (UKM), Hospital Canselor Tuanku Muhriz, Kuala Lumpur, Malaysia

Hearing loss is a silent handicap, but one should know it is the only sensory loss that can be treated successfully even if the hearing loss is complete. Hence, universal newborn hearing screening is carried out in many hospitals to diagnose hearing loss at early stage and intervene accordingly for speech and language development as well as to improve quality of life. Cochlear implantation is a well-established and effective treatment for children with sensorineural hearing loss (SNHL). Nowadays, cochlear implant is widely accepted as standard of care for population with severe-profound hearing loss. It has resulted in greatly increased auditory performance, as compared to the use of conventional hearing aids. Prolonged auditory deprivation among patients with profound sensorineural hearing loss has been shown to cause degeneration in the central auditory system. Thus, there is increasing evidence advocating for earlier implantation within a critical neuroplastic window period. In the past, there were concerns regarding surgical safety and feasibility including anesthesia risk young infants. When comparing to older children, CI surgery in young children potentially poses a greater challenge to surgeons due to an underdeveloped mastoid tip, higher bone marrow content, thinner calvarium as well as relatively superficial course of the extratemporal facial nerve. Bleeding during surgery is always significant and may affect the vital signs. The decision to proceed with CI is a shared-decision making process and should be determined on a patient-specific basis. There may be justifiable reasons to perform surgery after 9-12 months in certain population. Limitations can include family indecision, progressive hearing loss, or complex medical conditions increasing the risk and morbidity of early implantation. Universiti Kebangsaan Malaysia (UKM) pioneered CI program in 1995 in the South East Asia. One of our study objectives on paediatric implantees supported that age is an important factor in predicting long-term outcomes. A cross sectional observational study was performed in 2016 on paediatric implantees. The results showed 69.8% communicating orally, and 58.5% attended mainstream education with the mean age of implantation of 38 months. Age of implantation also reliably predicted whether implantees would enroll into the mainstream education. Another descriptive study performed in 2019 showed favourable outcomes in children using bilateral cochlear implants. The auditory performance, hearing abilities based on the CAP-II scale and speech perception, spatial hearing and hearing quality (SSQ-P) were found to improve with increasing duration of CI usage. Favourable outcomes were also seen in patients with congenital abnormalities (enlarged vestibular aqueduct, Incomplete partition type II) and congenital TORCHES infection using bilateral CI. In conclusion, prelingually hearing loss children should receive CI as early as possible to facilitate the development of speech perception and speech intelligibility. This can only be achieved by the experienced multidisciplinary team; inter professional effort and commitment in the CI program along with committed parents or caregiver that provide equally important factors to ensure a successful outcome.

Symposium 19

Pediatric CI Issues
SP 19-5

Insertion of different electrode types in a 3D model of a patient with incomplete partition type III malformation

Janez REBOL

Department Of Otolaryngology, University Medical Center Maribor, Slovenia

Background: Incomplete partition type III (IP III) is a rare inner ear malformation. During cochlear implantation a cerebrospinal fluid (CSF) leak always occurs and a strong possibility exists of positioning the electrode in the internal auditory canal (IAC). There is no consensus concerning the choice of electrode, but authors report that both straight and perimodiolar electrodes are suitable for correct insertion. The reported series of implantation are few and this makes the decision about which electrode to choose difficult. We tested the insertion of three different types of electrodes in a model of an IP III patient.
Methods: A 3D model of the inner ear of the operated patient with IP III was constructed. The model had a canal wall up mastoidectomy and an enlarged round window approach as performed during real surgery. For the insertion we used a straight electrode, a perimodiolar electrode, and a slim periomodiolar electrode, which is inserted through the sheath in the basal turn of the cochlea. We checked the position of the electrode after each insertion. Each type of the electrode was inserted 20 times.
Results: The 3D model of the IP III inner ear malformation proved to be a good accessory for testing different electrodes. Successful insertion was achieved in 95% with the slim perimodiolar electrode, 85% with the perimodiolar electrode, and 75% with the slim straight electrode. After the twelfth attempt all the insertions were successful, indicating that training and can play an important role in preparation for surgery on this rare inner ear malformation. In the slim perimodiolar electrode an adaptation of the insertion technique is necessary because of the different position of the cochlea compared to a normal ear.
Conclusions: After repeated insertion in the 3D model, the slim perimodiolar electrode had the highest rate of successful insertion.

Symposium 20

Vestibular Implant
SP 20-1

The vestibular implant: implantation criteria and first results of the second generation device

Raymond VAN DE BERG

Otorhinolaryngology and Head & Neck Surgery, Maastricht University Medical Center+, The Netherlands

BACKGROUND:
Patients with bilateral vestibulopathy suffer from a variety of complaints, such as oscillopsia, imbalance and cognitive complaints. Individually, this leads to a decreased quality of life and on a socio-economic level, the burden is high. The vestibular implant was designed to restore the vestibular deficit by providing motion information through implanted electrodes. It was previously demonstrated that this neuroprosthesis is feasible, as it can (partially) restore the reflexes such as the vestibulo-ocular reflex and vestibulo-collic reflex, as well as functional improvements on dynamic visual acuity, posture, gait and quality of life.

METHODS:
Regarding implantation criteria for research, consensus was reached between 4 international research groups.
Additionally, 7 patients with bilateral vestibulopathy were implanted with the second generation vestibulo-cochlear implant using peroperative imaging techniques. Vestibular reflexes and perception were tested.

RESULTS:
Vestibular implantation criteria include chronic symptoms (e.g. postural imbalance, oscillopsia) combined with all vestibular tests (head impulse test, caloric test, rotatory chair test) demonstrating significant bilateral vestibular hypofunction.
In the patients receiving the second generation vestibulo-cochlear implant, all electrodes were surgically placed close to the ampullary nerve. It was possible to electrically elicit a vestibulo-ocular reflex in all but one patient. Obtained eye velocities were significantly higher with this second generation device. Different types of perception were evoked in all patients, and functional tests such as dynamic visual acuity and vHIT showed improvement.

CONCLUSION:
The latest vestibulocochlear implant can improve vestibular reflexes, vestibular perception, as well as functional tests. This shows its feasibility as a clinical useful device in the near future.

Symposium 20

Vestibular Implant
SP 20-2

Do we really need a vestibular implant for bilateral vestibular dysfunction?

Angel RAMOS-MACIAS

Department of Otolaryngology Head Neck Surgery, University of Las Palmas de Gran Canaria, Spain

Symposium 20

Vestibular Implant
SP 20-3

Recent advances on vestibular implant development

Angelica PÉREZ FORNOS[1,2]

[1]*Western Switzerland University Cochlear Implants Center, Geneva University Hospitals, Switzerland*
[2]*Department of Clinical Neurosciences, Faculty of Medicine, University of Geneva, Switzerland*

Vestibular implants are implantable devices that attempt to partially restore vestibular function using electrical currents to patients with severe bilateral vestibulopathy of peripheral origin. This disorder results in many disabling symptoms, including imbalance, oscillopsia, reduced mobility, and increased risk of falling. Unfortunately, the prognosis is poor and currently available treatment options have very low efficacy.

There have been substantial research efforts towards the development of vestibular implants in recent years. Our group, the Geneva-Maastricht team, developed an original concept based on a modified cochlear implant. This device, developed in close collaboration with MED-EL (Innsbruck, Austria), provides 1 to 3 extra-cochlear electrodes which are implanted in the vicinity of vestibular afferents in addition to the "standard" cochlear implant array. Specific stimulation paradigms as well as a novel, combined processor allowing specific activation of cochlear and vestibular electrodes according to stimuli captured with incorporated microphones and motion sensors have also been developed.

We started implantations in humans in 2007 and, to date, 21 patients with severe BV were implanted with these prototype devices without surgical or medical complications. Successful restoration of the different vestibular reflexes has been demonstrated using standard clinical tests (rotatory chair, video-head impulse test, and cervical myogenic vestibular evoked potentials). Controlled postural responses could also be obtained with our prototype vestibular implant device. Finally, visual abilities in dynamic settings were restored with the vestibular implant. The latter is a major step forward, providing the first ever demonstration of useful rehabilitation of this patient population. Latest experiments objectively evaluating the effects of vestibular stimulation on patients' signs and symptoms during whole weeks of continous implant activation demonstrated significant benefits in all aspects of function. Subjective reports from patients also demonstrated substantial benefits. Concurrent electrical stimulation of the auditory and vestibular systems showed no alteration of auditory performance when evaluated using clinical audiological measures.

Results obtained so far in humans are very encouraging. We hope that the increasing interest in this field and the substantial research efforts allocated lead to a clinical application in the near future. The vestibular implant opens new perspectives, not only as an effective therapeutic tool, but also pushes us to go beyond current knowledge and well established clinical concepts.

Symposium 20

Vestibular Implant
SP 20-4

Vestibular implant surgery, novel approach.

Manuel MANRIQUE RODRIGUEZ

Otorhinolaryngology, Clínica Universidad De Navarra, Spain

Introduction. Research carried out in animals and humans leads to the concept that restoring vestibular function with a prosthesis can be similar to restoring hearing with a cochlear implant. At this point, research has focused on developing a VI to be placed in the semicircular canals (SC). No attempt has been made yet to stimulate the otolithic organs. Utricle and saccule receptors (maculae) play a role in self-position awareness and coordination of body movements to maintain dynamic balance.

Purpose of the study:
Describe the feasibility of surgically placing a VI at the level of the maculae.

Materials and Methods. We have developed a device and also a procedure to generate electrical signals that can stimulate the saccule and utricle. A vestibular prosthesis has been designed considering anatomical landmarks. A group of 11 patients were treated with this device in a multicentric study. Surgeries were performed by four experienced surgeons in otology and neurotology procedures.

Results. In a total of 11 patients, a standard transmastoid posterior tympanotomy approach via a facial recess with an antero-inferior extended round window and superior extended oval window cochleostomy approach. The most accessible and safety area, for a penetrating electrode is the otolith area locates in the most anterior and close to the cochlear where the Scarpa ganglion of the inferior vestibular nerve is more accessible. So, a stapedotomy close to the anterior crura was performed. In all patients the VI were successfully placed in the vestibule, No complications were found with this procedure,

Conclusion. The surgical approach to place a vestibular implant on the maculae is feasible without provoking any significant complication.

Symposium 21

Inner Ear Gene Therapy
SP 21-1

Therapeutic strategies for KCNQ4-associated hearing loss

Heon Yung GEE

Pharmacology, Yonsei University College of Medicine, Korea

Pathogenic variants of KCNQ4 cause symmetrical, late-onset, progressive, high-frequency-affected hearing loss, which eventually involves all frequencies with age. KCNQ4 is the most frequently mutated gene among genes associated with autosomal dominant nonsyndromic hearing loss in Yonsei University Hearing Loss cohort. In addition, we demonstrated by analyzing large genomic data that Koreans harbor overlooked KCNQ4 variants which may contribute to hearing loss that starts in adulthood. Despite its high prevalence, there is still no curative treatment for hearing loss resulting from KCNQ4 variants. Nonspecific KCNQ activators are available; however, the prevalent pathogenic variants of KCNQ4 around the pore region variants do not respond to KCNQ activators. To overcome this limitation, new therapeutic approaches based on gene transfer and gene editing tools are being developed in animal models. In this presentation, I will focus on the successful restoration of auditory functions in Kcnq4 mouse model, paving the way for future clinical applications.

Symposium 21

Inner Ear Gene Therapy
SP 21-2

Gene therapy and cochlear implantation: Can they be compatible?

Chen-Chi WU

Otolaryngology, National Taiwan University College of Medicine, Taiwan

Cochlear implantation is currently the treatment of choice for children with severe to profound sensorineural hearing impairment (SNHI). Although most patients with SNHI have good speech perception after cochlear implantation, they do not regain "natural hearing" and cannot enjoy music satisfactorily. Cochlear implants convert external sounds into electrical signals and function only as a mechanical prosthesis. Cochlear implants cannot provide full recovery of hearing sensitivity and/or restoration of the native inner ear sensory epithelium. Furthermore, the benefits of cochlear implants may be limited due to the involvement of retrocochlear pathologies. Therefore, new biological therapeutic approaches based on gene transfer and gene editing tools are being developed to address these unmet clinical needs.

It can be envisioned that gene therapy for SNHI will start from certain scenarios: (1) OTOF-related SNHI, as recent animal studies have demonstrated the potential of gene therapy to reverse cochlear pathologies caused by OTOF mutations; (2) syndromic hearing loss, such as Usher syndrome, as there are already FDA-approved gene therapies for ocular or neurological diseases; (3) SLC26A4-related SNHI, as there may be a therapeutic window for gene therapy due to the progressive/fluctuating nature of SNHI; and (4) genetic etiologies associated with poor CI outcomes, such as retrocochlear pathologies caused by PJVK mutations. In this talk, I will discuss these scenarios and present our recent data in humans and experimental models.

Symposium 21

Inner Ear Gene Therapy
SP 21-3

Dominantly inherited hearing impairment: Cochlear implantation or disease-modifying therapy? Past, present and future.

Vincent VAN ROMPAEY[1,2]

[1]Otorhinolaryngology, Antwerp University Hospital, Belgium
[2]Translational Neurosciences, University of Antwerp, Belgium

DFNA9 is the most frequent hereditary disorder in Belgium and the Netherlands causing hearing loss at 20-30 years and evolving towards deafness by 60-70 years. Additionally, patients suffer from bilateral vestibulopathy by the age of 40 years. Over 30 different pathogenic variants in the COCH gene have been reported worldwide. Currently, there is no cure available although we can restore speech understanding to some level with hearing aids and cochlear implants. Ideally, a disease-modifying therapy would have the ability to delay or stop the progression of hearing loss in DFNA9. In DFNA9, only one of the two copies of the COCH gene (one inherited from either parent), is mutated and encodes for a toxic protein that affects the aging inner ear in general, and the spiral ligament and spiral limbus more specifically. It therefore presents us with a target anatomically as well as genomically. The DFNA9 population is particularly relevant to develop and evaluate a disease-modifying gene therapy for sensorineural hearing loss because: potential carriers are aware of their hearing-impaired relatives, potential carriers can get routine genetic testing and know their carrier status, once aware of their carrier status, a significant pre-symptomatic stage of several years starts, carriers are aware they will inevitably develop severe-to-profound SNHL and are open to future clinical trials with gene therapy, as identified during a patient advocacy meeting.

Symposium 21

Inner Ear Gene Therapy
SP 21-4

Therapeutic base editing for genetic hearing loss

Sang-Yeon LEE

Department of Genomic Medicine, Department of Otorhinolaryngology-Head and Neck Surgery, Seoul National University College of Medicine, Seoul National University Hospital, Korea

Genetic disorders affect over 350 million individuals worldwide, with over 7,000 known disorders, including genetic hearing loss. Inherited or acquired disease-causing mutations can lead to genetic disorders, and many of these disorders are fatal and currently incurable. Gene therapy in various forms has produced clinical benefits for several human disease, and gene-editing technologies are expected to play a major role in the field's future. The gene-targeting methods such as programmable nucleases (e.g., CRISPR-Cas system) are crucial for curing genetic diseases. The CRISPR-based technologies enable mammalian genome editing and their various applications to rescue the genetic disorders. The canonical CRISPR nucleases generate DNA double-stranded breaks (DSBs) at target sites, which would be repaired by cell's repair system majorly including non-homologous end joining (NHEJ) and homology-directed repair (HDR). While HDR can correct the disease-causing mutations, CRISPR-mediated DSBs basically lead to many unintended editing outcomes such as small insertions and/or deletions (indels) as well as large DNA deletion, chromosomal depletion, and p53-driven programmable cell death. Alternatively, base editors that consist of Cas9-nickase and cytidine or adenosine deaminases were developed, which do not induce DSBs. Notable examples of such innovations include cytosine base editors (CBE) and adenine base editors (ABE). In general, CBE and ABE can introduce G•G to T•A and A•T to G•C substitution, with high efficiency, respectively. Given that point mutations represent over half of all identified pathogenic genetic variants in humans, base editors possess significant therapeutic potential for correcting disease-causing mutations. At present, base editors are undergoing clinical trials for several rare diseases, thus mutations in disease-causing genes associated with sensorineural hearing loss will be promising candidates for human clinical trials using base editing-based gene therapy. However, to our best knowledge, there is no evidence of therapeutic base editing for genetic hearing loss in the literature yet. Today, I would like to share my experience with using base editors for correcting disease-causing mutations in genetic hearing loss. In summary, gene-editing technologies such as base editors have potential for targeted genome engineering and therapeutic applications for genetic hearing loss.

Symposium 21

Inner Ear Gene Therapy
SP 21-5

Precision medicine and gene therapy for hearing loss

Xue Zhong LIU

Department of Otolaryngology, University of Miami Miller School of Medicine, Miami, Florida, USA

Hearing loss (HL) is the most common sensorineural disorder worldwide and arises from a heterogeneous set of genetic and environmental etiologies. Currently, therapy for sensorineural HL is non-specific and limited to amplification devices and implanted neuroprosthetics. Recent advances in the burgeoning field of precision medicine (PM), focused on individualizing disease diagnosis and tailoring treatment to each patient's own biology, hold great promise to providing precise care and improving outcomes for HL patients. In this review, we discuss the current diagnostic algorithm and treatment options for HL, the use of PM tools to identify specific genetic mutations that predisposes to or results in HL, the role of genetics in determining surgical outcomes following cochlear implantation, recent advances in gene and stem cell therapies for treating HL, and patient-specific disease modeling using induced pluripotent stem cells. Gene therapy is emerging as a potentially effective therapeutic strategy for HL. Viral gene delivery approaches have proven successful in human clinical trials for two inherited causes of blindness and are being used for HL in animal models and a human trial. Non-viral gene therapy approaches are useful in situations where a transient biologic effect is needed or for delivery of genome editing reagents (such as CRISPR/Cas9) into the inner ear. The development of new treatment modalities and use of improved cellular (for example, induced pluripotent stem cells (iPSCs)) and animal models of hearing loss for HL will pave the way for future applications in humans leading to improved quality of life for many affected individuals and their families.

Symposium 22

Pediatric CI Outcomes
SP 22-1

Outcomes of early implanted children from early intervention 2016 – 2021: Barriers and facilitators

Aleisha DAVIS

Department of Hearing Services, The Shepherd Centre, Australia

Objective: Existing literature on communication outcomes following early cochlear implantation commonly investigates the predictive influence of factors such as the age of implantation and the presence of additional needs. While we have gained a comprehensive understanding of certain factors, such as the critical role of early implantation in mitigating the impact of hearing loss on the developing auditory system, outcomes for children—even those implanted early—remain diverse. Despite the acknowledged significance of early implantation in optimizing the development of children with hearing loss, the influence of early intervention on outcome diversity is not frequently investigated. This study aims to investigate the impact of early intervention, considering factors that serve as both barriers and facilitators to outcomes and explore their relationship to language development in children implanted early. Specifically, this research examines the outcomes of children who received cochlear implants through an early intervention service employing a listening and spoken language approach.

Methods: This study retrospectively examined a cohort of n=227 children with cochlear implants who attended interdisciplinary team based early intervention services before 2021. The analysis examined the demographic details and standard assessment results at the ages 5-6 years, marking the conclusion of their early intervention services and preceding their transition to school. To gauge the correlation between language scores and various identified factors, measures of association suitable for continuous, categorical ordered, and unordered explanatory variables were applied.

Results: Aligning with prior research, the age of implantation exhibits a positive correlation with language proficiency. Notably, the timing of entry into intervention significantly influences outcomes, with early entry into services linked to positive results for both cochlear implant recipients and those without. Factors such as delayed diagnosis of hearing loss, restricted access to early intervention services, and variable family engagement contribute to greater variability in outcomes. Socioeconomic factors and variations in the individualisation and customisation of intervention services also exert influence on the observed results.

Conclusion: The findings of this study underscore the critical role of early intervention in shaping the language and communication outcomes of children with cochlear implants. By understanding the barriers and facilitators involved, practitioners can tailor intervention strategies and support systems to maximize the potential of early implanted children, ensuring their successful integration into the hearing world and enhancing their overall quality of life.

To improve outcomes, it is imperative to systemically address the identified barriers. Raising awareness of the importance of both early identification and factors related to intervention is likely to facilitate timely cochlear implantation. Expanding access to early intervention services and promoting active family involvement in the child's communication development are essential components in achieving positive outcomes.

Symposium 22

Pediatric CI Outcomes
SP 22-2

Factors impacting cochlear implant outcomes - Lessons learnt

Kapil SIKKA

Otolaryngology, All India Institute of Medical Sciences, India

Introduction: Among the children implanted with cochlear implants (CIs), the speech and language outcomes are highly variable and are influenced by several factors including age at onset of deafness, duration of profound deafness, communication mode, pre-operative residual hearing, nonverbal cognition etc. These factors can persuade the gain a cochlear implant can provide to an individual. However, regardless of wide research investigating postoperative outcomes, the substantial unevenness in post implant performance of recipients remains to a greater degree. Therefore, this study was designed to assess the factors associated either positively or negatively in pediatric cochlear implant recipient's outcomes and to analyze the relationship between outcome measures of cochlear implantation and impacting factors. Method: An ambispective longitudinal observational study was carried out including five hundred subjects. Subjects with bilateral severe to profound hearing loss and the age range between 1-14 years were included. Two distinct questionnaires were administered for baseline and follow-up assessments. On the prospective population, the questionnaires were administered at six occasions over a period of three years. i.e., at baseline, 6 months, 12 months, 18 months, 24 months and 30 months after implantation. The demographic details along with the hearing history such as residual hearing, pre-implantation hearing aid use, audio verbal training (AVT), age at implantation, radiological details were obtained. Also, the potential factors affecting the implant outcomes such as communication mode of the child and parents, child's educational setting, language exposure, social-economic status, proximity to therapy center, family participation were assessed. Similarly, the outcome measures i.e., auditory perception, speech intelligibility and linguistic skills were evaluated using CAP (Categories of Auditory Performance) and SIR (Speech Intelligibility Rating). Parental Satisfaction graded on the scale of 0-10 were obtained at 6 monthly intervals till 3 years of implant age. Results: The descriptive analysis of primary outcome factors revealed upward tendency post implantation. The CAP and SIR scores increased over the time period suggesting that all the subjects showed significant improvement in auditory perception and speech intelligibility using cochlear implant. The statistical analysis revealed positive effect of duration of implant device usage on outcome measures. Longer the duration of device usage better were the CAP, SIR, RLA and ELA. This indicated that device post implantation should be used for all the waking hours to achieve optimum benefits. Another pre operative factor i.e., radiological domain had statistically significant effect on CAP scores, RLA and ELA. This implied that lesser the radiological abnormalities better were the implant outcomes. Similarly, one of an interesting finding of the study was impact of family size and economic status on RLA of the subjects. Larger family size and better economic status had statistically significant impact on RLA. This indicates that a greater number of members at home gave better communicative opportunities to children and hence they showed improvement in language reception. This can be further investigated with more targeted studies on effect of communication opportunities at home on language skills of implanted children. Conclusion: The present study assessed the probable factors affecting CI outcomes in a large sample size giving us insight into how these factors can impact the post-surgical rehabilitation process. Evaluation of these factors inched us closer to predicting the CI outcomes in children with hearing loss. Also, it can pave the way to planning the tailor-made intervention plan for these children considering their individual requirements. Alongside, it will help us to provide effective counselling to parents/caregivers before as well as after implantation by giving them the realistic picture and shape their expectations.

Symposium 22

Pediatric CI Outcomes
SP 22-3

How effective is the use of EAS in pediatric CI users?

Young-Myoung CHUN

Soree Ear Cliic, Soree Ear Clinic, Korea

The combined electric acoustic stimulation (EAS) of one ear is a topic that has received considerable attention over the last 10 years. Its development has followed several parallel strands, including the modification of existing surgical approaches and the use of different CI devices, as well as having been applied to various groups of patients. Despite the outstanding results achieved by the application of EAS in adults, there has been little confidence whether EAS can be applied to children who have significant amount of residual hearing in the ear selected for implantation.

Objectives
The primary goal of this study was to find out how much benefit children using EAS would receive. The second is to examine the conditions under which EAS can be benefited.

Materials & Methods
Out of 21 ears of EAS candidates with preserved useful residual hearing, 15 ears were chosen as the subject to study after disregarding ears with inner ear deformity or multiple handicaps. All children were compared in two different conditions, EAS mode and CI only mode, for speech understanding in quiet/noise environment, directionality, ability to listen to music, and subjective satisfaction. And the analysis was divided into groups with or without the EAS benefit. The use of hearing aid prior to surgery, the stability of hearing preservation, mapping strategy, and family support, etc., were evaluated on how the benefits of EAS were influenced.

Results
15 ears of 11 subjects preferred to use amplified acoustic sound, in which EAS mode was better than CI only mode in one or more parameters in speech, directionality, and music. All three ears that did not benefit from EAS in all parameters were rarely experienced with hearing aids before CI surgery. It was clear that the amount of residual hearing preserved is an important factor in benefiting from EAS, but it was not always the case. In other words, the use of EAS was preferred also in the case of children with relatively small residual hearing among users who have experienced hearing aid prior to the surgery. In addition, the optimal fitting strategy and family support seemed to be important factors for successful use of EAS.

Conclusion
Our experiences of pediatric EAS trials showed that EAS could give a significant benefit to congenital deaf children with residual hearing at lower frequencies just like to adult EAS. Especially, early hearing rehabilitation through hearing aids prior to CI is also essential for successful EAS use.

Symposium 22

Pediatric CI Outcomes
SP 22-4

Long term cochlear implant sound processor usage in children with single-sided deafness cochlear implantation

Jafri KUTHUBUTHEEN[1,2]

[1]*Otolaryngology Head and Neck Surgery, Perth Children's Hospital, Australia*
[2]*Division of Surgery, Medical School, University of Western Australia, Australia*

Objective: To assess cochlear implant (CI) sound processor usage over time in children with single-sided deafness (SSD) and identify factors influencing device use.
Study Design: Retrospective review study.
Setting: Paediatric tertiary referral centre.
Patients: Children with SSD who received CI between 2014 and 2020.
Outcome Measure: Primary outcome was average daily CI sound processor usage over follow-up.
Results: Fifteen SSD children who underwent CI surgery were categorized based on age of diagnosis and surgery timing. Over an average 4.3-year follow-up, patients averaged 4.6 hours/day CI usage. Declining usage trends were noted over time, with the first 2 years post-switch-on showing higher rates. No significant usage differences emerged based on age, surgery timing, or hearing loss aetiology. Conclusions: Long-term usage decline necessitates further research into barriers and enablers for continued CI use in paediatric SSD cases.

Symposium 22

Pediatric CI Outcomes
SP 22-5

Routing Speech Perception to Long term Outcomes in Children with CI

Banumathy NAGAMANI

ENT, Post Graduate Institute of Medical Education and Research, India

Enriched auditory experience is vital for children with hearing loss as it will enhance their speech perception skills, which in turn would facilitate the child's ability to discriminate speech sounds. Improving children's access to sound, including early fitting and regular use of hearing devices is one of the best predictors of later receptive and expressive language outcomes. However, children who use cochlear implants with relatively good audibility perform better in novel word learning tasks than their peers with poor audibility, still may not be at the levels of children with normal hearing due to lack of quality auditory experience.

The predictive relationship between speech perception and phonemic awareness in hearing-impaired children is very different. Imperfect speech perception (at the level of audition and phonetic labelling) might be associated with poor reading and phonological difficulties in children with hearing loss. It has been suggested that print awareness, vocabulary, morphosyntax and phonological awareness skills are important in earlier stages of emergent reading and oral language skills as they play a greater role as and when the complexity and reading skill increases later in development. Preschoolers with hearing loss showed deficits on measures of print and word concept knowledge relative to preschoolers with normal hearing (NH). They suggested that this disparity might be due to differences in shared storybook reading practices between caregivers and children with hearing loss relative to caregivers and children with NH. The knowledge gaps should be assessed by the clinician and children with hearing loss should be assessed for reading skills, phonemic awareness and other literacy domains.

The importance of phonological awareness for reading and that reading success is critical for mastery of a variety of school achievement skills, is to be realized. Hence the rehabilitation of children with hearing loss should focus on the emergent literacy skills of these children, which is the ultimate long term outcome that is expected from children with cochlear implantation (CI). Thus the talk will levy its focus on routing speech perception skills to long term outcomes in pediatric CI users.

Roundtable 05

CI Complication
RT 05-1

Complications in Pediatric Cochlear implantation and How to avoid?

Shankar B MEDIKERI

OTOLARYNGOLOGY, MEDIKERI SUPER SPECIALTY ENT CENTER, India

Aim of the study: Retrospective study of 899 Cochlear implantations done over the last two decades for various complications that occurred for their management strategies.

Materials & Methods : Of the 889 implantations done 849 (95.5%) were pediatric and 40(4.5%) were adults. I have mentored 40 ENT surgeons from different parts of India, Srilanka and Vietnam. The complications that we are discussing were managed by me at our center and mentorship centers. We had 85 (9.5%) complications and all of them were in children. Of these 57 (6.4)% were intra-operative complications and 28(3.1%) were post-operative complications.

Results & Discussion:

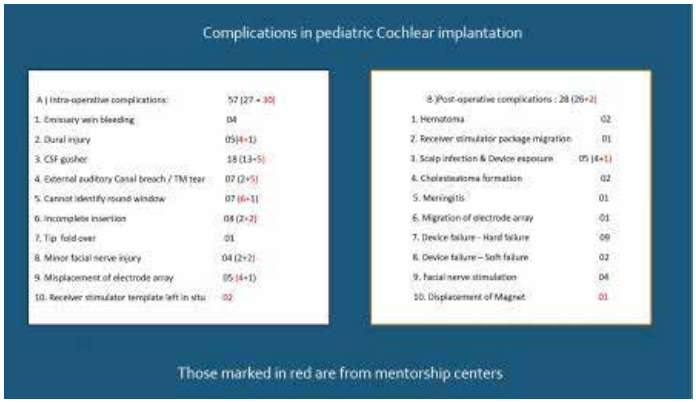

Table Complications in pediatric cochlear implantation

A) Intra-operative complications:

1.Bleeding from Emissary Vein was controlled with Bipolar cautery or Bone wax. Excess Blood loss to be avoided as it can lead to hemodynamic instability in young children. This can be avoided by careful planning of the periosteal flap.

2. Dural injury usually happens while drilling the Implant bed and making tie holes as the cortical bone is thin in young children.

The Dural defect was plugged with a piece of connective tissue / muscle and covered with temporal fascia before putting the implant in its bed. To Avoid Dural injury, leave an island of bone in the center of the bed and Protect the dura with a small periosteal elevator while drilling the tie holes for anchoring the implant.

3. CSF Gusher happened in children with enlarged vestibular aqueduct and incomplete partitions of the Cochlea., They were managed with Head end elevation, Intravenous Dexamethasone & Hyperventilation to reduce the intracranial pressure. We waited for the gusher to reduce before inserting the electrode and Cochleostomy was packed with Periosteal tissue. Usually straight electrode with a sleeve of temporalis facia proximal to the active electrodes was used to seal the Cochleostomy or Round window. These children were nursed in head high position post-operatively and were given Acetazolamide 10 -15 mg/kg body weight for a period of ten days. We did not require Lumbar puncture and drainage in any of our cases.

4. External auditory Canal breach / annulus injury happened during thinning of posterior canal wall and posterior tympanotomy. These defects were closed with Tragal cartilage and temporalis facia graft at the end of the surgery. These can be avoided by just adequate thinning of canal wall and posterior tympanotomy.

5. Some of our mentee surgeons could not find round window. By careful study of the CT scan pictures and middle ear anatomy, we were able to resolve the issue and show them the location of round window and site for doing Cochleostomy. In one case transposition of the posterior canal wall along with the canal skin was done to have wider access to middle ear.

6. Incomplete insertion usually happens if the tip of the electrode is abutting against either the lateral wall or the modiolus. By withdrawing the electrode a bit and rotating it with the hand and reinserting slowly, we were able to do complete insertion. Incomplete insertion can be avoided by careful study of the CT and MRI scans and following proper trajectory of electrode insertion for round window or Cochleostomy .

7. Tip fold over happened in one of our case of nucleus profile plus implant with CI632 electrode. We had to remove the electrode and reload it and follow the strict guidelines for insertion and were successful in avoiding the tip fold over. Tip fold over is common in slim Perimodiolar electrodes.

8. Minor facial nerve injury happened while doing posterior tympanotomy because of facial nerve exposure. As the nerve sheath was intact, all of them recovered completely with steroids.

9. Some of our mentee surgeons had misplacement of electrode array in the Eustachian tube, internal auditory canal, Crotch area and semicircular canal. These electrodes were explanted and Re-implantation was done with new electrodes. Proper study of the CT scans for round window anatomy and meticulous surgical technique can avoid extra Cochlear electrode placements.

10. Two of our mentees had left Receiver stimulator template in sub

periosteal pocket. It was noticed on post operative check X-ray and was removed with a separate incision.

B)Post-operative complications :
1.& 2. Hematoma & Receiver stimulator package migration was managed by drainage of hematoma and relocation and anchoring of implant after through washing of the wound with Betadine. Child was treated with rifampicin for 6weeks.
3. Scalp infection & Device exposure did not respond to antibiotics, surgical debridement, relocation of implant and periosteal rotation flap closure. They had to be explanted and re-implantation was done at a later date. Prevention is better than cure.
4. In Cholesteatoma formation, Modified Radical Mastoidectomy with Explantation of the device and implantation on the contralateral side was done in one case and the other case underwent Subtotal petrosectomy with explantation of the device & blind sac closure. Reimplantation was done in the second stage.
5. Meningitis child for whom bilateral implantation was done for bilateral profound hearing loss following Meningitis and congenital compliment deficiency developed meningitis twice again two years and eight years after implantation. Both the times was managed with antibiotic therapy and ICU care. Evaluations for any other routes of infection spread were negative. At the moment she is studying in secondary school.
6. Migration of electrode array happened in one case and was managed with deactivation of basal electrodes and frequency transposition to the remaining electrodes & Reprograming.
7 & 8. We had both hard and soft Device failures. Majority of them were either Nucleus 5 or AB HiRes ultra V1 failures because of hermetic seal issues. They were explanted and Reimplantation were done with Nucleus Freedom CA or AB HiRes Ultra 3D implants respectively. One mentally challenged child with post traumatic failure received bilateral implantation.
9. In facial nerve stimulation cases reducing the stimulation current level and switching off few offending electrodes helped. They were managed with frequency transposition & Reprogramming.
10. Displaced magnet was repositioned in to the socket .
Conclusion: Knowledge of CI complications and their management strategies are useful for successful implant program.

Roundtable 05

CI Complication
RT 05-2

Congenital CI recipients –up-grade surgery effective and reasonable

Rolf SALCHER

Department of Otorhinolaryngology, Head and Neck Surgery, Hannover Medical School, Germany

Roundtable 05

CI Complication
RT 05-3

DECISION MAKING IN REVISION/SALVAGE/ EXPLANATION & REIMPLANTATION IN COCHLEAR IMPLANT SURGERY - TIPS & TRICKS

Sumit MRIG[1,2]

[1]*ENT & COCHLEAR IMPLANT SURGERY, MAX SMART SUPER SPECIALITY HOSPITAL, India*
[2]*ENT & AUDIOLOGY, SANKALP ENT & COCHLEAR IMPLANT CENTRE, India*

IN THE LAST 30 YRS COCHLEAR IMPLANT SURGERY HAS BEEN THE TREATMENT FOR PRELINGUAL & POST LINGUAL SEVERE TO PROFOUND SENSORINEURAL HEARING LOSS . WITH THE INCREASE IN THE NO OF COCHLEAR IMPLANT SURGERIES IN THE PAST WE ARE NOW REACHING A STAGE WHERE REVISION SURGERIES ARE BECOMING COMMON BECAUSE OF SOFT FAILURES / INFECTION & DOING LOT OF SALVAGE SURGERIES . IMPORTANT DURING SURGERY IS STERILITY TO AVOID ANY INFECTION POSTOPERATIVELY & SO IS TRAUMA AFTER COCHLEAR IMPLANATAION . IN THIS TALK WE DISCUSS ABOUT HOW TO PLAN A FAILED COCHLEAR IMPLANT SURGERY WHERE ELECTRODE WAS ALSO NOT LEFT IN SITU DURING EXPLANATION. ALSO HOW TO SALVAGE A FAILING IMPLANT BECAUSE OF INFECTION AT THE RECEIVER STIMULATOR SITE . THIS TALK ASLO TALKS ABOUT PROTOCOL FOR SALVAGE SURGERY .

Roundtable 05

CI Complication
RT 05-4

Facial Nerve Stimulation in Narrow Bony Cochlear Nerve Canal After Cochlear Implantation

Moo Kyun PARK

Otorhinolaryngology, Seoul National University Hospital, Korea

Facial nerve stimulation (FNS) is a well-known complication of cochlear implant (CI) restricting optimal use of the device. Recently spotlighted narrow bony cochlear nerve canal (BCNC) could be a possible cause of FNS by elevating the stimulating current level. The aim of this study was to evaluate the correlation between narrow BCNC and FNS after CI and their underlying mechanisms and finally to predict the risk of FNS in patients with BCNC prior to CI. A total of 70 cases who underwent CI in Seoul National University were included for this study. Only pediatric patients were included and all cases of inner ear anomaly or otosclerosis were excluded. Among them, 35 cases experienced facial nerve stimulation after CI and another 35 cases were selected from our cohort of 817 pediatric implantees by stratified random sampling for age and gender. The width of BCNC, the relative size of cochlear nerve (CN) comparing to facial nerve (FN) (CN/FN ratio), the diameter of internal auditory canal (IAC), T-level, C-level were compared between groups. Strategies for eliminating the FNS and their results were also analyzed. The both group showed similar distribution of age and gender. The FNS group showed significantly narrower BCNC (1.06 mm) over control group (2.00 mm, $p<0.01$) and significantly lower CN/FN ratio (0.28) over control group (1.33, $p=0.023$), significantly narrower IAC diameter (4.00 mm) over control group (5.64 mm, $p<0.01$). The FNS group also showed significantly higher T-level (168.5 μA) and C-level (201.0 μA) over control group (T-level: 141.7 μA, $p<0.01$, C-level: 188.9 μA, $p=0.043$). The width of BCNC showed significantly negative correlation with T-level ($R=-0.372$, $p=0.001$). The CN/FN ratio showed significantly negative correlation with T-level ($R=-0.448$, $p<0.01$) and C-level ($R=-0.299$, $p=0.024$). Adjustment of C-levels and/or pulse width, switching off offending electrodes was tried for eliminating FNS. Successful elimination was achieved in 71.4% of cases. FNS group showed significantly low CAP scores (2.80) over control group (5.97, $p=0.019$) after adjustment.
Narrow BCNC could be a cause of FNS after CI. Therefore, careful selection of the side for CI and programing strategies is required for reducing FNS.

Roundtable 05

CI Complication
RT 05-5

Pathophysiology of facial nerve stimulation after CI surgeries: A retrospective analysis from 1151 patients

Hong Ju PARK

Department of Otorhinolaryngology-Head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Objectives: To analyze characteristics and propose mechanisms of FNS in cochlear implant surgeries.
Participants: Thirty-two ears from 29 patients with FNS were evaluated from among 1151 ears which received a cochlear implant between April 1999 and July 2016.
Materials and Methods: Locations of electrodes involved with FNS, presence and types of cochlear anomalies, presence of cochleo-facial dehiscence, and the current levels were analyzed. The current levels were compared to those of age- and sex-matched control group.
Results: Incidence of FNS was 2.8% (32/1151), and it was higher in ears with a cochlear anomaly (6.4%, 25/391) than in those without an anomaly (0.9%, 7/760). Patients without an anomaly showed two types of FNS: FNS at apical electrodes related to cochleo-facial dehiscence with low current levels, and FNS at basal electrodes with high current levels and partial insertion of electrodes. Patients with an anomaly showed a third type of FNS at most electrodes with high current levels, which was the most common type in patients with a common cavity or narrowing of the bony cochlear nerve canal.
Conclusions: Facial nerve stimulation occurred at various current levels and locations of electrodes by different mechanisms related to incomplete insertion of electrodes, cochleo-facial dehiscence, and types of cochlear anomalies. Our findings might provide insight for preventing facial nerve stimulation when performing cochlear implant surgeries.

Roundtable 06

CI in SSD and AHL
RT 06-1

The effect of duration of hearing loss on cochlear implant outcomes in single-sided and highly asymmetric hearing loss

Cathy SUCHER[1,2]

[1]Brain and Hearing, Ear Science Institute Australia, Australia
[2]School of Medicine, University of Western Australia, Australia

Objective: To determine the impact of duration of severe-to-profound hearing loss on speech perception outcomes for individuals with unilateral hearing loss.
Study Design: Retrospective cohort study.
Setting: A large Western Australian cochlear implant clinic
Methods: The outcomes of 125 cochlear implant recipients with unilateral hearing loss (UHL) were reviewed. Cochlear implant recipients included adults implanted between 10/08/2013 and 21/02/2022 with either a) hearing ≤30 dB HL between 500 and 4000Hz in one ear, and severe-to-profound hearing loss (>70 dB HL) in the other ear, or b) individuals with a pure tone average (i.e. average dB HL at 500, 1000 and 2000 Hz) asymmetry of >60 dB between the good and bad ear. Speech perception was assessed using the Consonant-Nucleus-Consonant (CNC) test (words and phonemes) (n=106) and the City University of New York (CUNY) sentence test (n=107) presented at 65 dBSPL in the freefield at 0 degrees azimuth with speech noise presented to the better ear at 60 dBHL via insert earphone. Duration of severe-to-profound hearing loss was converted to a relative percentage based on recipient age (Durage). Pure tone averages (average hearing threshold level at 500, 1000, 2000, and 4000 Hz) were calculated for each ear. Implant use (hr/day) was collected. Data was analysed at 3-, 6-, 12- and 24-months post implantation through ANOVA, pearson correlations and linear mixed-models.
Results: Linear mixed-models indicated that recipients with >30% Durage had lower CNC words and phonemes scores, and CUNY scores at 6- and 12- months compared with those with <10% Durage ($p<0.05$). Pearson correlations revealed that average daily implant use was not related to Durage or speech outcomes ($p>0.05$).
Conclusion: CI recipients who have a hearing loss relative to age of >30% in the implanted ear achieve improvements in speech perception post-implant in the CI ear, however these benefits are significantly lower than those with hearing loss relative to age of <10%. CI use does not appear to be intrinsically dependent on speech perception ability or duration of hearing loss relative to age. Further research is required to identify alternative reasons for device use and rejection.

Roundtable 06

CI in SSD and AHL
RT 06-2

Benefits of cochlear implantation in children with unilateral hearing loss.

Kevin David BROWN

University of North Carolina, Department of Otolaryngology and Neurosurgery, USA

Objective: Children with unilateral sensory hearing loss (UHL) struggle to understand speech in noise and locate the origin of sound and have reduced quality of hearing. This clinical trial will determine the benefits of cochlear implantation in children with UHL.

Study Design: Prospective clinical trial.

Methods: Twenty children with at least moderate to profound sensory hearing loss and poor speech perception (word score <30%) in one ear and normal hearing in the contralateral ear participated in a Food and Drug Administration-approved clinical trial. Subjects were evaluated for speech perception in quiet, speech perception in noise, sound localization, and subjective benefits after implantation.

Results: CNC word score perception in quiet significantly improved (1% to 50%, $P < .0001$) by 12 months after activation. Speech perception in noise by BKB-SIN significantly improved in all three noise configurations; there was a 3.6 dB advantage in head shadow ($P < .0001$), a 1.6 dB advantage in summation ($P = .003$), and a 2.5 dB advantage in squelch ($P = .0001$). Localization improved by 26° at 9 months ($P < .0001$). Speech, Spatial, and Qualities (SSQ) demonstrated significant improvements in speech (5.2 to 7.4, $P = .0012$), qualities of hearing (5.9 to 7.5, $P = .0056$), and spatial hearing (2.7 to 6.6, $P < .0001$). SSQ subscales associated with binaural hearing were significantly improved, as was listening effort ($P = .0082$). Subjects demonstrated a non-significant improvement in fatigue. These benefits were maintained through the 24-month post-activation interval.

Conclusions: This study demonstrates that children with UHL significantly benefit from cochlear implantation.

Roundtable 06

CI in SSD and AHL
RT 06-3

Factors influencing performance and device use in children with unilateral hearing loss who use a cochlear implant

Lisa PARK

Otolaryngology Head and Neck Surgery, The University of North Carolina at Chapel Hill, USA

Introduction: In the United States, the criteria for cochlear implantation have broadened to include children aged five and above with unilateral hearing loss (UHL). Implantation has resulted in enhanced speech recognition among pediatric cochlear implant (CI) users with UHL. However, research detailing the hearing hour percentage (HHP) and the prevalence of non-use within this specific group of pediatric CI recipients is scarce. This study was conducted to delve into the various factors influencing outcomes in children with UHL who utilize CIs, with a secondary focus on identifying temporal factors affecting device usage patterns within this demographic.

Methods: A thorough examination of a clinical database identified a cohort of 97 pediatric CI recipients who had UHL and were implanted between the years 2014 and 2022 and had datalog records. The clinical assessment protocol encompassed speech recognition evaluation using CNC words with the CI alone and BKB-SIN tests with simultaneous stimulation of the CI and the normally hearing ear. In the BKB-SIN tests, both collocated and spatially-separated configurations were utilized to assess spatial release from masking (SRM). To comprehend the factors influencing performance (CNC and SRM), we employed a multiple regression model that considered the variables time since activation, duration of deafness, hearing preservation status (HHP), and age at activation. A linear mixed-effects model evaluated the main effects of age at testing, duration of device use, duration of deafness, and onset of deafness on HHP.

Results: A significant positive correlation was found between CNC word scores and both time since activation and HHP. A significant negative correlation was found between duration of deafness and CNC word scores. Age at device activation was not found to be a significant predictor of CNC outcomes. For SRM, children with a higher HHP experienced a larger SRM. A significant negative correlation was found between HHP and both time since activation and age at test. Those with sudden hearing loss were found to have a higher HHP than those with progressive and congenital hearing losses.

Conclusions: These data do not support a cut-off age or duration of deafness for consideration of a CI in children with UHL. They do expand on the importance of device use and the factors that are related with decreased use. Understanding these factors can help clinicians provide better counseling and care for pediatric CI recipients with UHL

Roundtable 06

CI in SSD and AHL
RT 06-4

Simultaneous cochlear implantation and intracochlear schwannoma removal

Yun-Hoon CHOUNG

Otolaryngology, Ajou University School of Medicine, Korea

One of causes for single sided deafness or asymmetric hearing loss is intracochlear schwannoma. Intracochlear schwannoma is very rare, and complete loss of hearing is inevitable after the removal of this tumor. Here, we discuss cochlear implantation (CI) performed simultaneously with the removal of an intracochlear schwannoma. Simultaneous CI and intracochlear schwannoma removal were performed in four subjects. After subtotal cochleostomy, the tumors were removed meticulously, with preservation of the modiolus. A new slim modiolar electrode (Nucleus CI632) was placed in a manner that hugged the modiolus. The surgical outcomes of functional gain, word recognition score, sound localization, and hearing in noise and speech intelligibility test were investigated. Intracochlear schwannomas were removed successfully, with no remnant tumor, in the four patients. The mean aided hearing threshold 6 months after surgery was 25.0 ± 1.8 dB, and the mean aided word recognition score with a 60 dB stimulus was 36.0% ± 18.8% (range 16–60%). The Categorical Auditory Performance (CAP) score of the three single-sided deafness patients under contralateral ear masking was 7. The CAP score of the patient with bilateral sensorineural hearing loss was 6, improved from a preoperative score of 0. When intracochlear schwannoma does not completely invade the modiolus, CI with simultaneous tumor removal can be performed successfully, resulting in good hearing performance. A slim modiolar electrode can be placed stably at the modiolus after schwannoma removal

Roundtable 07

"Older Adults": The Future of Cochlear Implants?
RT 07

Are "Older Adults" the Future of Cochlear Implants? Achieving holistic outcomes for "older" adults with significant hearing loss through consideration of Anatomical, Surgical, Psychosocial, and Audiological dilemmas.

Michael Gluth[1], Mark A. Eckert[2], Dona Jayakody[3], Sunil Dutt[4], Cathy SUCHER[5]

[1]Section of Otolaryngology-Head & Neck Surgery, Comprehensive Ear & Hearing Center, University of Chicago Medical Center, USA
[2]Hearing Research Program, Department of Otolaryngology - Head and Neck Surgery, Medical University of South Carolina, USA
[3]Brain and Hearing Department, Ear Science Institute Australia, Ear Sciences Centre, Medical School, University of Western Australia, Australia
[4]Department of Otolaryngology (ENT) & Head-Neck Surgery, Cochlear Implant Program, Apollo Karnataka Region, Apollo International Hospitals, India
[5]Ear Science Institute Australia, Ear Sciences Centre, Medical School, University of Western Australia, Australia

Background:

It has been estimated that by 2050 over 900 million people will be living with disabling hearing loss. As the global population ages, the proportion of older adults living with significant levels of hearing loss will continue to rise. The World Health Organization (WHO) has estimated the global cost of neglecting to appropriately address hearing loss, at any age, poses a global cost of around 750 billion dollars annually. Whilst significant inroads have been made in ensuring that the majority of children who could benefit from a cochlear implant receive one, we know that cochlear implant uptake amongst eligible adults lies at around 5-10% in developed countries, and lower in developing countries. Failing to appropriately treat severe-profound hearing loss may contribute to reduced quality of life, social isolation, reduced physical and mental health, loss of independence, early retirement and loss of earning. The cost to society, and the economy, of failing to appropriately treat significant levels of hearing loss in older adults is something that can't be ignored.

Despite this, it is evident that there are a number of economic, and social and cultural barriers to the recommendation of cochlear implantation for older adults that need to be considered in addition to the potential dilemmas associated with an aging auditory system, and increased levels of medical co-morbidity.

We will discuss the neuroanatomical changes that occur within an aging auditory system including evidence of recent MRI findings looking at age and hearing loss related changes and the impact of hearing rehabilitation. Following this highly experienced cochlear implant surgeons with discuss the medical and surgical considerations, dilemmas and outcomes associated with implanting older adults, from both a US, Australian and South Asian perspective. Results from recent CI studies investigating the psychosocial, psychological and cognitive changes associated with severe profound hearing loss on older adults, and how use of CIs to manage severe-profound hearing loss can alter the trajectory of these changes. Finally, we will look at the audiological management of older adults both pre and post-operatively, can impact their hearing outcomes and quality of life. We will present research relating to how audiological processes could be changed to improve the quality of life, and hearing outcomes of older adults.

Prof Mark Eckert: Neuroanatomical changes within an aging auditory system. New discoveries in from imaging studies investigating age and hearing loss related changes and the impact of hearing rehabilitation.

Prof Michael Gluth: Surgical candidate assessment considerations unique to "older" adults. Surgical and perioperative care factors. Range of expected outcomes and avoidance of surgical complications—especially in adults with medical comorbidities.

Dr Sunil Dutt: Surgical and social considerations, dilemmas, and outcomes implanting "older" adults highlighting the cultural and social differences across the Asia Pacific that influence CI in "older" adults. Newer and emerging indications for CI in older adults

Dr Dona Jayakody: The psychosocial, psychological and cognitive implications of severe profound hearing loss on older adults. How can support our patients better?

Dr Cathy Sucher: The journey of the "older" adult from CI referral to post-operative management and outcomes. Changing our processes to radically improve the quality of life of older adults with significant hearing loss.

Roundtable 07

"Older Adults": The Future of Cochlear Implants?
RT 07-3

Surgical and psychosocial challenges after cochlear implantation in older adults

Sunil Narayana DUTT

Department of Otolaryngology (ENT) & Head-Neck Surgery, Apollo International Hospitals, India

Cochlear implantation in the elderly involves a number of unique issues that can affect patient outcomes. Various factors include age-related changes in the auditory pathways, prolonged duration of deafness, psychosocial problems, and many more. The results of cochlear implantation in the elderly are similar to that of the younger generation. However, a few challenges are to be considered here.

Pre-surgical:

Audiologically, the factors that affect the outcomes include the amount of residual hearing, electrical sensitivity of the auditory nerve, duration of auditory deprivation, presence of intact nerve, and patient preference.

General pre-operative considerations include physical, mental and psychosocial co-morbidities which can affect the outcomes. Proper pre-operative planning and informed consent is essential to have a safe surgical procedure. Elderly patients ae often on multiple medications for cardiopulmonary, renal, or central nervous system problems which may need to be continued or stopped before the surgery.

Surgical:

Surgical considerations include longer anesthesia time, difficulty tolerating and recovering from the anesthesia, flap/wound-related problems because of compromised blood supply, atherosclerotic vaso-occlusive disease or atrophic and thin overlying skin, and poor wound healing. A thorough pre-operative assessment and planning is essential for such patients.

Post-surgical and psychosocial:

The challenges post-surgery could be dizziness/vertigo/tinnitus, diminished vestibular compensation and body strength and the presence of osteoporosis and hence frequent falls. Psychosocial issues like depression, social isolation, anxiety, and loneliness are all prevalent in the deaf and the elderly and hence they affect the outcomes of cochlear implantation as well.

The costs of the device, surgery, habilitation, and maintenance in the Asia-Pacific region are of concern in emerging nations where state support is available only for paediatric cochlear implantation. In these regions, the older adults may not wish to burden the families with these additional costs.

Implant recipients also require a lengthy rehabilitation period during which they learn to use the device. They also need frequent post-operative follow-ups, mapping sessions, repair, and troubleshooting of the device for which they need to visit the specialized centers on a regular basis. This can add to the already existing economic burden.

References:

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Roundtable 08

Challenging Cases II
RT 08-1

Cochlear Implantation in Neurobrucellosis

Yüksel OLGUN

Otorhinolaryngology, Dokuz Eylül University School of Medicine, Türkiye

Brucellosis is endemic in countries bordering the Mediterranean region. Central and/or peripheral nervous system involvement occurs in %5 of the patients. Cranial nerve involvement is not rare and vestibulocochlear nerve is a site of predilection.
The aim of this speech is to present and discuss our clinical experience in cases of neurobrucellosis. Sensorineural hearing loss due to neurobrucellosis may be the result of an injury anywhere along the auditory pathway, and candidacy for CI should be thoroughly evaluated and promontory stimulation test seems to be most helpful in this regard.
Cochlear implantation may be successful in patients with sensorineural hearing loss due to neurobrucellosis. Positive promontory stimulation test is useful for selecting patients for CI deafened by neurobrucellosis.

Roundtable 08

Challenging Cases II
RT 08-3

Cochlear implants in hypoplastic nerves - a South Gujarat experience

Saumitra SHAH

Cochlear implant, Shruti cochlear implant centre, India

Cochlear implantation is an effective method for the rehabilitation of bilateral severe to profound hearing loss. Cochlear Malformations are reported to occur in approximately 20% of children with congenital sensorineural hearing loss. Cochlear nerve deficiency is not an uncommon cause of profound SN lossWe present a study of 26 patients with hypoplastic cochlear nerves who were classified according to Govaerts Classification into either a type II a Hypoplasia or a type II b Hypoplasia. We operated them using the standard transmastoid facial recess approach and followed them for upto 24 months.

Based on their performance, we divided them into 2 groups at 24 months, details of which will be discussed in the presentation.

In our experience,

- The outcomes of cochlear implantation in these 26 children with cochlear nerve deficiency are extremely variable,
- ranging from sporadic cases in which open set speech perception and acquisition of a spoken language are achieved, to most cases in which only an improved access to environmental sound develops.
- Regardless of these limited outcomes, all patients in our series use their device on a daily basis and derive benefits in everyday life.

In conclusion, cochlear implantation in patients with cochlear nerve anomalies is still controversial but some selected cases may achieve good audiological outcomes with cochlear implantation. It can be an expensive trial for these patients but it has less complications and it is an easy method compared with surgery of a brainstem implant

Roundtable 08

Challenging Cases II
RT 08-4

Unusual Cochlear Implant Surgeries- A Singaporean experience

Barrie TAN

Otolaryngology, Barrie Tan ENT Head & Neck Surgery, Singapore

To the experienced surgeon, standard cochlear implant surgeries often proceed uneventfully. In this presentation, 3 unusual types of cochlear implant surgeries are presented, which require some additional surgical steps or considerations in surgery, even for the experienced surgeon. Firstly, surgery for patients with previous irradiation to the head and neck region sometimes involve mastoid cavities and external auditory canals that are involved with osteoradionecrosis or are more prone to post surgery wound infections. Typical additional steps involved in single stage or separate staged surgeries for this group of patients include the use of subtotal petrosectomy and blind sac closure to avoid post implantation complications. The second group of patients are those who have had severe wound infections post implantations and requiring surgical debridement and attempts to salvage the implant. Some thoughts on how best to surgically manage these serious wound infections are discussed. The last group of patients are implantations in those who have intracochlear schwannomas. The surgical technique involved is briefly described and discussed.

Roundtable 08

Challenging Cases II
RT 08-5

Under-emphasised complications of Cochlear implantation

Heng Wai YUEN[1,2]

[1]*Otorhinolaryngology-Head & Neck Surgery, Changi General Hospital, Singapore*
[2]*Ear, Nose, Throat, Head & Neck Surgery, Mount Elizabeth (Orchard) Medical Center, Singapore*

As the number of cochlear implant recipients increased worldwide, the hitherto uncommon complications of cochlear implantation have become more common. While major and minor complications of cochlear implantation have been widely reported and studied, some complications are not as well reported or studied, but might cause difficulties and distress to CI recipients and potentially lead to non-use. These complications include: pain over the implant site, displacement/ extrusion of cochlear implant electrodes , and magnet displacement during magnetic resonance imaging (MRI) scans.

These 3 complications of CI surgery are discussed. Firstly, while pain after CI surgery is uncommon, it is vexing to recipients and surgeons when it occured. Different causes of pain after CI have been proposed, including infection, neurogenic, device migration , and foreign body reaction, but none has been proven. Secondly, amongst the different types of electrode displacement post CI surgery, electrode extrusion - especially through the posterior canal wall - is the most challenging and controversial. Depending on many factors, including whether hearing function is affected or presence of infection, revision surgery with soft tissue coverage, or explantation may be required. Thirdly, more patients with CI are undergoing MRI scans. While new generation CIs have been modified to improve MRI safety, there is a significant number of patients with previous generation CIs that would require management when going for MRI scans. Currently, head bandages are usually applied to prevent dislodgement of the CI magnets. However, despite this measures, the magnets are still at risk of dislodgement. When that occured, an endoscopic re-location technique is useful instead of the traditional wide and large incision approach. The personal experience of the speaker and management of these three under-emphasised complications will be discussed.

Roundtable 08

Challenging Cases II
RT 08-6

Cochlear Implantation in NF2 Patients Without Intracochlear Schwannoma Removal

Patrick AXON

Dept Otolaryngology, Cambridge University Hospitals, UK

Objective: To determine if cochlear implantation without removal of inner ear schwannomas (IES) is an effective treatment option for Neurofibromatosis 2 (NF2) patients. To determine how the presence of an intracochlear schwannoma might impact cochlear implant (CI) outcomes and programming parameters.
Study design: Retrospective chart review.
Setting: Tertiary center for cochlear and auditory brainstem implantation.
Patients: Of 10 NF2 patients with IES, 8 are reported with no previous tumor removal on the implanted ear.
Interventions: Cochlear implant without tumor removal.
Main outcome measures: Performance outcomes with CI at least 1-year post intervention. Programming parameters, including impedances, for patients with IES.
Results: All patients had full insertion of the electrode arrays with round window approaches. Performance outcomes ranged from 0 to 100% for Bamford-Kowal-Bench sentences. Impedance measurements for active electrodes for patients with IES were comparable to those measured in patients without vestibular schwannoma (VS). Only patients who had radiation treatment before receiving their implant had elevated threshold requirements for CI programming compared with CI recipients without VS.
Conclusion: Cochlear implantation without tumor removal is an effective option for treating NF2 patients with IES. The presence of an intracochlear tumor did not have an impact on CI performance or programming requirements compared with patients without VS; however, previous treatment with radiation may be related to elevated current requirements in the CI settings

Roundtable 09

Long-term Outcomes
RT 09-1

Long term outcomes with first generation Cochlear Implants – Australian experience

Robert James BRIGGS[1,2]

[1]Surgery, Otolaryngology, The University of Melbourne, Australia
[2]Cochlear Implant Programme, The Royal Victorian Eye and Ear Hospital, Australia

The first commercially manufactured multi-channel cochlear implant, the Nucleus 22, was implanted in Melbourne in 1982. In 1985 the Cochlear Mini receiver stimulator (CI22M) was introduced and designed to be suitable for children. This design, with a hermetically sealed titanium can containing the electronics and an internal magnet and antenna housed in silicone, remains fundamental to current Cochlear Implants.
The CI22M was used in Melbourne until 1998 with 250 adults and children receiving the original Nucleus implant or subsequent versions of CI22M. Whilst many of the adult recipients are now deceased and others have undergone re-implantation because of device failure or medical issues, many adults and children continue to benefit from these 1st generation devices. Provision of backwardly compatible new generation speech processors has facilitated progressively improved outcomes.
This paper will review the outcomes achieved and discuss the reliability of these early devices, the recognition of device failure and issues associated with re-implantation.

Roundtable 09

Long-term Outcomes
RT 09-2

Stable long time speech comprehension in cochlear implantation

Rudolf HAGEN

Klinik fuer Hals-Nasen-Ohrenheilkunde, Plastische, Aesthetische und Rekonstruktive Kopf-Hals-Chirurgie und das Comprehensive Hearing Center, Universitaet Wuerzburg, Josef-Schneider-Str. 11, Wuerzburg, D-97080, Germany

Providing hearing impaired patients with a cochlear implant has become a standard worldwide over the last 25 years. Patients can achieve excellent speech understanding after implantation. However, the question arises whether this remains stable after a long period of usage

A retrospective data analysis was conducted. Inclusion criteria were defined as age over 18 at the time of implantation and existing speech audiological examinations at 2 time periods (10 - 22 months and > 9.5 years postoperatively). The examination included Freiburger numbers (70 dB), Freiburger monosyllabic words (65 and 70 dB), HSM sentence test (70 dB) in quiet and HSM sentence test (70 dB) at 10 dB SNR.

Data sets of 65 patients could be collected. All patients were fitted with a Med-El Combi 40+ implant. The mean implantation age was 52.12 years. The audiological data evaluated at the early time point were measured after an average of 14.0 (10.8 - 21.3) months and the long-term data after 12.7 (9.7 - 20.4) years. There were no significant differences between the early and late measurement time points with the exception of the Freiburger monosyllabic word test which was most likely a result of a changed test scheme with a reduction of the sound level from 70 dB (early measurement) to 65 dB (late measurement).

The data collected show that speech comprehension in CI patients is stable, even over long follow-up periods. The present study is the first to investigate speech understanding with a very long follow-up period of 12 years on average. The data will help to advise patients before CI implantation about the chances and audiological results even after a long period of wear.

Roundtable 09

Long-term Outcomes
RT 09-3

Hearing preservation and EAS: Our "long, long-term" experience

Georg SPRINZL

Department of Otorhinolaryngology, St. Pölten University Hospital, Austria

Roundtable 09

Long-term Outcomes
RT 09-4

Long-term course of elderly cochlear implant users: 10 years from age 65 and beyond

Yasushi NAITO

Department of Otolaryngology, Comprehensive Ear and Hearing Center, Kobe city medical center general hospital, Japan

As society ages, the number of elderly people with hearing loss who need cochlear implants is increasing. In addition, the number of people with profound hearing loss who underwent cochlear implant surgery when they were younger continue to use cochlear implants also enter senior years. However, there are many issues that remain unclear regarding the use of cochlear implants in the elderly, such as how long cochlear implants are effective for the elderly and whether there are any problems specific to the elderly in the use of cochlear implants. In this study, the utility and challenges of cochlear implants were examined retrospectively in elderly patients with long-term cochlear implant use.

Subjects and Methods:
The subjects were adult patients with cochlear implant who had undergone cochlear implantation at our department. Of the 22 patients who were over 65 years old and had a cochlear implant 10 years earlier, 21 were included in the study, excluding one patient who had self-interrupted his cochlear implant use. These patients were examined for current wear status, cochlear implant effectiveness, age-related changes in speech-language performance, cochlear electrode resistance, and progress in electrical stimulation settings (T/C level).

Results:
Fifteen of the 21 patients are still wearing cochlear implants, and in many cases, good wearing efficacy was maintained. Although there were three deaths during the course of the study, the cochlear implants were effective before death and the patients wore them until the end of their lives. There were three cases in which cochlear implant use was discontinued midway, and the reasons given for discontinuation included difficulty in managing the cochlear implant, such as turning the power on and off and changing programs; difficulty in learning how to use the cochlear implant; discomfort with sounds heard through the cochlear implant; and poor physical condition, such as headaches and dizziness when wearing the implant. The age-related changes in the results of speech perception showed that good and stable results were obtained until the late elderly, after which there was a tendency for listening performance to decline with age.
The resistance of the cochlear electrodes did not change over time. T/C levels stabilized 6 to 12 months after surgery and changed little thereafter. In terms of the relationship with the speech perception performance, the T/C levels tended to be higher in the better-performing group.

Discussion:
Cochlear implants have been used effectively for a long time in the elderly, supporting their active lives. Even in cases where the patients died in the middle of the observation period, the cochlear implants were used until the end, presumably helping them to benefit from the last period of their lives. The electrical stimulation status of cochlear implant remains stable over time, even in the elderly, and when problems with speech perception with cochlear implants occur in the elderly, it may thus be necessary to consider the effects of higher-order central dysfunction. In addition, cognitive decline prevents proper use of cochlear implant devices, so support from family members and nursing homes may also be important.

Roundtable 09

Long-term Outcomes
RT 09-5

Advancing Hearing Health Equity for Older Adults: Lessons from the HEARS RCT

Carrie NIEMAN[1,2]

[1]*Otolaryngology-Head & Neck Surgery, Johns Hopkins School of Medicine, USA*
[2]*Johns Hopkins Cochlear Center for Hearing & Public Health, Johns Hopkins Bloomberg School of Public Health, USA*

OBJECTIVES:

Age-related hearing loss that impairs daily communication is independently associated with adverse health outcomes, but the use of hearing aids by older adults is low and disparities exist. The incorporation of community health worker (CHW)-partnered models, including peer mentors, is an approach that reduces barriers and addresses disparities. Within hearing care, particularly for older adults, CHW-partnered models have received limited study, despite national and international recommendations.

The HEARS (Hearing health Equity through Accessible Research & Solutions) intervention was designed as a structured hearing care program delivered by CHWs in a community setting that incorporates provision of a low-cost amplification device with education and counseling on age-related hearing loss. An initial pilot study demonstrated feasibility and acceptability. To assess the efficacy of CHW-delivered hearing care when provided to older adults, a randomized clinical trial was conducted to test the hypothesis that the intervention improves self-perceived communication function 3-months post-intervention compared to waitlist control.

DESIGN:

An open label randomized clinical trial was conducted between April 2018 and October 2019 with 3-month data collection completed in June 2020. The trial took place in 13 community sites, including affordable independent housing complexes (n=10), senior centers (n=2), and an older adult social club (n=1) in Baltimore, Maryland. 348 older adults were screened and 151 participants with hearing loss were randomized.

Participants were randomized to receive a CHW-delivered hearing care intervention (n=78) versus waitlist control (n=73). The 2-hour intervention consisted of fitting a low-cost amplification device and instruction.

The primary outcome was change in self-perceived communication function (Hearing Handicap Inventory for the Elderly-Screening [HHIE-S]) from baseline to 3-months post-randomization. The average treatment effect was estimated using the doubly-robust weighted least squares estimator, which uses an outcome regression model weighted by the inverse probability of attrition to account for baseline covariate imbalance and missing data.

RESULTS:

Among 151 participants randomized (mean [SD] age, 76.7 [8.0] years; 101 (67.8%) females; 65 (43%) self-identified as African American; 96 (63.6%) with low income [<$25,000 annual household income]), 136 (90.1%) completed 3-month follow-up for the primary outcome. In the intervention group, 90.5% completed the intervention session and reported at least 1 hour of daily amplification use at 3-month post-randomization. Self-perceived communication function significantly improved in the intervention group compared with the control group, with an estimated average treatment effect of the intervention of a -12.98 point HHIE-S change (95% CI: -15.51, -10.42). No intervention-related adverse events were reported.

CONCLUSIONS:

Among older adults with hearing loss, a CHW-delivered personal sound amplification device intervention, compared with a waitlist control, significantly improved self-perceived communication function at 3 months. The improvements were comparable in magnitude to improvements documented for older adults who received conventional clinic-based hearing care with provision of hearing aids by audiologists. Improvements were maintained to 12-months post-intervention. To the authors' knowledge, this randomized clinical trial was the first of a CHW-delivered hearing care intervention designed for older adults that included provision of amplification. Furthermore, this trial is one of the largest trials to date of a hearing care intervention in the U.S. of African American older adults and low-income older adults with hearing loss.

Roundtable 10

CI under Local Anesthesia
RT 10-1

Cochlear Implantation under local anesthesia with conscious sedation in the elderly patient

J. Thomas ROLAND JR.

Department of Otolaryngology-Head and Neck Surgery, NYU Langone Medical Center, USA

An increasing number of elderly patients are seeking hearing rehabilitation strategies, including cochlear implantation. Elderly patient who are frail or those with significant pre-existing comorbidities have a higher risk of perioperative morbidity after undergoing surgery with general anesthesia. Additionally, there is a growing concern that general anesthesia could increase the risk of dementia or postoperative cognitive decline. In patients who wish to avoid the perceived medical and cognitive risks attributed to general anesthesia or for those who are deemed medically unfit for general anesthesia, surgery under local anesthesia with conscious sedation may be offered. This presentation details the surgical technique of local anesthesia with conscious sedation and describes the modifications and technical nuances which may be employed for executing a successful surgery. Additionally outcomes, including costs, will be discussed comparing cases in similar cohorts with general and local anesthesia.

Roundtable 10

CI under Local Anesthesia
RT 10-2

Monitored anesthesia care for cochlear implant under local anesthetic in elderly patients

Akira ISHIYAMA

Department of Head and Neck Surgery, UCLA School of Medicine, USA

As the audiologic criteria for cochlear implantation continues to change and expand, increasing number of patients with hearing loss meet the audiologic criteria for surgical intervention. Untreated hearing loss has been associated with progression of dementia in the elderly, and thus many patients who can benefit from the use of amplification device or cochlear implantation will be of older age. The care of older patients with severe and profound hearing loss can be challenging since it is not uncommon for them to have comorbidities and medical problems, leading to concerns to undergo surgical intervention under general anesthesia.

In recent years, a small number of the patients have received cochlear implantation under monitored anesthesia care combined with local anesthesia. Using the combination of centrally acting alpha-2 agonist and local anesthesia, we have sucessfully conducted cochlear implantation surgery under monitored anesthesia care and local anesthesia for thity five patients above 85 years of age with hearing loss. The age of patients ranged from 85 to 102 (average age 88.2) and there were 20 men and 15 women. The surgical time including the use of Smart Nav was less than an hour, ranging from 35 minutes to 60 minutes. All of the patients were discharged home several hours after the procedure and there were no complications. Using our protocol, no patient needed to be converted to general anesthesia.

In this presentation, we describe our anesthesia protocol in detail. The success of the sedation protocol for cochlear implant under local anesthetic significantly relies on appropriate patient selection. Close communication and understanding between the patient, surgical, and anesthesiology teams are vital to patient safety and comfort, and the avoidance of conversion to general anesthesia. The patient's willingness and motivation to participate with the protocol is crucial.

Elderly patients are at high risk for neurocognitive side effects from sedatives and anesthetic agents. The agent selections for cochlear implant under local anesthetic with MAC for elderly patients are strategically chosen based on their pharmacodynamics and pharmacokinetics to minimize the neurocognitive effects on this fragile patient population.

Roundtable 10

CI under Local Anesthesia
RT 10-3

COCHLEAR IMPLANT SURGERY WITH CONSCIOUS SEDATION IN THE VERY ELDERLY: A FEASIBILITY STUDY

Melville John DA CRUZ[1,2]

[1]*Department of Otolaryngology, Westmead Hospital, Australia*
[2]*Sydney Medical School, University of Sydney, Australia*

Aims. To characterize outcomes of very elderly patients following CI under awake conditions to determine if anaesthesia is a modifiable factor in recovery from surgery.

Background. Increasingly adults receiving CI's are of advanced age. Surgical experiences in this group indicate that general anaesthesia (GA) can be related to prolonged post-operative confusion and accelerate cognitive decline. The potential of CI surgery under awake conditions (LA) potentially minimising the effects of GA, is attractive.

Materials and Methods. Retrospective case review of 16 patients 80+ years who underwent CI surgery under awake conditions assisted by conscious sedation (Dexmedetomidine/remifentanil) were compared to 28 age matched patients implanted under GA (propofol/remifentanil/sevofluorane).

Results. Surgical experiences were similar in both groups. Immediate post-operative experiences were also comparable except for 2 patients in the GA group who had prolonged confusion lasting greater than 2 days. In one patient the confusion lasted 7 days requiring prolonged inpatient stay. Generally, patients found CI surgery under both conditions comfortable.

Using univariant modelling the limited data set shows: For every one-minute increase in duration of anaesthetic, the risk of post op confusion) increases by 1.042-fold (OR=1.042; 95% CI: 1.1 to 131.2; P=0.042). As the number of comorbidities increases the risk of confusion increases by almost two and half times (OR: 2.4, 95% CI: 0.9 to 6.1; P=0.065). Although not significant (due to small sample size), for every unit increase in ASA score the risk of confusion increases by three-fold (OR: 3.041; 95% CI: 0.328-28.185; P=0.328). Type of anaesthetic (LA v's GA), age or gender did not have a significant effect on post op confusion.

Conclusion. CI surgery under GA and LA with conscious sedation produces similar outcomes. The effect of procedure duration, number of comorbidities and ASA score has a greater effect on post-operative confusion than anaesthetic type or age.

Roundtable 10

CI under Local Anesthesia
RT 10-4

Cochlear implantation under local anesthesia: The correlation of the patient's sound perception and ECocG responses during the electrode insertion.

Aarno DIETZ[1,2]

[1]*Department of Otorhinolaryngology, Kuopio University Hospital, Finland*
[2]*Institute of Clinical Medicine, University of Eastern Finland, Finland*

Background
To date, cochlear implant (CI) surgery under local anesthesia has been sporadically applied to primarily elderly patients with risks for general anesthesia. However, with growing experience, CI surgery under local anesthesia with or without conscious anthesia is performed more frequently, including also younger patients. Cochlear implantation in awake patients offers interesting possibilities for monitoring their hearing thresholds during electrode insertion. It also offers a unique possibility of validating the patients' subjective sound perception against intraoperative electrocochleography (ECochG) responses. Intraoperative ECochG measurements have never been validated against the patient's subjective hearing perception of the loudness of stimuli during electrode insertion.
The main objectives of this study were to investigate the feasibility of cochlear monitoring based on the patient's hearing and to validate it against intraoperative ECochG measurements during CI surgery under local anesthesia.

Material & Methods
Ten patients eligible for cochlear implantation with residual hearing (PTA 250-1000Hz ≤ 75 dB HL) were recruited for the study. The inclusion criteria were that patients should be able to hear ECochG stimuli at 250 Hz, 500 Hz, or 1000 Hz at ≤ 100 dB (HL).
The main outcome measure was the development of ECochG amplitudes in correlation to the patients' subjective perception of the sound stimuli. Secondary outcomes were the preservation of the residual hearing and insertion trauma assessed by postoperative cone-beam computer tomography.
Two different insertion strategies were applied. In all patients, we continued the insertion up to a preoperatively planned insertion depth angle, whenever the subjective loudness perception did not change, irrespective of the ECochG amplitudes. In subjects eligible for electric-acoustic stimulation, we planned for a partial insertion of a long lateral wall electrode aiming for an insertion depth angle of at least 300 degrees. The rationale behind this approach was to maximize atraumaticity for more reliable hearing preservation associated with shallower insertion depth angles. The advantage of partial insertion is that it provides the opportunity to advance the electrode deeper into the cochlea for better neural coverage at a later stage, should the patient's residual hearing deteriorate.

Results
Five patients were preoperatively candidates for electric-acoustic stimulation, i.e., their hearing thresholds at 125-500 Hz were ≤ 55 dB (HL). Five patients did not qualify for electric-acoustic stimulation. All patients were able to assess on a scale the loudness of the sound stimuli. Intraoperative ECochG was successfully measured in seven patients. 15 distinct ECochG events were recorded of which in nine events (60%) patients reported a simultaneous decrease in the perceived loudness of the stimulus. We detected multiple declines in ECochG amplitude in two patients of which one developed a total loss of residual hearing and postoperative imaging revealed scala tarnaslocation. The other patient had partial hearing preservation. In all patients with partial insertion, the residual hearing could be preserved.

Conclusion
This is the first report of comparing cochlear monitoring by means of ECochG with the patient's actual hearing during cochlear implantation. We observed a good match between the patient's sound perception to the stimuli loudness and ECochG results during insertion of the cochlear implant electrode. Cochlear monitoring by ECochG or the patient's feedback could be used for guiding the insertion process and both may help preventing insertion trauma. Multiple or large negative events, or the lack of them, may predict the postoperative hearing preservation. Hence, this study supports that monitoring the patients subjective sound perception during insertion is reliable and feasible for preventing insertion trauma. It also support the application of ECochG, whenever a direct feedback from patient is not possible.

Table Patient demographics and insertion data

Roundtable 11

Public Consensus and Policy
RT 11-1

Humanitarian aspect in cochlear implants

Prepageran NARAYANAN

Department of Otolaryngology Head & Neck Surgery, University of Malaya, Malaysia

Roundtable 11

Public Consensus and Policy
RT 11-2

Cost-benefit Analysis of Cochlear Implants: A Societal Perspective

Johan FRIJNS[1,2,3,4]

[1]Department of Otorhinolaryngology and Head & Neck Surgery, Leiden University Medical Centre, The Netherlands
[2]Finance Department, Leiden University Medical Centre, The Netherlands
[3]Medical Decision Making, Department of Biomedical Data Sciences, Leiden University Medical Centre, The Netherlands
[4]Leiden Institute for Brain and Cognition, Leiden University, The Netherlands

Objectives:
While the costs and outcomes of cochlear implantation (CI) have been widely assessed, most of these analyses were solely performed from the perspective of healthcare costs. This study assesses the costs and benefits of cochlear implantation in the Netherlands from a broader societal perspective, including health outcomes, healthcare cost, educational cost, and productivity losses and gains.

Methods:
The cost and benefits of CI were analyzed in this cost-benefit analysis, in which a monetary value is put on both the resources needed and the outcomes of CI. The costs and benefits were analyzed by prototypical instances of three groups, representing the majority of cochlear implant patients: prelingually deaf children implanted at the age of 1, adults with progressive profound hearing loss implanted at the age of 40 and seniors implanted at the age of 70 with progressive profound hearing loss. Costs and benefits were estimated over the expected lifetimes of the members of each group, using a Markov state transition model. Model parameters and assumptions were based on published literature. Probabilistic and one-way sensitivity analyses were performed.

Results:
In all three patient groups the total benefits of CI exceeded the total cost, leading to a net benefit of CI. Prelingually deaf children with a bilateral CI had a lifetime positive outcome net benefit of €433,000. Adults and seniors with progressive profound hearing loss and a unilateral CI had a total net benefit of €275,000 and €76,000, respectively. These results ensue from health outcomes expressed in monetary terms, reduced educational cost, and increased productivity.

Conclusion:
Based on estimates from modeling, the increased healthcare costs due to CI were more than compensated by the value of the health benefits and by savings in educational and productivity costs. In particular, for children and working adults, the societal benefit was positive even without taking health benefits into account. Therefore, CI generates an advantage for both patients and society

Roundtable 11

Public Consensus and Policy
RT 11-3

Over-the-Counter Hearing Aids in the USA

Frank LIN

Otolaryngology, Johns Hopkins University, USA

On October 17, 2022, the Food and Drug Administration (FDA) enacted regulations permitting the sale of a new class of over-the-counter (OTC) hearing aids that would be available to adults without the need to see a health professional. This action represented an attempt to help address the long-standing public health and market failure of hearing loss remaining largely untreated in U.S. adults. This public health challenge is not unique to the United States, however, and the introduction of OTC hearing aids in the United States may influence the hearing-care market in other countries in the coming years.

Roundtable 11

Public Consensus and Policy
RT 11-4

Application of the 60/60 cochlear implant referral criteria in a diverse patient population

Molly SMEAL

Otolaryngology, University of Miami, USA

Cochlear implantation is a well-established treatment for significant hearing loss; however, these devices continue to remain under-utilized in patients who could benefit from them. Zwolan and colleagues (2020) proposed a referral guideline for cochlear implant candidacy evaluations termed the "60/60 Guideline". This guideline recommends referring for a cochlear implant evaluation for adults who have a better ear pure tone average (PTA) of >60 dB HL and unaided monosyllabic word recognition score (WRS) of <60%. However, this was developed in an English-speaking cohort, and it is unclear if the detection rate for cochlear implant candidates would apply in a more diverse population. The purpose of the present retrospective study is to determine the efficacy of this tool in a group of English and Spanish speaking patients.

Of 673 patients who underwent a cochlear implant evaluation during a five year period, 402 were included for analysis. When evaluating the 402 who underwent a traditional cochlear implant evaluation (68% in English, 32% in Spanish), 209 (52%) met traditional cochlear implant candidacy criteria of both unaided bilateral moderate to profound SNHL and best aided sentence recognition score of <60% correct. Conversely, 193 patients did not meet traditional cochlear implant candidacy, most of whom did not meet the unaided portion of the candidacy criteria. The 60/60 Guideline was applied to English and Spanish speakers who met cochlear implant candidacy, which revealed a positive predictive value of 64.8% and a negative predictive value of 75%. However, when considering these results by language, the negative predictive value for Spanish speakers falls to 33%. In both languages, the unaided WRS is the more restrictive component of the 60/60 Guideline.

To better understand the patients being referred for a cochlear implant evaluation at our center, we reviewed the patient profile of all patients who were referred, regardless of meeting candidacy criteria. Most of our English and Spanish speaking patients had an unaided PTA of 50 dB HL or poorer. Yet when looking at unaided WRS, 95% of English speakers had an unaided WRS of 80% or poorer and 91% of Spanish speakers had an unaided WRS of 90% or poorer. If providers apply the 60/60 Guideline to both English and Spanish speakers, a large portion of Spanish speaking patients who could benefit from a cochlear implant will be under-referred. With respect to aided testing, more than half of the cohort met the aided candidacy criteria (<60%) when tested using sentences in quiet, regardless of language. Only half of the patients in this cohort elected to proceed with cochlear implantation. Even amongst those who met unaided and aided candidacy criteria, 58.1% opted not to proceed. In patients who did not meet both components of the candidacy criteria, 41.9% still received a cochlear implant.

The 60/60 Guideline is a developed referral tool that can help providers understand when to send English speaking patients for a cochlear implant evaluation. However, it is too restrictive for Spanish speaking patients. This is likely due to known language differences that contribute to Spanish speakers presenting with higher unaided WRS. Spanish speaking patients who have an unaided PTA of 60 dB HL or poorer should be referred for a cochlear implant evaluation regardless of unaided WRS.

Roundtable 11

Public Consensus and Policy
RT 11-5

Hearing rehabilitation for congenital canal atresia patients: What do they want?

Bee See GOH[1,2]

[1]*Department of Otorhinolaryngology and Head and Neck Surgery, Faculty of Medicine Universiti Kebangsaan, Malaysia*
[2]*Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan, Malaysia*

Introduction: Congenital aural atresia (CAA) and stenosis is a rare defect affecting the external auditory canal which causes varying degrees of hearing impairment. This malformation may be unilateral or bilateral. Timely hearing rehabilitation in these patients is paramount to ensure appropriate speech and language development. Thus, early detection with proper hearing assessment and intervention in the form of hearing aids is crucial. There is a wide range of hearing aids available for these patients, catering to individual needs and preferences. This research investigated the options and choices of hearing rehabilitation among patients with CAA in our center. This study also compares the hearing gain of different types of hearing aids and patient satisfaction levels. Methods: This was a retrospective analysis of 55 patients with congenital aural atresia or stenosis under follow-up at the Otorhinolaryngology and Audiology Clinic of Hospital Canselor Tuanku Mukhriz, UKM. Data on the timing of hearing loss diagnosis and intervention, type of hearing rehabilitation, hearing gain, Jahrsdoerfer score and patient satisfaction level was collected and analyzed. Results: Fifty-five patients were recruited with ages between 3.6 months to 58 years old. The majority of patients (63.6%) had moderate hearing loss, followed by severe hearing loss (18.2%), mild hearing loss (9.1%) and profound hearing loss (7.3%). 52.7% of patients had early hearing loss diagnosis by one year old, while 47.3% were diagnosed after one year of age. Bone anchored hearing aid (BAHA Attract/Connect) gave the highest mean hearing gain of 35.23dB (SD ± 9.75) compared to air conduction hearing aid, bone conduction hearing aid and canalplasty. Patients implanted with BAHA Attract/Connect reported the highest average satisfaction scores of 7.74. Discussion: Our study found that most patients were diagnosed and intervened late, after 3 months and 6 months of age respectively. Almost all of our patients were referred from other centers, which could have contributed to the delay. This study also found that patients with moderate to severe hearing loss were more likely to receive hearing aids, indicating that the degree of hearing deficit affected patients' choice to seek hearing rehabilitation. Conclusion: A significant proportion of patients have delayed diagnosis and intervention. Bone-anchored hearing implants provide excellent hearing improvements in patients with CAA with good patient satisfaction and was the preferred option for CAA hearing rehabilitation with good hearing outcome. We must always emphasize on the function of children with microtia and canal atresia and plan out the journey for both hearing rehabilitation and cosmetic part of the individual case to ensure both parents and children understand the needs and the timely treatment plan.

Roundtable 11

Public Consensus and Policy
RT 11-6

Cochlear implantation in developing world: Public Perspectives in Indian Subcontinent

Grace BUDHIRAJA

Otorhinolaryngology and head and neck surgery, Adesh Institute of Medical Sciences and Research, India

The acceptance and policies regarding cochlear implants can vary from country to country and even within different regions of a country. In India, cochlear implants have gained attention and importance over the years as a potential solution for individuals with hearing impairments.

Public Consensus: Public consensus regarding cochlear implants in India has generally been positive, but there have been debates and discussions on various aspects. Many people view cochlear implants as a valuable technology that can significantly improve the quality of life for individuals with hearing loss, especially children, allowing them to communicate and interact effectively.

However, some segments of society might have concerns about cultural aspects, language development, and the preservation of local languages and identities in the face of increasing adoption of cochlear implants. There could also be debates around the cost and accessibility of these devices, as they can be quite expensive and might not be easily affordable for everyone.

Policy: As of 2021, India didn't have a single overarching policy specifically dedicated to cochlear implants. Instead, policies related to cochlear implants might fall under broader healthcare and disability-related policies.

The Government of India has been taking steps to address the needs of individuals with disabilities, including those with hearing impairments. The "Rights of Persons with Disabilities Act, 2016" aims to ensure equal opportunities, protection of rights, and full participation for persons with disabilities, including access to healthcare services.

Government initiatives and partnerships with non-governmental organizations have led to increased awareness, outreach, and subsidized programs for cochlear implants, particularly for children. These initiatives have aimed to make cochlear implants more accessible to individuals who might not have the financial means to afford them at market rates.

There were several initiatives and schemes in India aimed at increasing access to cochlear implants for individuals with hearing impairments. Keep in mind that the situation may have evolved since then, so it's advisable to check with official sources for the most up-to-date information. Here is an overview of some of the prominent cochlear implant schemes in India:

1. ADIP Scheme (Assistance to Disabled Persons for Purchase/ Fitting of Aids and Appliances): This central government scheme is implemented by the Department of Empowerment of Persons with Disabilities under the Ministry of Social Justice and Empowerment. It provides financial assistance to individuals with disabilities, including hearing impairments, to purchase aids and appliances, including cochlear implants.
2. Samajik Adhikarita Shivir (Social Empowerment Camps): These camps are organized by the Ministry of Social Justice and Empowerment. They aim to provide on-the-spot distribution of aids and appliances, including cochlear implants, to people with disabilities in rural and remote areas.
3. State-Level Schemes: Many states in India have initiated their own programs to support individuals with disabilities, including those who need cochlear implants. These programs vary in terms of eligibility criteria, benefits, and implementation. States like Maharashtra, Karnataka, and Tamil Nadu have been active in implementing such schemes.
4. NGO and Private Initiatives: Various non-governmental organizations (NGOs) and private healthcare institutions have taken initiatives to provide cochlear implants to children from economically disadvantaged backgrounds. These initiatives often involve partnerships with healthcare providers, manufacturers, and funding agencies.
5. Partnerships with International Organizations: Some initiatives have been launched in collaboration with international organizations and foundations that focus on hearing health and accessibility.
6. Corporate Social Responsibility (CSR) Initiatives: Some corporate entities have contributed to funding cochlear implants for individuals in need as part of their CSR activities.
7. Research and Academic Institutions: Certain research institutions and academic organizations have undertaken projects to develop affordable cochlear implant solutions tailored to the Indian context.

Opening up satellite centers for rehabilitation across the country has greatly helped to improve the attendance and outcomes. The Indian model has been hugely successful and has helped start similar cochlear implantation programs in neighboring countries such as Nepal, Sri Lanka and Bangladesh.

It's important to note that the availability and terms of these schemes can vary widely based on factors such as location, income level, age, and severity of hearing impairment.

Oral Presentation 04

OP 04-1

Efficient bone conduction pathway for unilateral deafness in fresh frozen cadaver

Young Joon SEO[1], Jihyeon LEE[1], Wan Ho CHO[2]

[1]*Otorhinolaryngology, Yonsei University Wonju College of Medicine, Korea*
[2]*Division of Physical Metrology, Korea Research Institute of Standard and Science, Korea*

The aim of this study was to determine the most effective pathway for bone-conducted sound to travel across the skull bone to reach the contralateral ear of patients with unilateral deafness who use bone-anchored hearing aids (BAHA). The realistic contralateral transmission pathway of bone conduction (BC) vibrations is investigated through each osseous structure in the midlines of the fresh-frozen whole head. BC stimulation is applied to the mastoid using a bone vibrator, and acceleration responses are observed on the contralateral mastoid bone and seven midline points of skull bones using triaxial accelerometers. The range showing the highest contralateral transmission efficiency of bone vibration is the intermediate frequency range with contralateral direction. Within this range, a significant amplitude of acceleration response is measured at the face-side points and the back and upper parts of the head. A frontal side of the face had a high contralateral BC efficiency. Signal transmission from the specific midline to the mastoid can be more efficient than the conventional configuration of BC from the mastoid to the mastoid.

Keywords : Bone conduction hearing, Unilateral deafness, Triaxial accelerometer

Oral Presentation 04

OP 04-2

Electrophysiological and Behavioral Programming Parameters in Patients with Facial Nerve Stimulation Post-Cochlear Implantation

Isra ALJAZEERI[1], Farid ALZAHRANI[2], Abdulrahman HAGR[2]

[1]*Otology, Ministry of Health, Saudi Arabia*
[2]*Otology, King Saud University, Saudi Arabia*

Abstract
Objective:
The aim of this study is to compare patients who develop facial nerve stimulation (FNS) after cochlear implantation (CI) and are managed with triphasic stimulation pulse pattern (TPP) to those who do not develop FNS regarding the behavioral mapping parameters including the most comfortable loudness level (MCL) charge and amplitude, and the threshold level (THR) as well as the electrophysiological mapping parameters including phase duration and impedance level.
Methodology: A retrospective chart review of the patients who developed FNS at any point after device activation and managed with TPP, was carried out. Electrophysiological and behavioral mapping parameters were retrieved from the programming software database in three time-points: the time of implantation, the time of shift to TPP and the last programming session. A control group with no FNS was matched randomly to evaluate any difference in the mapping parameters that could be attributed to FNS.
Results: Sixteen ears with FNS were found to be eligible for inclusion in this study. These cases were matched to 16 ears in the control group. The programming was changed from BPP to TPP (timepoint -1) after a period of 22.37+/- 14.62. Resolution of FNS was achieved in 14 ears (87.5%) by using TPP alone.
Conclusion:TPP mapping strategy in addition to decreased PD showed successful results in managing facial nerve stimulation while allowing an increase in the hearing strength in the form of MCL amplitude.

Keywords : Facial nerve stimulation, Programming, Electrophysiology

Oral Presentation 04

OP 04-3

Effects of extended frame shift on speech perception with cochlear implants

Jiawen LI[1], Huali ZHOU[1], Nengheng ZHENG[1], **Qinglin MENG[2]**

[1]Guangdong Key Laboratory of Intelligent Information Processing, College of Electronics and Information Engineering, Shenzhen University, China
[2]Acoustics Laboratory, School of Physics and Optoelectronics, South China University of Technology, China

The advanced combination encoder (ACE) coding strategy is one typical n-of-m cochlear implant (CI) strategies. It uses a fast Fourier transform (FFT) based filter-bank to convert a one-channel input signal into multiple-channel temporal envelopes. Before FFT, the signal is buffered into several frames. Our study is to investigate the impact of extended frameshift on CI speech perception, while maintaining the original stimulation rate in ACE. Three frame-shift conditions (i.e., ACE1, ACE4 and ACE8) were compared using a recently developed CI simulation model, the Gaussian-enveloped Noise (GEN) vocoder, in 17 normal hearing (NH) listeners. They were 18, 72 (= 18 × 4), and 144 (= 18 × 8) sampling points with a sampling rate of 16 kHz in an ACE strategy with a frame length of 128 points. Simulation rate was fixed at 889 pulse-per-second (corresponding to the 18-point shift). The envelope data were replicated in successive 1, 4, or 8 frames, respectively, for electric stimuli generation under the three conditions. Speech-reception-thresholds (SRTs) in babble noise were measured using the Mandarin Hearing In Noise Test (MHINT) materials. Results show the worst performance was in ACE8. There was a significant difference between the mean SRTs obtained in ACE1 and ACE8 (2.4 dB; $p < 0.001$) and ACE4 and ACE8 (2.1 dB; $p = 0.008$). No significant difference was found between the mean SRTs with ACE1 and ACE4. It suggests that extending the frameshift from 18 to 72 points may not affect the intelligibility of speech-in-noise but further extending it to 144 points will negatively influence it. The negative influence may be due to the envelope smoothing or loss of data (144 – 128 = 16 points). The simulation experiment parameters and data are warranted be extended in actual CI users to extensively examine the effects of frameshift on speech perception with CIs.

Keywords : Frame shift, Speech perception, Advanced combination encoder

Oral Presentation 04

OP 04-4

The effect of place-frequency mismatch on performance with CIs

Luis LASSALETTA[1], Miryam CALVINO[1], Isabel SANCHEZ-CUADRADO[1], Javier GAVILAN[1]

[1]Otolaryngology, La Paz University Hospital, Spain

Objectives
(1) to determine the frequency-to-place mismatch in cochlear implant users implanted with equal electrode array length and (2) to compare anatomy based fitting (ABF) vs standard fitting in terms of speech and subjective outcomes.
Material and Methods
Prospective study. The Synchrony ST Flex28 was used in the eight adults. The length of the cochlear duct and the insertion depth was measured, taking the first most apical active electrode as reference. The tonotopic distribution of each electrode was calculated using the specific Otoplan software. The frequency-to-place mismatch was calculated through the difference between the ABF distribution and that performed by the standard fitting software. Speech tests (disyllables in silence, and MATRIX test with fixed noise at 55dB), as well as the patient preference were evaluated after nine months with ABF and one month later of the standard fitting.
Results
ABF showed lower mismatches for each individual electrode than standard fitting. The data for ABF showed a lower mismatch by 0.207 than for standard fitting ($p<0.001$, T-test). The deeper the insertion angles are, the smaller difference between Standard fitting and ABF was. The mean score of disyllables in silence was 73%±11 vs 72%±16 with ABF and standard fitting, respectively. The Signal to Noise Ratio to achieve the SRT was 4±3 vs 4±5 dB with ABF and standard fitting, respectively. All patients except one preferred ABF when they were asked about their preference.
Conclusions
Insertion depth is critical in finding the best tonotopic match. ABF showed lower mismatch than standard fitting In spite of similar hearing outcomes most patients prefer ABF vs standard fitting. More data are necessary to corroborate the benefit of the ABF over standard fitting in speech and subjective tests.

Keywords : Cochlear Implants, Fitting, Anatomy based fitting

Oral Presentation 04

OP 04-5

Optimising Sound Perception of CI Users by Low-frequency Stimulation

Martina BRENDEL[1], Sven KLIESCH[2], Raphael KONING[1], Andreas BUECHNER[2]

[1]*European Research Center, Advanced Bionics Gmbh, Germany*
[2]*Ent Department, Medical University of Hannover, Germany*

Background
In order to improve sound perception for cochlear implant (CI) users in the low-frequency range, a so-called "Phantom" channel was developed. By stimulating the two most apical electrodes in opposite phase and with different amplitudes, the electric field is shifted further into the cochlea to achieve a local pitch shift. In this study, different settings for optimising this virtual channel are compared.
Material and Methods
A total of 15 CI users (unilateral and bilateral) participated in the study with a mean age of 60.0 years and a mean duration of CI use of 8.1 years. The adaptation of the study programmes was done by an electrical adaptation of the low-frequency channel comparable to the clinical adaptation as well as by a self-adjustment of the channel by the subjects for speech understanding as well as music listening. Speech intelligibility threshold (SRT) was determined in the Oldenburg sentence test in stationary noise and word comprehension in the HSM sentence test with an individually set signal-to-noise ratio to an interfering speaker. In addition, hearing thresholds were determined and the setting was characterised by means of sound evaluation. The different study programmes are compared with the clinical fitting after long-term adaptation phases of several weeks.
Results
The hearing thresholds show a transmission of frequencies in the range of 125Hz through the study programmes. In subjective evaluations, 80% of the participants clearly favoured the programme with the self-adjusted low-frequency channel. Situation-dependent preferences for the speech or music-optimised programme emerged. There were no significant differences in speech understanding between the individual study programmes and the clinical programme.
Summary
The so-called "Phantom channel" improves sound perception in the low-frequency range and thus achieves greater satisfaction. Speech comprehension is not affected by this.

Keywords : Low-frequency, Cochlear Implant, Sound Coding Strategy

Oral Presentation 04

OP 04-6

Novel speech coding strategy for better understanding of Indian languages and music perception: A preliminary report.

Prahlada NAYAKA BASAVANTHAPPA[1], Gopika RAJ[1], Shailashri NAYAKA PRAHLADA[1]

[1]*Department of Ent - Head and Neck Surgery, Basaveshwara Medical College and Hosptial, India*

Introduction: Most Indians speak multiple languages, and there are 22 scheduled languages with few languages being in the world's top 20 languages. Besides, Indian languages are onomatopoeic, expressive, echoing, and frequently use paired words and many alien words. Such diverse nature of languages and limited resources for speech rehabilitation makes cochlear implantation challenging in the Indian subcontinent. The ability of speech coding strategies to effectively decompose speech signals into multiple channels of narrow-band electrical pulses for stimulation of the auditory nerve forms the basis of performance of a cochlear implant. Currently available speech coding strategies have certain limitations and may not provide sufficient information to encode regional languages. To improve the performance of cochlear implants in Indian users, we developed a novel speech-processing strategy. Hereby we present the hearing and music perception with this novel speech coding strategy.
Methods: We built an algorithm to extract the narrow band signals and fundamental frequency and identified the general patterns of pitch variations in different characteristic attributes of the Indian languages. The effectiveness of the extraction algorithm was verified first with electrodogram, second, with an artificial Intelligence (AI) and machine learning (ML) platform (artificial neural network) that recognized Indian language patterns from the extracted fundamental frequency and F0 information, and finally with human subjects. Next, we compared the novel strategy with the envelope-extraction CIS strategy on all three platforms.
Results: This novel strategy provided statistically significant improvement with Pearson's $\chi 2$ test in perception of multiple Indian languages, tones, phrases, and sentences. One of the surprising by-product was better appreciation of music.
Conclusion: This novel coding strategy with dynamic modulation of both frequency and amplitude is promising for the design of regional language specific or multi-lingual cochlear implant devices for patients with sensorineural deafness in the Indian subcontinent.

Keywords : Speech coding strategy, Cochlear Implant, Sensorineural deafness

Oral Presentation 04

OP 04-7

Effect of deep neural network based singlechannel noise reduction on sound perception in cochlear implant users

Lenneke KIEFER[1], Dietmar BASTA[1], Raphael KONING[2], Nicolas FURNON[2], Arneborg ERNST[1]

[1]*Clinic For Ears, Nose, and Throat, Unfallkrankenhaus Berlin, Germany*
[2]*European Research Center, Advanced Bionics, Germany*

Speech intelligibility (SI) in cochlear implant (CI) users can be very good in quiet, however, they still suffer from a decrease in SI in noisy listening conditions. Noise reduction (NR) algorithms based on deep neural networks (DNNs) try to overcome that deficit by removing as much noise as possible from the noisy microphone signal.
In this study, the effect of changes in spectral resolution of the DNN based NR on sound reception was studied in 16 unilateral CI users. The processing was performed on a spectral resolution of 128 and 512 points at a sampling frequency of 22050 Hz. The evaluation was done with the German OlSa matrix sentence test in terms of speech intelligibility and a MUSHRA sound quality rating. Sound samples were preprocessed and streamed directly via Bluetooth to the Advanced Bionics' speech processor Marvel CI.Results showed a significant SI improvement of around 2.5 and 4 dB in speech reception threshold for the low and high frequency resolution version of the DNN speech enhancement scheme compared to the clinical baseline. The high frequency version outperformed significantly the low frequency version in terms of SI. In the MUSHRA sound quality rating, an average significant improvement of around 20 points was obtained for both DNN based NR algorithms compared to the baseline condition. There was no significant difference between both DNN versions in the sound quality rating obtained.
The results of this study underline the potential for sound perception improvement in CI users when DNN based NR algorithms are used as speech enhancement features in adverse listening conditions

Keywords : Artificial intelligence, Noise reduction, Deep Neural Networks

Oral Presentation 05

OP 05-1

Determining optimal cochlear implant electrode array with OTOPLAN software

Hidekane YOSHIMURA[1], Yutaka TAKUMI[1], **Shin-Ichi USAMI**[2]

[1]*Department of Otorhinolaryngology - Head and Neck Surgery, Shinshu University School of Medicine, Japan*
[2]*Department of Hearing Implant Sciences, Shinshu University School of Medicine, Japan*

Objective: To investigate the cochlear duct length (CDL) in patients who underwent cochlear implantation (CI) using OTOPLAN, and compare the results of angular insertion depth (AID) between estimation by OTOPLAN and postoperative X-ray.
Methods: The study included 105 Japanese patients who underwent CI with normal cochlea and were implanted with either a FLEX SOFT, FLEX 28, FLEX 26 or FLEX 24 electrode produced by MED-EL. The mean age at implantation was 42.3 years (range 0-90 years). CDL was investigated using the OTOPLAN version 3.0 and results were evaluated for sex, laterality and implanted age. We measured the position of the tip channel of the electrode according to each selected electrode array, and estimated the AID by the software. Subsequently, the AID measured preoperatively using OTOPLAN was compared with that using postoperative X-ray.
Results: The mean CDL was 35.1 ± 1.6 mm (range: 31.7-39.1 mm). Males had longer CDL compared to females (35.5 mm vs. 34.8 mm, $p = 0.023$), while other variables demonstrated negative correlations with CDL. Preoperatively, the mean AID estimated was 580.3 ± 57.8° (range: 380.4-695.7°). Postoperative X-ray revealed a mean AID of 583.0 ± 56.7°, demonstrating a strong correlation between both measurements ($R2 = 0.635$).
Conclusion: Our findings revealed that CDL had a wide range of variation consistent with previous studies. To achieve better speech perception performance, surgeons should select proper length of CI electrode array based on the individual's CDL. The preoperative measurement of each CDL by OTOPLAN prior to surgery, which is clinically feasible and comparable to postoperative evaluation, can be used to ensure proper selection of electrode array length.

Keywords : Cochlear implantation, Cochlear duct length, Angular insertion depth

Oral Presentation 05

OP 05-2

Brain MRI findings of prelingually deaf children and cochlear implant outcome

Majed ASSIRI[1], Afrah ALSHALAN[1], Rawan ALQAHTANI[2], Yassin ABDELSAMAD[3], Abdulrahman ALSANOSI[1]

[1]Otolaryngology, King Abdullah Ear Specialist Center, Saudi Arabia
[2]King Saud University Medical City, King Saud University, Saudi Arabia
[3]Research Department, Med-el Gmbh, Saudi Arabia

Objective: To estimate the incidence of brain abnormalities in a cohort of prelingually deaf children and whether these abnormalities can impact the hearing outcomes of patients eligible for cochlear implantation (CI). Methods: We performed a retrospective review of consecutive medical charts of prelingually deaf children under 12 years of age who underwent brain magnetic resonance imaging (MRI) during their preoperative workup for CI surgery. We used the category of auditory performance (CAP) test and the speech intelligibility rating (SIR) test to assess the hearing and speech performance of the children, respectively.
Results: The MRIs of 285 patients, 174 boys and 111 girls with a mean age of 36.4 (±16) months, were evaluated for this study. We identified 31 patients with abnormal findings (10.88%): (17/31) (54.8%) had MRI brain abnormalities, (9/31) (29%) had inner ear anomalies, and (5/31) (16.1%) had both inner ear and brain abnormalities. The most frequent inner ear anomaly was an enlarged vestibular aqueduct, while white matter lesions were the most common brain abnormality. The CAP and SIR mean score of patients with inner ear anomalies was slightly, but not significantly, higher than those of patients with brain abnormalities. Conclusion: CAP and SIR scores were not significantly different in children with brain abnormalities than inner ear anomalies. These patients can still benefit from CI to improve their overall hearing and speech performance.

Keywords : Cochlear implantation, White matter lesion, Inner ear anomalies

Oral Presentation 05

OP 05-3

Cochlear Duct Length Estimation

Tawfiq KHURAYZI

Cochlear Implant Center, King Fahad Central Hospital, Saudi Arabia

Objectives:
To compare different cochlear parameters in cochlear duct length CDL estimation and investigate the correlation between these measurements.
Methods:
Retrospective descriptive study, a total of 127 human ears were investigated of which 88 ears met the inclusion criteria with normal cochlear morphology.In the first step, the 3D segmentation was used to confirm the normality of the cochlea. In the second step high resolution thin cut CT was preformed. Then, the diameters of the cochlea A-value for length, B-value for width, and H -value for height of the cochlea measured.
Results:
Both A-value and B-value showed a high positive correlation to CDL. However, the B-value showed a stronger correlation to CDL than A-value (r=0.63 for A and r=0.96 for B)Conclusion:Cochlear width B-value has a strong correlation to CDL. Thus, we suggest thee combination of A AND B to accurately estimate the CDL rather than using one of them

Keywords : B-value, A-value, COCHLEAR DUCT LENGTH

Oral Presentation 05

OP 05-4

Anatomy-Based Frequency Allocation in Cochlear Implantation: The Importance of Cochlear Coverage

Isra ALJAZEERI

Otology, King Abdullah Ear Specialist Center, Saudi Arabia

Objectives/hypothesis: This study aimed to compare the predicted anatomy-based frequency allocation of cochlear implant electrodes with the default standard frequencies.
Study Design: Retrospective study.
Methods: A retrospective analysis was performed using computed tomography (CT) images of patients who received cochlear implants at a tertiary referral center. Patients were excluded if they had any congenital or acquired cochlear anatomi- cal anomalies. The CT images of the patients were uploaded to the surgical planning software. Two independent reviewers allo- cated the anatomical parameters of the cochlea. The software then used these parameters to calculate the frequency allocation for each electrode according to the type of electrode and the length of the organ of Corti (OC) in each patient. These anatomy- based frequency allocations were compared with the default frequency settings.
Main Outcome Measure: Frequency-to-place mismatch in semitones.
Results: A total of 169 implanted ears in 102 patients were included in this study. The readings of the two reviewers were homogenous, with a Cronbach's alpha of 0.98. The mean anatomy-based frequency allocation was 487.3 202.9 Hz in electrode 1; 9,298.6 490.6 Hz in electrode 12. The anatomy-based frequency allocations were found to be significantly higher than the frequencies of the default frequencies for each corresponding electrode (one-sample t-test, $P < .001$). The frequency- to-place mismatch was negatively correlated with cochlear coverage and positively correlated with the cochlear duct length (Pearson correlation > 0.65, $P < .003$).
Conclusions: The anatomy-based frequency allocation of each electrode is significantly different from the default fre- quency setting. This frequency-to-place mismatch was affected mainly by the cochlear coverage.

Keywords : Mapping, Fitting, ABF

Oral Presentation 05

OP 05-5

Outcome variability of language development following cochlear implantation within the early critical period of 2 years

Angelika ILLG[1], Doris ADAMS[1], Anke LESINSKI-SCHIEDAT[1], Thomas LENARZ[1], Andrej KRAL[1]

[1]Ent-department, Medical School Hannover, Germany

Outcome variability is an ongoing unresolved issue of cochlear implantation. Also in pediatric cochlear implantation, further shift in the implantation age below two years improved performance, but did not eliminate the variability. Children's language acquisition is subject to high variability even if the temporal order of psycholinguistic features is known.
Standardized, age-appropriate language acquisition tests have been performed for children with cochlear implants (CI) in our clinic. These are the "Marburg Speech Comprehension Test for Children" (MSVK) (N=84). In addition, there are data on speech comprehension in quiet and in noise like monosyllables (MST) and sentences. The data have been statistically evaluated and analyzed.
In monosyllabic test, the children achieved a median performance of 75.0±12.88%. In the sentence test in quiet, the median performance was 89±12.69%, but dropped to 54±18.92% in noise. A simple main effects analysis showed a significant main effect of age on monosyllabic words comprehension ($p=9.9*10-4$) but no significant effect of comorbidities without cognitive effects ($p=0.24$). Language acquisition values corresponds to the normal range of children with normal hearing. Approximately 25% of the variability in the language acquisition tests is due to the outcome of the monosyllabic speech perception.
Congenitally deafened children who are fitted bilaterally in the first year of life can develop age-appropriate language skills by the time they start school. The high variability of the data is partly due to implantation age, but additional factors influence the variability. Special etiology and additional comorbidities without cognitive effects do not have a significant impact on this high variability.

Keywords : Outcome variability, Children, Language development

Oral Presentation 05

OP 05-6

Analysis of Mapping Characteristics of Patients with Autism Spectrum Disorder with Cochlear Implant

Euyhyun PARK[1], Pyung Gon THAK[1], Bongil PARK[1], Soo Jeong CHOI[1], Yoon Chan RAH[1], June CHOI[1], Jae-Jun SONG[1], Sung Won CHAE[1], Hak Hyun JUNG[1], **Gi Jung IM[1]**

[1]Department of Otorhinolaryngology-head and Neck Surgery, Korea University College of Medicine, Korea

Objectives: The aims of this study were to analyze the CI post-operative performance and mapping characteristics by comparing normal cochlear implant (CI) patients and patients with autism spectrum disorder (ASD), and suggest CI mapping solutions in patients with ASD.
Methods: This study was a prospectively enrolled the 10 patients with ASD who received a CI (ASD group), and 20 normal patients who received a CI during the same period were compared and analyzed (normal group). The CI performance was analyzed by speech perception tests and sound field test. The mapping characteristics focused on variables related to the stimulus intensity and the fine-tuning.
Results: Despite an average of more than 10 years of mapping, in all speech perception tests and sound field test, the performance of the ASD group was significantly lower than that of the normal group. At the C (comfortable) and T (threshold) level, the ASD group was significantly lower than the normal group. Therefore, the dynamic range of the ASD group was significantly narrower than the normal group. The ASD group had a significantly lower pulse width, sensitivity, and volume than the normal group.
Conclusions: Despite best efforts, there are practical limitations to mapping in cochlear implant patients with ASD. To avoid overstimulation in cochlear implant patients with ASD, the dynamic range is set narrow or the C/T level is set lower than normal. Key control factors, such as pulse width, sensitivity, and volume, should also be set lower than those for normal patients. As a result of this, a relatively low performance is generally expected from patients with ASD using CI. Therefore, a long-term mapping of dedicated effort and patience is required for successful mapping in CI patients with ASD.

Keywords : Autism spectrum disorder, Cochlear implant, Mapping

Oral Presentation 05

OP 05-7

Dynamic Range and Neural response threshold in cochlear implant mapping, can be useful in predicting prognosis related to post-operative speech perception

Gi Jung IM[1], Pyung Gon THAK[1], Bongil PARK[1], Euyhyun PARK[1], Soo Jeong CHOI[1], Hak Hyun JUNG[1]

[1]Department of Otolaryngology-head and Neck Surgery, Korea University College of Medicine, Korea

Aim: To analyze mapping changes in Dynamic Range (DR) and neural response threshold (NRT) as prognostic factors for cochlear implant (CI), and the results of speech perception performance were evaluated according to changes in DR and NRT.
Method: The speech comprehension data of 33 CI patients were retrospectively analyzed after 1, 3, 6, and 12 months of device use. All subjects were post-lingually hearing impaired CI users with Cochlear Nucleus device. Speech perception performance were evaluated in aided PTA, consonant, vowel, one word, two words, and sentences test.
Result: Average of Initial NRT was 197.8 ± 25.9 mA, and average of DR changes was 22.2 ± 18.4 μV. Initial DR was 40.8 ± 16.6 μV, DR at 3 months post-op was 50.3 ± 16.4 μV, DR at 6 months was 58 ± 12.3 μV, and DR at 12 months was 62.9 ± 10.4 μV. During first year of CI, gradual increase of DR was observed. Compared with initial DR value, significant increases of DR were observed at 3 months ($P<0.05$), 6 months ($P<0.001$), and 12 months ($P<0.001$). Compared with initial speech performance outcomes, significant gain of all performance outcomes was achieved at 12 mon ($P<0.001$). Patients with low NRT after CI surgery were able to initially set DR to a wider range and had better final speech perception outcomes. Conversely, patients with high NRT after CI surgery had to set up a gradual increase in DR while adjusting the T-C level, and the final speech perception outcomes were worse.
Conclusion: DR and NRT, which are the main variables of CI mapping, can be useful in predicting prognosis related to speech perception outcomes after surgery. The lower the initial NRT, the wider the final DR, and the younger the age, the better the post-CI speech perception results were.

Keywords : Cochlear Implant, Dynamic Range, Neural Response Telemetry

Oral Presentation 05

OP 05-8

Reference values for early auditory preverbal skills of children with cochlear implants

Haihong LIU[1], Yidi LIU[1], Yue LONG[1], Xinyu WANG[1], Jiaying HU[1], Jie ZHANG[1], Jun ZHEGN[2], Xin NI[1]

[1]*Department of Otorhinolaryngology, Beijing Chidlren's Hospital, China*
[2]*Department of Otorhinolaryngology, Beijing Tongren Hospital, China*

Objective: Auditory and verbal abilities of children with early cochlear implant (CI) surgery usually take some time to develop, and a reference index of early development for horizontal comparisons is urgently needed to guide the mapping process and adjust rehabilitation programs. Therefore, the aim of this study was to establish a reference value for early auditory preverbal skills development in children with CI and investigate the developmental curve and influencing factors for these children. Method: The LittlEARS® Auditory Questionnaire (LEAQ) scores of 287 eligible Chinese participants were obtained at 1, 2, 3, 6, 9, 12, 18, 24, 28, and 36 months interval after CI activation. The median and standard deviation of the LEAQ score of each hearing stage for these children with different activation ages were calculated to establish the reference values. Result: Quadratic regression was conducted to fit the expected developmental curve of the LEAQ score ([0 to 20 months]). With a linear mixed-effects model, we found that the receptive auditory behavior increased rapidly after CI activation, while expressive language skills developed at a steady rate. We also found that the following factors all significantly influenced the LEAQ: the duration of CI use, the development quotient, age of implantation and activation, and the presence of large vestibular aqueduct syndrome or auditory neuropathy spectrum disorder. Conclusion: The reference values and the expected developmental curve for the LEAQ in children with CI established by the present study provides guidance to clinicians and parents as well as realistic expectations regarding language and speech outcomes.

Keywords : Children, Auditory development, Mandarin

Oral Presentation 05

OP 05-9

Comparing Beliefs and Self-Efficacy in Korean and American Parents of Young Children with Hearing Loss

Eun Kyung JEON[1], **Jongmin JUNG**[2], Yukyoung KIM-LEE[3], Soyeong PAE[4]

[1]*Communication Sciences and Disorders, University of Iowa, USA*
[2]*Institute of Humanities, Chosun University, Korea*
[3]*Research Lab, Oh Hearing Center & Lab, Korea4Division of Speech Pathology & Audiology, Hallym University, Korea*

Previous research highlights the importance of parental beliefs and self-efficacy in fostering a supportive environment for children's development, particularly in the case of children with hearing loss (CHL). This study aimed to explore the beliefs and self-efficacy of Korean parents with young CHL and to compare their beliefs with those of American parents of CHL. A total of 61 Korean parents participated, with their children averaging 20 months of age, using hearing aids (n = 36) or cochlear implants (n =25). The Scale of Parental Involvement and Self-Efficacy-Revised in Korean (SPISE-R-K) measures belief, self-efficacy, and involvement in children's auditory access and spoken language development. American parents' belief scores were obtained from Ambrose et al. (2020) using the SPISE-R.

We found significant correlations between one belief statement and Korean parents' self-efficacy (rho ≥ 0.35, ps ≤ 0.01) and involvement (rho = 0.4, $p < 0.001$); that is, parents agreeing more strongly that children can overcome hearing loss effects with the right support were likely to have higher knowledge, confidence, and action in their children's hearing device use and language development. In addition, there were significant group differences between Korean and American parents in three belief statements (ps < 0.002). Korean parents agreed more in one statement and less in two others than American parents. Differing beliefs included the effectiveness of hearing devices for communication and concerns about device dependency.

Based on the results, we recommend that hearing professionals should help Korean parents of young CHL understand the relationship between beliefs and self-efficacy, which can affect the outcomes. They should also support parents in improving their self-efficacy and becoming more actively involved in their children's early interventions.

Keywords : Cochlear implant, Early intervention, Parental self-efficacy

Oral Presentation 05

OP 05-10

A novel approach of activating cochlear implant intraoperatively – A comparative study

Koralla Raja MEGHANADH

Department of Ent, Maa Ent Hospitals, India

Introduction: The functioning of cochlear implant (CI) is affected by the growth of collagen Fibers/ connective tissues (post-operatively) around the electrode array, which in turn is likely to be affected by the timing of the Switch ON/activation of cochlear implants. Intra-Operative Switch ON (IOSO) is a novel clinical approach of activating the cochlear implant during the surgery adopted at our cochlear implantation center.

Methods: In this study, electrode impedances of 185 cochlear implantees, 93 of whom received IOSO and 92 POSO, recorded over 10 years were analyzed retrospectively. For each CI recipient, electrode impedances were measured at the time of Switch ON (during surgery for IOSO group and after 21 days for POSO group) & at the 3rd, 6 th , 9 th , and 12 th months of cochlear implantation.

Results: Electrode impedances of IOSO group were significantly lower than POSO group at witch ON and 3 rd , 6 th , 9 th, and 12 th months post cochlear implantation. In IOSO group, 3 rd month's electrode impedances were high when compared to electrode impedances at Switch ON. Beyond the 3 rd month, electrode impedance remained unchanged. In POSO group, there were no significant differences in electrode impedances between any measurement schedule.

Conclusions: To our knowledge, this is the first study to investigate in detail the electrodeimpedances of the two above-said conditions of Switch ON in the process of cochlearimplantation. This study concludes that timing of CI Switch ON has a significant effect onthe electrode impedances. These results may affect the choice of cochlear implant Switch ONtiming.

Keywords : Cochlear Implant, Electrode Impedance, IOSO (Intra-Operative Switch ON)

Oral Presentation 05

OP 05-11

Influence of Noise Reduction Algorithms and Wireless Streaming on Speech and Language Skills of Pediatric Cochlear Implantees

Aninda Duti BANIK[1], Mithila POONACHA[2], Divya M[3], Fatema JAGMAAG[4], Sasidharan P[6], Aravind NAIR[5], Smita AGRAWAL[7], Martina BRENDEL[8]

[1]Clinical & Research - Audiology, Advanced Bionics India Pvt Ltd, India
[2]Habilitation, Advanced Bionics India Pvt Ltd, India
[3]Audiology & Speech Language Pathology, Dr. Manoj's Ent Super Specialty Institute & Research Center Mesiarc, India
[4]Audiology & Speech Language Pathology, Shaba Speech & Hearing Clinic, India
[5]Clinical, Advanced Bionics India Pvt Ltd, India
[6]Audiology & Speech Language Pathology, Dr. Manoj's Ent Super Specialty Institute & Research Center Mesiarc, India
[7]Clinical Research, Advanced Bionics Gmbh, European Research Cente, Germany
[8]Clinical Research, Advanced Bionics Llc, USA

Purpose:
One of the goals that a cochlear implantee (CI) aims to achieve is acquiring age-appropriate speech and language (SLV) skills. However, there are many factors that affect these outcomes and one of them is the sound processing technology. In this study, objective and subjective measures of speech perception, speech-language development, voice, fluency, and articulation-phonological skills were obtained in CI recipients who were not enrolled in formal therapy. The objective was to assess if these skills were impacted by the introduction of new automatic noise-reduction algorithms over a period of one year.
Methods:
13 CI recipients (7 - 23years; 12 children) upgraded to the Marvel CI sound processors and were evaluated for their SLV skills compared to their previous processor. Besides audiological measures [aided audiometry, SRT , WRS in noise, SSQ-12], various measures of voice, articulation, phonology, fluency and speech intelligibility were obtained. Developmental-milestone scales for attention, cognition and a validated 30-point questionnaire on performance and benefits were also administered.
Results & Discussion:A 5-10 dB improvement was noted in CI assisted free-field audiometry, with a 26% improvement in WRS scores in noise, and a 5 dB improvement in SRT. At the end of 3months, 10/12 children had significant improvement in vocabulary, expressive skills, speech-intelligibility, articulation and reduced nasality. Subjective improvement was noted in emphasis, phrasing and rate of speech. Comprehension of non-contextual questions were observed to have greater accuracy. By the 6th month, further improvements were noted in substitution errors of stops (p-b contrast) and nasal-oral consonant contrasts. Lastly, attention was also seen to improve in the objective measure that were used.
Conclusion: Automatic front-end noise reduction systems and wireless streaming can provide measurable and clinically relevant improvements in speech-language-voice skills in the real world amongst CI users. This also improved academic, socio-emotional skills and quality of life.

Keywords : Cochlear implantee, Automatic noise-reduction algorithm, Speech and language skills

Oral Presentation 05

OP 05-12

Can narrower frequency allocation improve speech perception in Korean cochlear implant users?

Soo Jeong CHOI[1], Pyung Gon THAK[1], Bongil PARK[1], Hak Hyun JUNG[1], Gi Jung IM[1], **Euyhyun PARK[1]**

[1]Otorhinolaryngology - Head and Neck Surgery, Korea University College of Medicine, Korea

Objectives: Cochlear implant (CI) mapping is post-operative adjustment process of the CI device and it should be precisely implemented according to individual's condition and needs. Frequency allocation is the important parameters of CI mapping and is known to affects the speech perception of CI. In previous studies, restricting the upper end frequency is known to improve speech perception, but few studies have been conducted on this. Therefore, in this study, the authors conducted a study on the relationship between frequency allocation and speech perception.
Methods: We prospectively conducted a study on 10 Korean cochlear implant users. All participants were post-lingual hearing-impaired CI users who were implanted with the Cochlear Nucleus. All participants were assigned a frequency of 188 Hz to 7938 Hz, and a speech perception test was performed 2 weeks later. After that, a frequency allocation of 188 Hz to 5938 Hz was set, and a speech perception test was performed after 2 weeks, and compared with the previous results.
Results: In this study, the narrower frequency allocation of 188 Hz to 5938 Hz showed statistically significant improvement in monosyllable speech perception tests compared to the frequency allocation of 188 Hz to 7938 Hz (88.3 ± 8.7 vs 79.4 ± 8.0, P=0.03). There was no significantly difference in the CAP score, Ling 6 sound test, vower, consonant, disyllable, and sentence test.
Conclusions: This study estimated that narrower frequency allocation improve monosyllable speech perception in Korean CI users. CI mapping should be precisely implemented according to individual's condition and needs, and there are various factors and parameters that need adjustment. Among them, the authors think that when it is necessary to improve the speech perception of Korean CI users, setting a narrower frequency allocation could be considered.

Keywords : Frequency allocation, Speech perception, Korean CI users

Oral Presentation 05

OP 05-13

Localization ability in bilateral cochlear implant users and unilateral cochlear implant users for single-sided deafness and asymmetric hearing loss

Taegyeong KIM[1], Dong Kyu LEE[1], Yun Ji LEE[1], **Hong Ju PARK[1]**

[1]Otorhinolaryngology-head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea

Purpose: Normal-hearing (NH) listeners rely on two binaural cues, the interaural time (ITD) and level difference (ILD), for sound localization. However, cochlear implant (CI) listeners rely almost entirely on ILDs. We wanted to determine whether significant improvements in sound source localization are achieved in cochlear implant (CI) recipients with single-sided deafness (SSD), a hearing aid (HA) in the contralateral ear (asymmetric hearing loss, ASHL), and bilateral CI recipients.
Methods: This is a retrospective study of 10 CI recipients with NH in the contralateral ear (SSD), 12 CI recipients with a HA in the contralateral ear (ASHL), and 9 bilateral CI recipients. Sound source localization assessment was performed after at least 6 months from the date of cochlear implantation. Participants were asked to indicate the sound source presented randomly at varied frequencies (500 Hz and 4 kHz) and 65 dB HL stimulation levels from one of 7 speakers along a semi-circle. Localization performance was quantified as average error degree (AED) error and right-to-left correct discrimination ratio (RLD).
Results: Overall, the bilateral CI group showed better localization abilities in AED and RLD at 500 Hz than the other groups, and the ASHL group showed poor localization ability. Compared to unaided localization abilities in SSD and ASHL groups, superior post-CI localization performance was obtained with CI use. In both SSD and ASHL groups, a significant improvement in RLD at 4 kHz was observed in aided condition compared to the unaided condition. A significant improvement in AED at 500 Hz and 4 kHz was observed in only SSD.
Conclusion: CI recipients experience significant improvements in sound source localization, as demonstrated in the sound localization test. Our findings suggest that the bilateral CI group uses ITD cues for sound source localization better than the ASHL group, though some SSD groups may also use ILD cues.

Keywords : Sound source localization, CI, Single-sided deafness

Oral Presentation 05

OP 05-14

Effect of an ambient noise reduction algorithm on cochlear implant users' speech perception and listening effort as a function of noise type

Verena MÜLLER[1], Amanuel UKUWAIT[1], Katrin FRÖSSLER[1], Ruth LANG-ROTH[1]

[1]*Otorhinolaryngology, Head and Neck Surgery, University Clinic of Cologne, Germany*

Objective:
In order to improve speech perception of cochlear implant (CI) users in noisy situations, pre-processing mechanisms such as different microphone modes or noise reduction algorithms can be used. The SONNET 2 audio processor from the manufacturer MED-EL has a transient and an ambient noise reduction algorithm. This study investigated if the noise reduction algorithm embedded in the SONNET 2 audio processor improves speech perception in CI users as a function of different noise signals. Further, the effect on the subjective listening effort was evaluated.
Methods:
20 adult CI users fitted with a MED-EL SONNET 2 audio processor were included in the study. Speech perception and listening effort in the presence of four different noise signals, ranging from stationary noise to fluctuating noise and speech maskers, were measured. Patients were tested once with the noise reduction algorithms activated and once when it was deactivated. Speech was presented from the front (S0) and noise from the back (S±135). Patients were binaurally hearing impaired and fitted unilaterally, bimodally or bilaterally with CIs. Regardless of the mode of fitting, only one CI side was tested.
Results:
Speech perception altered in the four noise conditions. Speech perception improved in presence of one stationary and one fluctuating noise when the noise reduction algorithm was activated. Listening effort was reduced only with one stationary noise signal. In presence of the remaining signals, the activated noise reduction showed no benefit.
Conclusion: When activating the noise reduction algorithm of the SONNET 2 audio processor, speech perception improved in parts. Listening effort was either better or equal. It can be recommended to use the noise reduction algorithm in corresponding everyday situations.

Keywords : Noise reduction, Listening effort, Speech perception in noise

Oral Presentation 06

OP 06-1

The interphase gap (IPG) effect on electrically evoked compound action potential recorded from cochlear implant users with varied deaf duration

Jeong-Seo KIM[1], Sung Hwa HONG[2], Il Joon MOON[1,3]

[1]*Hearing Research Laboratory, Samsung Medical Center, Korea*
[2]*Department of Otolaryngology, Myongji Hospital, Hanyang University Medical Center, Korea*
[3]*Department of Otolaryngology - Head and Neck Surgery, Sungkyunkwan University School of Medicine, Korea*

Introduction: The sensitivity of electrically evoked compound action potential (ECAP) to changes in the interphase gap (the IPG effect) is associated with the survival of spiral ganglion neurons and presumed functional status of the auditory nerve in CI users that could be important for outcomes. This study aimed to investigate the feasibility of the IPG effect on ECAP responses to characterize the functional status of the auditory nerve across CI users. Methods: Twenty-nine adults who were implanted with Nucleus CI participated in this study. They were divided into two groups per the deaf duration on the implanted ear; thirteen had relatively shorter deaf duration (mean = 60.6 months) while nineteen had longer deaf duration (mean = 295.5 months). ECAP responses were recorded via neural response telemetry by changing the interphase gap of the electrical pulse (IPG 7, 28, 56) across various levels. The IPG effect on ECAP threshold, maximum ECAP amplitude, and the slope of the growth function were calculated and compared between groups.
Results: When the IPG was increased from the default (7) to 28, the IPG effect on maximum ECAP amplitude and the slope of the growth function were significantly larger in subjects with shorter deaf duration than those with longer deaf duration. The IPG effect on ECAP threshold was not significantly different between groups. When the IPG was further extended from default (7) to 56, the IPG effect on maximum ECAP amplitude and the slope were significantly larger in the shorter duration group, while the ECAP threshold showed a marginal IPG effect between groups. Conclusion: Results indicate the IPG effect of ECAP amplitude and the slope of the growth function may have the potential as sensitive metrics to characterize the functional status of the cochlear nerve that could help better understand large individual variabilities in CI outcomes.

Keywords : ECAP, Interphase gap effect, Deaf duration

Oral Presentation 06

OP 06-2

Real-time monitoring of electrocochleography during cochlear implantation via Advanced Bionic's AIM system

Jianan LI[1], Shuwei WANG[1], Qian WANG[1], Shuoshuo KANG1, **Shiming YANG[1]**

[1]Senior Department of Otolaryngology-head & Neck Surgery,, Chinese Pla General Hospital,, China

Background and purpose
Intracochlear electrodes can be utilized to record electrocochleography (ECochG) responses and therefore provide real-time feedback about the health of the cochlea during electrode insertion. The AIM system is an integrated device developed by Advanced Bionics, which measures ECochG responses in real-time during insertion of the electrode array. Clinical experience with AIM and the relationship between ECochG and hearing preservation were evaluated in the current study.
Methods
EcochG was recorded using multiple stimulation frequencies across 250Hz to 2000Hz during the electrode array insertion. The trace of the ECochG response was analyzed for amplitude changes, as well as the overall insertion duration (indicating speed of insertion). Changes of hearing thresholds pre- to post-surgery were compared with the intraoperative ECochG patterns. All implantees' electrode arrays were fully inserted into the cochlea till the blue marker.
Results
Recording was performed for four surgeries so far and three of them showed reliable responses above noise floor. The duration of insertion varied from 99 seconds to 435 seconds, while the maximum response amplitude varied from 14.4μV to 136.8μV. Participants with better hearing thresholds at low frequencies generally showed higher response amplitudes during electrode insertion. The pattern of a continuous growth of ECochG amplitude from the beginning of insertion until completion showed remarkable hearing preservation.
Conclusion
Intraoperative ECochG potentials measured through the implant via the AIM system provide valuable feedback during the surgery. Preliminary results are encouraging and more data are needed to better understand the underlying relationship between ECochG patterns and postoperative hearing outcomes.

Keywords : Cochlear implant, Electrocochleography, hearing preservation

Oral Presentation 06

OP 06-3

Intraoperative Estimation of the Coupling Efficiency in Active Middle Ear Implants

Mario CEBULLA[1], Carolina KÖSTLER[1], David HERRMANN[1], Rudolf HAGEN[1], Kristen RAK[1]

[1]Department of Otorhinolaryngology, University Hospital Würzburg, Germany

Introduction
Active middle ear implants can be used to treat adults and children with sensorineural, conductive, and mixed hearing loss. For the stimulation, the actuator of the implant can be coupled to different structures of the middle ear depending on the hearing loss and pathology. Thereby, hearing improvement is highly dependent on the coupling efficiency. An auditory brainstem response (ABR) based method has now been successfully used to intraoperatively measure aided thresholds for verifying the coupling efficiency.
Methods
ABRs were measured intraoperatively via the active middle ear implant Vibrant Soundbridge (VSB; MED-EL, Austria). For this purpose, a standard ABR system was used to stimulate the actuator of the implant and record ABRs. The ABRs were evoked by chirp-sounds presented at different stimulation levels. ABR thresholds were estimated by identifying wave V of the recorded ABRs.
Results
Intraoperative ABR thresholds were determined in 75 patients. ABRs could be identified in all patients and allowed the determination of aided hearing threshold. The analysis revealed a good correlation between preoperative bone conduction and intraoperative ABR thresholds (r = .72). Also, the correlation between bone conduction and postoperative vibrogram thresholds was good (r = .61).ConclusionThe presented method for performing ABR measurements in patients with an active middle ear implant can be easily used for intraoperative monitoring of the implantation process. This allows reliable estimation of the coupling efficiency between the actuator of the implant and the middle ear structure to ensure successful hearing improvement.

Keywords : Active Middle Ear Implant, Intraoperative Monitoring, Auditory Brainstem Response

Oral Presentation 06

OP 06-4

Use of the AIM tablet for intra-operative monitoring: interpreting the data

Shaza SALEH[2], Farid ALZHRANI[2], Rana ALSHIHRI[1], **Patrick BOYLE**[1]

[1]*European Research Center, Advanced Bionics Gmbh, Germany*
[2]*Ent Department, King Saud University, Saudi Arabia*

Background
In recent years, it has become possible to record electrocochleography (ECochG) via a cochlear implant . The majority of attention has focused on minimizing trauma during electrode insertion. However, to make sense of the intra-operative recordings it is wise to also make more extensive recordings post-operatively.
Method
The cochlear microphonic (CM) component of the ECochG signal was recorded both intra- and post-operatively. Intra-operative recordings were made from contact 1 (apical), while post-operatively recordings were made from each electrode contact, producing an electrode scan (ES). ESs were made using acoustic stimulation levels that dropped in 10 dB steps until responses reached noise floor. Recordings were made for 250, 500, 1,000 and 2,000 Hz stimulation frequencies. A comparison was made between ESs and intra-operative recordings. An audiogram predicted from the CM was compared to an audiogram measured on the same day as the ES recording.
Results
CM was recorded for 13 ears where residual hearing was preserved following surgery. Responses above noise floor were present from 12 ears (93%). The CM amplitude varied between 2 uV and 350 uV both between participants and within an ES.. The CM amplitude was 6 dB or more higher on contacts other than contact 1, the intra-operative recording contact, in 10 (83%) cases. For 9 (75%) cases the amplitude responses were well ordered, respecting the stimulation level used to record them. In a minority of cases the CM amplitudes were more difficult to associate with the stimulation used to elicit them.
Conclusion
Recording an ES, from each of the intra-cochlear electrode contacts, can give insights into the cochlea that are not available from intra-operative monitoring. The interpretation of intra-cochlear monitoring should also consider the ES. Multiple stimulation levels can allow individual predictions of hearing levels. These measures may inform programming for individual cochlear implant recipients.

Keywords : Electrocochleography, Intra-operative monitoring, Cochlear trauma

Oral Presentation 06

OP 06-5

First experience in ECAP measurements with SmartNav System

Vigen BAKHSHINYAN[1,2], Gayane SARGSYAN[1,3], Gegham KHANDANYAN[1,3], George TAVARTKILADZE[2], Akira ISHIYAMA[4]

[1]*Ent Department, Erebouni Medical Center, Armenia*
[2]*Department of Audiology, Russian Medical Academy of Continuing Professional Education, Russia*
[3]*Ent Department, Yerevan State Medical University, Armenia*
[4]*Otolaryngology, Otology-neurotology, Ucla School of Medicine, USA*

Aim: The new Nucleus SmartNav is a wireless system from "Cochlear", Australia. It provides the diagnostic measurements to confirm the device integrity, auditory system response and support post-operating fittings. For surgeons it gives the additional information that the electrode array is properly placed (angular insertion depth measurement, speed of insertion and placement check functions). The goal of our study was to prove that a new system can replace the standard clinical computer set-up for cochlear implant intraoperative ECAP measurements and equivalent in measuring electrodes impedances and Electrically evoked Compound Action Potentials (ECAP).
Material and methods: A prospective between subject comparison study was conducted with 32 test subjects (17 males and 15 females aged from 9 m-38 y.o.) whom cochlear implantation was performed at Erebouni Medical Center in 2021-2022. The ECAP threshold measurements were performed intra-operatively using both the Nucleus SmartNav system and the standard clinical system (CS EP) and compared.
Results: In all cases ECAP thresholds were measured successfully intraoperatively with both tested systems. The Wilcoxon Signed Ranking Test was used to confirm that ECAP threshold measurements obtained with SmartNav were found to be equivalent to the Custom Sound system within a clinically acceptable range. ECAP thresholds were measured and found to correlate closely between the two measurement systems (r is tending towards +/- 1).
During the electrode impendences measurements comparison obtained by both system the visible difference in electrodes impedances measured at the basal electrodes (E1-8) was found but the difference was statistically not significant ($p>0.05$).
Conclusions: The new Nucleus SmartNav system provides equivalent electrode impedances and ECAP threshold registration results, including success of making measurements, compared to the standard clinical set-up. Taking into the account provided additional information provided by SmartNav system it will give more opportunities for increases the efficiency of the CI implantation and clinical process.

Keywords : Cochlear implantation, ECAP measurements, AutoNRT

Oral Presentation 06

OP 06-6

Do differences between cochlear implant electrode length based on clinician selection versus 3D-imaging-based selection influence hearing outcomes?

Dayse TAVORA-VIEIRA[1], Marcus VOOLA[1], Jafri KUTHUBUTHEEN[1], Peter FRIEDLAND[1], Daren GIBSON[1], **Aanand ACHARYA[1]**

[1]Department of Otolaryngology, Head & Neck Surgery, Fiona Stanley Hospital, Australia

AIM
The aim of this study is to evaluate to what extent clinician-based choice of cochlear implant (CI) electrode array (length) differs from that recommended by a 3D-imaging software and whether this influences hearing outcome.
METHODOLOGY
With Ethics Committee approval and patient consent, a retrospective cohort study was undertaken of all patients that received a MED-EL cochlear implant at a tertiary hearing implant centre between 2013-2020. Pre-operative computed tomography (CT) scans were analysed using a 3D-imaging software (OTOPLAN) to recommend an appropriate electrode array. Participants were divided into 3 groups: those that received the 'same' electrode as that recommended by the 3D-software, a 'longer' electrode or a 'shorter' electrode. Speech in quiet (Consonant-Nucleus-Consonant test, CNC) and speech in noise (Bamford-Kowal-Bench Speech In Noise test, BKB-SIN) performance was compared between the 3 groups. Statistical analysis was performed using SPSS.
RESULTS
Of one hundred and fourteen participants included, 47% received the same array, 18% received a longer array and 34% received a shorter array than recommended by OTOPLAN. Depth of insertion has a bearing on sound quality and OTOPLAN was more accurate in predicting the angle of insertion and frequency reached by the most apical electrode. While were no significant differences between the 3 groups for speech in noise performance, patients with longer electrodes demonstrated significantly better speech in quiet performance at 12-months post-CI.
CONCLUSION
Longer electrode arrays are associated with improved quality of sound from CI. One reason clinicians may elect to use shorter CI electrodes is to preserve residual hearing and to reduce the risk of incomplete insertion. Use of a 3D-imaging-based software to recommend an electrode array may give clinicians the confidence to use a longer electrode than they might have ordinarily selected, with the potential for a better hearing outcome for the CI recipient.

Keywords : Electrode Length, Cochlear implant, Outcome

Oral Presentation 06

OP 06-7

Brain volumetric analysis of elderly based on Hearing Levels Using Freesurfer

Yun Ji LEE[1], Eun-Jae LEE[2], Chong Hyun SUH[3], **Joong Ho AHN[1]**

[1]Otorhinolaryngology-head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea
[2]Neurology, Asan Medical Center, University of Ulsan College of Medicine, Korea
[3]Radiology and Research Institute of Radiology, Asan Medical Center, University of Ulsan College of Medicine, Korea

Objective: The aim of this study was to investigate the effects of hearing ability on the volume of brain, especially the limbic system and total gray matter, using FreeSurfer software based on T1-weighted brain magnetic resonance imaging (MRI).
Methods: This study used the data from the health screening dataset from Asan Medical Center from March to December 2019. In this period the total number of 1,341 subjects aged ≥ 60 years were enrolled. For each subject, high-resolution, volumetric T1-weighted 3D gradient-echo images were acquired. We divided the participants into three groups based on the average threshold of pure tone audiometry: a normal group with both ears having less than 20dB, a mild hearing loss group with 20-40dB, and hearing loss group with 40dB or more.
Results : The study included a normal group (n=328), a mild hearing loss group (n=338), and hearing loss group (n=87). There were significant differences observed among the three groups in terms of age, gender, hypertension(HTN), diabetes(DM), total cholesterol, and LDL levels. ($p<0.05$) Greater hearing loss severity was associated with higher age and male predominance, as well as increased prevalence of HTN, DM and hypercholesterolemia.
The volumes of bilateral cerebellar white matter, the accumbens area, and the hippocampus demonstrated a tendency of decreased volume as the severity of hearing loss increased ($p<0.05$). Multiple regression analysis revealed that all brain regions exhibited age-related atrophy. After adjusting for confounding factors (age, sex, HTN, DM and body mass index), the hippocampus and total gray volume still showed volume reduction in the mild hearing loss group.
Conclusion ; The findings from this study indicate that the occurrence of hearing loss in individuals beyond middle age might contribute to the atrophy of hippocampus and total gray matter.

Keywords : Magnetic resonance imaging (MRI), FreeSurfer, Hearing level

Oral Presentation 06

OP 06-8

Crista Fenestra Morphology and Cochlear Implant Approaches: A Temporal Bone Computed Tomography with Three-Dimensional Reconstruction Analysis

Atsumu TERAMURA[1], **Akinori KASHIO[1]**,
Toshihito SAHARA[1], Hajime KOYAMA[1],
Teru KAMOGASHIRA[1], Shinji URATA[1],
Tatsuya YAMASOBA[2]

[1]Department of Otolaryngology and Head and Neck Surgery, Faculty of Medicine, University of Tokyo, Japan
[2]Department of Otolaryngology, Tokyo Teishin Hospital, Japan

Introduction: Inserting a CI 632 or 532 electrode through the round window in some cases requires an extended round window (ERW) approach rather than a standard round window (RW) approach due to difficulties in inserting the sheath. A bony prominence called the crista fenestra (CF) is known to exist at the anterior-inferior edge of the round window and can make electrode insertion difficult. The aim of this study was to evaluate the morphology of the CF on high-resolution computed tomography (HRCT) of the temporal bone using a 3D reconstruction image and to investigate the relationship between the CF and the chosen insertion approach.
Methods: 48 ears in 37 cases inserted with CI 632 or CI 532 electrodes were reviewed in this study. HRCT images were reconstructed into three-dimensional images using Viewtify® 3DCG software and CF structures were identified. The identified CF cross sections were confirmed by HRCT axial sectioning and their heights were measured. Cases with abnormal cochlear morphology or slice thickness greater than 1 mm were excluded. The electrode insertion approaches for each case were divided into RW and ERW groups, and the CF height in each group was compared.
Results: The mean CF height was significantly higher in the ERW group (n=17, mean: 1.00mm, SD: 0.16mm) than in the RW group (n=31, mean: 0.82mm, SD: 0.15mm). There was no significant difference in laterality or age.
Discussion: Using Viewtify 3D reconstruction software, we were able to identify CF on HRCT and assess it's height on HRCT axial section. A correlation was found between the choice of cochlear implantation approach and CF height on HRCT. These results suggest that the measurement of CF on HRCT axial section is useful for preoperative cochlear implantation approach selection.

Keywords : Cochlear implant, Inner ear morphology, Crista fenestra

Oral Presentation 06

OP 06-9

Evaluation of semi-automatic radiological tools for detection of scalar translocation

Sebastiaan R ARENDS[1], Jeroen J BRIAIRE[1],
Johan H FRIJNS[1]

[1]Department of Otorhinolaryngology and Head & Neck Surgery, Leiden University Medical Centre, The Netherlands

Objectives: Intracochlear positioning of the electrode array is an important factor in speech recognition outcome and preservation of residual hearing after cochlear implantation. Postoperative feedback of translocation of the electrode from scala tympani to scala vestibuli is relevant for device fitting, refining surgical technique and improving electrode design. Detection of scalar translocation is possible using computed tomography (CT) images but manual detection is labor-intensive and prone to interobserver variability. The aim of this study was to evaluate the diagnostic performance of two novel radiological tools that semi-automatically detect scalar translocation.
Methods :Both tools use the preoperative CT to obtain a 3D cochlea model and the postoperative CT to localize the electrode contacts, but employ different methods to do this. Based on co-registration of the CT's, the scalar location of each electrode contact is determined. To evaluate diagnostic performance, we used a dataset containing 116 ears with HiFocus Mid-Scala (MS) implants and 52 with HiFocus 1J implants. We compared semi-automatic with manual scalar locations from an experienced radiologist, and computed intraclass correlation coefficient (ICC) for individual contacts and sensitivity and specificity for translocation of an array, defined as two or more contacts located in scala vestibuli.
Results: One tool supports MS implants only, for the scalar position of individual contacts we found an ICC of 0.89 and for the arrays as a whole sensitivity and specificity of 0.97 and 0.96 respectively. For the other tool, ICC, sensitivity and specificity were 0.82, 0.90 and 1.00 respectively for MS patients and 0.44, 0.83 and 0.67 respectively for 1J patients.
Conclusion: The radiological tools both have excellent diagnostic performance for translocation detection in MS patients. For 1J patients performance was not as good, which may be a reflection of the differences in shape, size and insertion depth between these array types.

Keywords : Radiology, Cochlea, Structure preservation

Oral Presentation 06

OP 06-10

Individualized CI surgery by new innovations in radiological image processing

Tim NAUWELAERS[1], Ersin AVCI[2], Stephan GEIGER[1]

[1]*Research and Technology, Advanced Bionics, Germany*
[2]*International Marketing, Advanced Bionics, Germany*

Introduction:
The goal was to develop a new research imaging tool to support the surgeon individualize CI surgery based on the individual analysis of CI subject's pre and post-operative CT by reconstruction of inner ear and electrode in a fast and convenient way. With structure preservation being an important factor during CI surgery, the goal was to include an accurate estimation of the location of basilar membrane and osseous spiral lamina within the reconstructed inner ear.
Materials and methods used:
The research software has been developed using active shape model and AI technology to determine the shape and size of individual cochlea and an accurate location of basilar membrane and osseous spiral lamina. The active shape model is derived from 35 high resolution and contrast microCT images. The software includes novel analysis measurements to plan structure preservation surgery. Internal studies have been performed to determine the accuracy of the cochlea and electrode model.
Results:
The research imaging software is able to assess shape of the cochlea and location of the basilar membrane. Validation of the model showed mean estimation error of 62µmIn order to assess the CI electrode array scalar location a 3 scale trauma rating was used (T0, T1, T2). T0 being the electrode located in Scala Tympany, T1 electrode interacting with basilar membrane or osseous spiral lamina and T2 indicating translocation into scala vestibuli.
Conclusion:
A novel imaging research software has been developed that detects the individual shape of the cochlea and position of the electrode based on CT images.
Due to the high accuracy of the predicted cochlea and electrode models, the software could be used to individualize of CI surgery, by means of individualizing pre-operative planning and post-operative assessment of CI surgery by assessment of electrode location.

Keywords : Cochlea model, Radiology, CI surgery

Oral Presentation 06

OP 06-11

Cochlear Implantation: Predicting Round Window Niche Visibility Using One Measurement in Temporal Bone-HRCT

Laila Mohamed TELMESANI

Ent, Imam Abdulrahman Bin Faisal University, Saudi Arabias

Objective: The purpose of this study was to determine the accuracy of a single measurement in Temporal Bone High-Resolution Computed Tomography (TB-HRCT) in predicting the visibility of the Round Window Niche (RWN) through posterior tympanotomy (PT) during cochlear implant (CI) surgery.
Materials and Methods: A longitudinal prospective study of 148 CI patients (165 ears) aged between 1 and 68 years who underwent cochlear implant surgery during the period January 2010 to December 2018 at tertiary CI center. The angle between the basal turn of the cochlea (ABTC) and the mid-sagittal plane of the cranium was measured by two readers blindly on the sub-millimeter (0.6 mm) in the axial cuts of HRCT images. The visibility of the RWN was classified based on the view during surgery (through posterior tympanotomy) into three types: fully visible, partially visible, and invisible. The ABTC was correlated to the intra-operative visibility of the RWN.
Results: The average measurement of the ABTC was 57.48 ±4.05 degrees with a range between 45.0 to 68.0 and the RWN was found fully visible in 85%, partially visible in 11%, and invisible in 4.2% of the studied ears. The mean value of the ABTC were 56.71o±3.74, 61.00o and 63.86 o±2.67 for fully visible, partially visible, and invisible RWN respectively. There was a significant difference (p=0.0002) between the ABTC in patients with partially visible/invisible RWN (61.80o±2.87) compared to the normally visible RWN (56.71o ±3.74).
Conclusion: This study showed that the visibility of RWN through posterior tympanotomy can be predicted by measuring the angle of the BTC in relation to the cranium's mid-sagittal plane in HRCT temporal bone pre-operatively.

Keywords : Cochlear implant, Roend window niche, CT of temporal bone

Oral Presentation 06

OP 06-12

Surgical results of cochlear implantation in congenital and acquired deafness

Erdenechuluun JARGALKHUU[1,2], **Makhbal ZAYA[2]**, B EHKHTUYA[2], B TSERENDULAM[2], J MARALGOO[2]

[1]Ent, Mnums Emjj-hospital, Mongolia
[2]Ent, Emjj-hospital, Mongolia

Purpose. The purpose was set to study the results of cochlear implant surgery for congenital and acquired deafness.
Method. We selected 112 children aged 0-18 who were diagnosed with congenital deafness and mute from 2009 to 2022. These children were selected through a comprehensive audiological examination. Then was performed cochlear implant surgery and determined the results. We did not include people with acquired deafness caused by middle ear diseases in our study.The children involved in the study were classified according to pre-lingual deafness and post-lingual deafness used in the field of audiology. 107 (95.5%) of those 112 children had Pre-lingual deafness and considering the age group, 85 (78.9%) were 0-3 years old, 18 (16.1%) were 3-5 years old, and 9 (8.0%) were over 5 years old. 91 (81.3%) of the people involved in the study were congenitally deaf and speech-impaired, 12 (10.7%) had IV grade sensorineural hearing loss with no speech development, and 4 (3.6%) had drug-induced deafness and with poor speech development and 5 (4.5%) had deafness after injury with weak speech development. We surgically implanted cochlear implants from Cochlear in Australia to 112 children who were deaf with no speech development and monitored the results. After 36 months, the total vocabulary of those kids were about 850-1000 words and they were able to speak one-two syllable words fluently. Ling can distinguish 6 sounds from 2 meter distance.
Conclusion. If the average level of auditory-speech development after cochlear implant surgery is summed up at 36 months, it is confirmed by our research that language development may occur in children aged 0-3 years who regularly attend audio-speech classes, and language development is poor in children of all ages who do not regularly attend audio-speech classes.

Keywords : Cochlear implant, Deafness, Pre-lingual, post-lingual

Oral Presentation 06

OP 06-14

Oval window electrode array insertion; an intra-operative decision making and its surgical and functional outcomes

Hafeza AHMAD[1],
Iskandar HAILANI[1], Ummu Athiyyah ABDUL RAZAK[1], Siti Aina Mardia ZAILANI[1]

[1]Department of Otorhinolaryngology-head and Neck Surgery, Hospital Kuala Lumpur, Malaysia

Standard practice of inserting cochlear implant (CI) electrode array into the scala tympani of the cochlea is done through either the cochleostomy or the round window membrane. There was very limited documentation in the literature on the oval window electrode array insertion. In this case, we report a 3 year-old girl who had the electrode array insertion through the oval window. She was diagnosed with congenital bilateral profound hearing loss. Preoperative imaging findings were bilateral incomplete partition type I (IP-I) cochlear malformation with bilateral cochlear nerve deficiencies in which the right cochlear nerve was better in size than the left cochlear nerve and the right jugular bulb was high riding. She had passed her CI candidacy assessment and was scheduled for the right cochlear implant surgery. Intraoperatively, despite the extended facial recess approach, the round window was obscured by the high riding jugular bulb. Decision for electrode insertion through the oval window was made on table. We discuss surgical issues and CSF gusher complication when the electrode array insertion was made through the oval window in the IP-I cochlear malformation and her hearing and speech outcomes after the surgery.

Keywords : Cochlear malformation, Oval window insertion, CSF gusher

Oral Presentation 07

OP 07-1

Prediction of cochlear implant effectiveness with surface-based morphometry

Shujiro MINAMI[1,2], Masahiro TAKAHASHI[3], Seiichi SHINDEN4, Kyoko SHIRAI[5], Naoki OISHI[6], Hiroshi NISHIMURA[7], Masatsugu MASUDA[8], Sawako MASUDA[9], Takanori NISHIYAMA[6], Makoto HOSOYA[6], Masafumi UENO[6], Akinori KASHIO[10], Hiroyuki YAMADA[11], Tatsuo MATSUNAGA[1,2], Kimitaka KAGA[1], Ayumi SHINTANI[12], Kiyotaka NEMOTO[13]

[1]Department of Otolaryngology, National Hospital Organization Tokyo Medical Center, Japan
[2]National Institute of Sensory Organs, Division of Hearing and Balance, National Hospital Organization Tokyo Medical Center, Japan
[3]Department of Otolaryngology, International University of Health and Welfare, Mita Hospital, Japan
[4]Department of Otolaryngology, Saiseikai Utsunomiya Hospital, Japan
[5]Department of Otolaryngology, Head and Neck Surgery, Tokyo Medical University, Japan
[6]Department of Otolaryngology, Head and Neck Surgery, Keio University, School of Medicine, Japan
[7]Department of Otolaryngology, National Hospital Organization Osaka National Hospital, Japan
[8]Department of Otolaryngology, Head and Neck Surgery, Kyorin University, School of Medicine, Japan
[9]Department of Otorhinolaryngology, National Hospital Organization Mie National Hospital, Japan
[10]Department of Otolaryngology, Head and Neck Surgery, The University of Tokyo, School of Medicine, Japan
[11]Department of Otolaryngology, Keiyu Hospital, Japan
[12]Department of Medical Statistics, Osaka Metropolitan University, Graduate School of Medicine, Japan
[13]Department of Psychiatry, University of Tsukuba, Institute of Medicine, Japan

This study investigates the potential of preoperative cortical surface-based morphometry from 3D T1-weighted MRI images to predict cochlear implant (CI) outcomes. We enrolled 64 patients with severe to profound bilateral hearing loss (≥70 dB), including 19 with congenital and 45 with acquired hearing loss, who were scheduled for CI surgery. High-resolution 3D T1-weighted brain MRI was performed and analyzed using FreeSurfer. We used the Desikan-Killiany cortical atlas for cortical parcellation and analysis of 34 regions of interests (ROIs). The thickness of the cortex within each ROI was determined by the residuals between the predicted and measured values based on regression lines from healthy hearing controls. Rank logistic regression analysis identified significant associations between CI effectiveness and ten ROIs across both hemispheres. Predictive modeling using right Entorhinal Cortex and left Medial Orbitofrontal Cortex ROIs significantly correlated with speech discrimination ability, more pronounced in acquired than congenital hearing loss cases. Our findings suggest that preoperative cortical morphometry could potentially predict CI outcomes, aiding in patient selection and clinical decision-making. However, further research with more diverse samples is needed for confirmation and generalizability.

Keywords : Surface-Based Morphometry, MRI, Predictive Modeling

Oral Presentation 07

OP 07-2

Using anatomy-based fitting to reduce frequency-to-place mismatch in experienced bilateral cochlear implant users: a promising concept

Anja KURZ[1], Tassilo MÜLLER-GRAFF[1], Rudolf HAGEN[1], Kristen RAK[1]

[1]*Comprehensive Hearing Center, Department of Otorhinolaryngology, University Hospital Wuerzburg, Germany*

Significant variability exists in angular insertion depth both across and within cochlear implant arrays. Mapping procedures use cochlear tonotopicity by assigning low- to high-frequency information across apical to basal electrodes but do not individualize frequency allocation using the exact location of electrode contacts. Anatomy-based fitting is a new fitting method that allows personalization. The prerequisite is new fitting software, in which patient-specific data can be imported from a planning platform for otological surgery. It is then possible to calculate and display each individual electrode contact's tonotopic frequency. The audiologist can then set a frequency-band distribution that is more closely aligned to the tonotopic frequency distribution. The aim of this study was to 1) compare the benefit of a new fitting methodology with the established fitting methodology and 2) evaluate other influencing factors, e.g., insertion depth and electrode array. Participants of this study were experienced bilateral adult cochlear implant users. In each individual, the angular insertion depth of the electrode array and the electrode contacts were calculated. The frequency filters in the audio processor were re-calculated and shifted to match the "better hearing" side.Speech perception in noise pitch perception and patient-reported outcomes were assessed at two intervals. At study start, subjects used their routine clinical map (with standard frequency bands). Subjects were then fit with an anatomy-based fit map. After three months of use with this map, subjects repeated the tests.The results show that bilateral users with different electrode array lengths had better overall sound quality and a higher acceptance rate with the anatomy-based fitted map than they did with their routine fitting. Initial acceptance of anatomy-based fitting in experienced users is dependent on the electrode array length and insertion angle. Anatomy-based fitting should be considered as an alternative to the standard clinical fitting in dissatisfied cochlear implant users.

Keywords : Frequency to place mismatch, Mapping, Speech perception outcome

Oral Presentation 07

OP 07-3

Association of hearing loss with anatomical and functional connectivity in patients with mild cognitive impairment

You Young AN[1], Eek-Sung LEE[2], Se A LEE[3], Joon Ho CHOI[4], Jung Mi PARK[4], Tae-Kyeong LEE[2], Hajoon KIM[5], **Jong Dae LEE[3]**

[1]*Department of Otorhinolaryngology, Severance Hospital, Yonsei University, Korea*
[2]*Department of Neurology, Soonchunhyang University Bucheon Hospital, Korea*
[3]*Department of Otorhinolaryngology, Soonchunhyang University Bucheon Hospital, Korea*
[4]*Department of Nuclear Medicine, Soonchunhyang University Bucheon Hospital, Korea*
[5]*Radnor High School, Radnor, Pennsylvania, USA*

Purpose: Hearing loss is the most important modifiable risk factor for cognitive impairment. This study is designed to evaluate the association of hearing loss with anatomical and functional connectivity in patients with mild cognitive impairment (MCI) by using multimodal imaging technology.
Design and Setting: This was a prospective cross-sectional study of patients with MCI under the care of a neurology clinic at the Soonchunhyang University Bucheon Hospital, Republic of Korea from April to September 2021.
Method: Pure tone averages (PTA) and word recognition scores were used to measure hearing acuity. Magnetic resonance imaging (MRI) and positron emission tomography scans of the brain were used to assess functional and anatomical connectivity. Results of diffusion MRI, voxel- and surface-based morphometric imaging, and global brain amyloid standardized uptake ratio were analyzed. Neuroimaging parameters of patients with MCI with hearing loss were compared with those of patients with MCI and no hearing loss. Correlation analyses among neuroimaging parameters, PTA, and word recognition scores were performed.
Results: Of 48 patients with MCI, 30 (62.5%) had hearing loss (PTA >25 dB) and 18 (37.5%) did not (PTA ≤25 dB). The group with MCI with hearing loss demonstrated decreased functional connectivity between the bilateral insular and anterior divisions of the cingulate cortex, and decreased fractional anisotropy in the bilateral fornix, corpus callosum forceps major and tapetum, left parahippocampal cingulum, and left superior thalamic radiation. Fractional anisotropy in the corpus callosum forceps major, and bilateral parahippocampal cingulum negatively correlated with the severity of hearing loss on PTAs. The two groups were not significantly different in global amyloid uptake, gray matter volume, and cortical thickness.
Conclusion: The findings of this study suggest that alterations in the salience network may contribute to the neural basis of cognitive impairment associated with hearing loss on the Alzheimer disease continuum.

Keywords : Hearing impairment, Mild cognitive impairment, Salience network

Oral Presentation 07

OP 07-4

Cochlear Implant Outcomes in the Elderly Patients: Experience over 10 years in Asan Medical Center

Hye Ah JOO[1], **Joong Ho AHN[1]**, Min Young KWAK[2], Jong Woo CHUNG[1], Hong Ju PARK[1], Woo Seok KANG[1]

[1]Department of Otorhinolaryngology-head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea
[2]Department of Otorhinolaryngology-head and Neck Surgery, Daejeon Eulji Medical Center, Korea

Objectives: To evaluate hearing outcomes of cochlear implant (CI) in the elderly patients who underwent surgery in Asan medical center and demonstrate factors which affect postoperative speech performance.
Patients and Methods: Ninety-three elderly patients (60~80 years of age) with post-lingual sensorineural hearing loss (SNHL) who underwent CI were classified into two groups according to the speech performance scores: the poor performance group (monosyllabic word scores <70%, n=55), and the good performance group (monosyllabic word scores ≥70%, n=38). The distribution and contribution of the potential factors related to post-CI outcomes were analyzed. We also identified how outcomes in speech performance could be predicted according to the causes of SNHL.
Results: The duration of hearing deficit was significantly related to post-CI speech performance (the poor performance group: 26.64±21.34, the good performance group: 13.05±13.99, p<0.001*). Elderly SNHL patients with more than 20 years of hearing loss duration showed significantly poorer speech performance than those with less than 20 years of hearing loss duration. There was no significant difference between the two groups regarding age at implantation, pre-operative residual hearing level, hearing level of the opposite ear, the cause of hearing loss, vestibular function, presence of associated symptoms (tinnitus, dizziness), education, region of residence(urban/rural), presence of job, and other comorbidities. Most of the patients (84%) had no postoperative complications and the most common complication was dizziness (4%).
Conclusion: From these results, we can expect better hearing performance in the elderly SNHL patients with less than 20 years of hearing loss duration. Nevertheless, CI is still considered as the only audiologic rehabilitation regarding SNHL in these patients, because other individual factors, such as age at implantation or coexisting diseases, did not affect surgical outcomes and cause serious postoperative complications.

Keywords : Cochlear implant, Sensorineural hearing loss, Elderly

Oral Presentation 07

OP 07-5

Difference of cochlear implant performances by various slim electrode types in postlingual deaf adults.

Se Eun YI[1], **Hong Ju PARK[1]**, Woo Seok KANG[1], Joong Ho AHN[1], Yeon Joo CHOI[1], Yun Ji LEE[1], Hye Ah JOO[1], Ji Yeon LEE[1], Jong Woo CHUNG[1]

[1]Otorhinolaryngology-head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea

We aimed to compare the result of cochlear implantation (CI) in postlingual deaf adults between slim straight and slim modiolar electrode.This is a retrospective study of 42 patients who underwent CI with slim straight electrode (CI 422, 522, 622) or slim modiolar electrode (CI 532, 632). We compared monosyllabic word recognition scores (WRS), open sentence recognition scores(SRS), threshold (T) levels , comfortable (C) levels and electrode impedance in postlingual adults (42 patients) with slim straight electrode (SSE, 11 patients) or slim modiolar electrode (SME, 31 patients). Preoperative air conduction was 103.0±18.6 dB in SSE and 101.5±17.4 dB in SME. Postoperative air conduction was 28.6±4.7 dB in SSE and 29.8±7.5 dB in SME. In both group, air conduction was significantly improved after CI (p<0.001, p<0.001, respectively). The WRS was 52.0±29.8% in SSE and 56.7±27.1% in SME. The SRS was 76.3±25.7% in SSE and 59.7±23.6% in SME. There were no significant difference in aspect of WRS and SRS according to type. (p=0.650, p=0.061, respectively). When we compared C levels , T levels and electrode impedance, The C levels of electrodes 22,21,1 and the T levels of electrodes 22,21,20,19,18,3,2 were significantly higher in SSE than in SME. And, the impedance of electrode 22 were significantly higher in SSE than in SME. Both SM group and SS group showed improvement in aspect of WRS before CI. C and T levels were relatively higher in apical and basal electrodes in SSE than in SME. Compared to SS, SM had smaller C and T levels and required less current in the long run, which can prolong the life of the cochlear implant.Because SM can make closer contact with the neural elements of the cochlea and showed smaller C and T levels, allowing for more sophisticated stimulation, so WRS may be better when more cases are aggregated.

Keywords : Slim straight electrode, Slim modiolar electrode, Postlingual CI

Oral Presentation 07

OP 07-6

Association of Regional Cerebellar Gray Matter Volume with Speech Intelligibility and Effectiveness of Cochlear Implantation in Elderly Hearing Loss

Seong Hoon BAE[1], Jun Yup KIM[2]

[1]*Otorhinolaryngology, Yonsei University College of Medicine, Korea*
[2]*Physical Medicine and Rehabilitation, Hanyang University Medical Center, Korea*

INTRODUCTION: Understanding the association of regional cerebellar gray matter volume with speech perception and effectiveness of cochlear implantation (CI) in the elderly with hearing loss may aid in the discovery of neuroimaging biomarkers to predict the effectiveness of CI. This study aimed to investigate the association of regional cerebellar gray matter volume with speech perception and effectiveness of CI in the elderly with hearing loss.
METHOD: CI group: 52 elderly individuals (aged ≥ 70 years) with hearing loss who underwent CI; two types of healthy control groups: (1) sex and age-matched healthy control group and (2) normal hearing group. Voxel-wise cerebellar gray matter volume were analized.
RESULTS: The CI, healthy control, and normal hearing groups consisted of 52, 52, and 13 subjects, respectively. Each group had 20 (38.5%), 19 (36.5%), and 6 (46.2%) males, with a mean (standard deviation) age of 75.5 (4.2), 76.1 (3.6), and 76.4 (3.2) years, respectively. Voxel-wise multiple regression analyses showed that the left cerebellar Crus I gray matter volume was associated with preoperative speech perception, and the cerebellar vermis VIIIa with right Crus I gray matter volume was related to the maximum scores ≥ 6 months after CI. The gray matter volume of the right Crus I was also related to the recovery rate of speech perception. Compared with each control group, the CI group showed a widespread decrease in the gray matter volume of the cerebellum.
CONCLUSIONS AND RELEVANCE: Regional cerebellar gray matter volume, especially that of bilateral Crus I, may be a useful biomarker of central speech perception and a predictor of effectiveness of CI in the elderly with hearing loss.

Keywords : Cochlea implant, Age, Hearing loss

Oral Presentation 07

OP 07-7

Applying next generation sequencing to an early detection of hearing loss program

Alicia HUARTE[1], Carlos PRIETO[1], Ana PATIÑO[2], Raquel MANRIQUE[1], Diego CALAVIA[1], Teresa IMIZCOZ[2], Eva CAÑADA[2], Gorka ALKORTA[2], Manuel MANRIQUE[1]

[1]*Otorhinolaryngology, Clínica Universidad De Navarra, Spain*
[2]*Fundación Para La Investigación Médica Aplicada, Cima-idisna, Spain*

Introduction: Newborn hearing screening programs (NHSP) indicate that diagnosis and treatment should be made during the first 6 months of life. Genetic tests could identify the causal mutation of hereditary hearing loss (HHL). Implanting genetic tests could avoid the significant costs and the diagnostic delay. New Generation Sequencing (NGS) tools have been developed and can be applied to NHSP and could study sets of 100-200 genes in a single sample, reducing the analysis costs.
Purpose of the study:To demonstrate, that the specific NGS panel, designed by the authors, call GHELP, to analyze 180 genes related to HHL. It is expected to be a cost-benefit tool in this days and long-term.
Material-and-Methods:One-hundred-fifty-three children were collected for the application of genetic tests. We selected them from the NHSP and separated into a prospective group, or into a retrospective group when they had a previous diagnose of hearing-loss.
Results: Twenty-three (15%) children were collected for the prospective study and 130(85%) for the retrospective. Fifty of 153 children were genetically diagnosed (32.67%) and 73 (47,71%) were not diagnosed. 30 (19,6%) children shown uncertain results in their results and there would be need to perform more genetic tests. The sensitivity of the panel was 32,67%. However, when the panel was applied in the prospective group the sensitivity was 52%. Disease-causing variants have been identified in the following genes: GJB2, OTOF, MYO7A, MYO15A, SLC26A4, MITF, TMPRSS3, TMC1, LOXHD1, COX1, EDNRB, FGF3, PAX3, CHD7.
Conclusion: NGS might be applied to NHSP. These tests would be useful in speeding up the diagnostic process, making it more affordable and opening the door to the personalized treatment of hearing loss.

Keywords : Hearing, Hearing Loss, Genetics

Oral Presentation 07

OP 07-8

Biphasic Effect of Apolipoprotein E ε4 Allele on Hearing Loss with Age: A Retrospective Multicenter Cohort Study

Jae Sang HAN[1], Sung Goo YOO[2,3], Sun Jung LEE[2,3], Hyun Jin LEE[4], In-Young CHOI[2,3], **Kyoung Ho PARK[1]**

[1]Department of Otolaryngology-head & Neck Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea, Korea
[2]Department of Medical Informatics, College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul 06591, Republic of Korea, Korea
[3]Department of Biomedicine and Health Sciences, College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul 06591, Republic of Korea, Korea
[4]Department of Otolaryngology-head & Neck Surgery, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Incheon, Korea, Korea

Background: Both ε4 variant of Apolipoprotein E(ApoE) gene and hearing loss are well-known risk factors of Alzheimer's disease. Since previous studies have reported conflicting results regarding the association between ApoE genotypes and hearing level, this study aimed to investigate their relationship.
Methods: Data from a clinical data warehouse of seven affiliated hospitals under the Catholic Medical Center were used in this study. Clinical Data of 1162 subjects with records of ApoE genotypes, audiometric tests, and cognitive function tests were retrospectively collected and analyzed.
Results: In Cox proportional hazard analysis, ε4 carriers had a higher hazard ratio of hearing loss in all frequencies of pure tone audiometry than non-ε4 carriers. A biphasic effect was observed with a cut-off value of 75.5 years. Subgroup analysis based on age revealed that ε4 carriers had better hearing in early life and worse hearing in later life. There was no discernible sex-based disparity.
Conclusion: The results suggest that the ε4 allele may have a biphasic effect depending on age, with a cut-off value of 75.5 years. This finding provides a potential explanation for the divergent findings of previous studies. Further research is necessary to understand the underlying mechanisms.

Keywords : Apolipoprotein E, Hearing loss, Aging

Oral Presentation 07

OP 07-9

Cochlear implantation in 47 syndromic hearing loss patients and the effect analysis

Yongyi YUAN[1], Shiming YANG[1], Dongyi HAN[1], Pu DAI[1]

[1]Ent, Chinese Pla General Hospital, China

The auditory intervention effect of 47 patients diagnosed as syndromic hearing loss were retrospectively analyzed. Thirteen kinds of syndromes including CHARGE (20 cases), Waardenburg (9 cases), DDOD (4 cases), Pendred (3 cases), Noonan Syndrome with Multiple Lentigines (2 cases), BOR (2 cases), BART-PUMPHREY (1 case), Perrault (1 case), Kabuki (1 case), FMD 2 (1 case), MFDAG (1 case), Coffin–Siris (1 case), and 12.7Mb deletion in chromosome 10 (1 case) were included. All of the 47 patients received genetic testing and cochlear implantation in one or both ears with the intervention age from 0.9~25 years old, and the average age was 3.22±4.05. Inner ear malformation, facial nerve malformation, cerebrospinal fluid leakage are the most common conditions encountered during the operation, and preoperative imaging evaluation is of great value to clarify the degree of deformity and to avoid facial nerve injury and electrode insertion difficulty. For patients with syndromes involving the cardiac and cartilage development, such as CHARGE, cardiac function and laryngeal cartilage development were evaluated to clarify the risk of anesthesia. For patients with syndromes involving coagulation disfunction, such as Noonan Syndrome with Multiple Lentigines, careful intraoperative hemostasia and prolonged compression dressing after surgery are recommended. For patients with syndromes involving the immune system, since the risk of infection after surgery increases, infection prevention and treatment during the perioperative period should be strengthened. For patients showing mild dysgnosia or auditory neuropathy, information on the possible unsatisfied rehabilitation effect should be given to the patients or their family members before surgery. Except for revealing the molecular causes of patients, genetic diagnosis can also help predict the prognosis of treatment and rehabilitation. The intervention effects are related to the mental level, function of auditory nerve, time between hearing loss onset and CI, and speech training.

Keywords : Syndromic hearing loss, Cochlear implantation, Rehabilitation

Oral Presentation 07

OP 07-10

The comparison of residual hearing preservation rates in cochlear implantation patients according to the types of electrodes

Jungho HA[1], Hannah PARK[1], Jisun YANG[1], Eun Youung JEONG[1], Jeong Hun JANG[1], Hun Yi PARK[1], **Yun-Hoon CHOUNG[1]**

[1]Department of Otolaryngology, Ajou University School of Medicine, Korea

Preserving residual hearing during cochlear implantation (CI) provides the opportunity for electroacoustic stimulation. This study aims to analyze hearing preservation outcomes based on different electrode types, such as slim modiolar, and straight type. This study included 103 patients who underwent cochlear implantation between 2011 and 2022 and had a preoperative low-frequency pure-tone average (LFPTA) of 80 dB HL or lower at frequencies of 125 Hz, 250 Hz, and 500 Hz. The electrode types were divided into three main types: slim modiolar (SME, n=13) including CI532 and CI 632 by Cochlear, slim straight (SSE, n=38) including CI422, CI522 and CI622 by Cochlear, and straight type(n=52) by Med-El. Of the 103 LFPTA patients with ≤80dB, the preoperative average was 61.2 ± 16.7 dB. The results of a study indicate that 3 months after implantation, the straight electrode of Med-EL had significantly better LFPTA (p=0.034) compared to the SSE of the cochlear. The hearing preservation rate was also found to be significantly better for the straight type from Med-EL than SSE (p<0.05), and showed a better tendency than the SME, but it was not statistically significant. The partial hearing preservation rate was significantly higher (84.6%) for the Med-EL electrode compared to the other two groups. In the case of SME, a partial hearing preservation rate of 92.3% was observed in the first month, but it decreased to 62.5% after 12 months. The straight type of both cochlear and Med-EL showed a similar or even improved trend over time. In conclusion, hearing preservation is considered to be an important factor in a patient's post-surgery function. The preservation rate of SME decreases over time, while the straight type shows a tendency to be maintained or improved, which suggests that the appropriate selection of electrode array is crucial based on the patient's preoperative LFPTA.

Keywords : Residual hearing preservation, Cochlear implantation, Electrode type

Oral Presentation 07

OP 07-11

Cochlear implantation in single-sided deafness: outcomes and its association with frequency-place mismatch

Shaza SALEH[1,2], Mariam ALAMRO[1], Yassin ABDELSAMAD[3], Fida ALMUHAWAS[1], Salman ALHABIB[1], Abdulrahman HAGR[s]

[1]King Abdullah Ear Specialist Center (kaesc),, King Saud University,, Saudi Arabia
[2]Ucl Ear Institute, University College London, UK
[3]Research Department,, Med-el Gmbh, Saudi Arabia

Lack of access to binaural-hearing negatively affects sound localization, speech perception, and overall quality of life in people with single-sided deafness (SSD).
Pre-operative planning technologies can help evaluate the frequency shift (FS) between the array and the natural cochlear tonotopy. Primary aim: to evaluate changes in hearing performance in nine-patients with SSD after cochlear implantation (CI). Secondary aim: measure the association of audiological-outcomes with the FS between the stimulated center-frequency for each electrode and the characteristic-frequency stimulated by the electrode as estimated by the pre-operative planning software. Collected data: pure-tone audiometry (PTA), speech reception thresholds (SRT), spatial release from masking, sound localization, Hearing Implant Sound Quality Index (HISQUI), and Speech, Spatial and Qualities of Hearing Scale (SSQ). FS was calculated based on the readings of four experts using radiological images and OTOPLAN software.
Results: (1) PTA-average (PTA4) decreased from a mean of 113.9 dB to 37.2 dB. (2) HISQUI scores were significantly better post CI ($t = 6.07$, $df = 7$, $p < 0.0005$). (3) post-CI SSQ Speech and Spatial subscales' scores were significantly better ($t = 7.24$, $df = 7$, $p < 0.0005$ and $t = 2.75$, $df = 7$, $p<0.05$ respectively) but not the qualities subscale. (4) SRT was significantly better ($t = 2.66$, $df = 17$, $p < 0.05$). (5) Localization was significantly better post-CI ($t = 2.74$, $df = 5$, $p < 0.05$). (6) The absolute frequency shift for all frequencies ranged from 0.08 to 40 semitones with an average of 11.1x (±7.47) semitones. (7) average frequency shift/participant for frequencies ≤ 1500 Hz had an average of 14.56 (± 6.67) semitones. (8) The shift in the lower frequency range (≤ 1500 Hz) had a significant association with the improvement in sound localization ($r (6) = -0.86$, $p < 0.05$) but not with speech perception.

Keywords : Single sided deafness (SSD), Binaural hearing, Cochlear implant

Oral Presentation 07

OP 07-12

Feasibility of day surgery for cochlear implantation under conscious sedation with same-day fitting

Ahmad M ALDHAFEERI

Otolaryngology, Hafr Albaten Cochlear Implant Center, Saudi Arabia

Objectives: To evaluate the feasibility of performing cochlear implantation under conscious sedation (CS) as day surgery with same-day fitting.
Methods: All patients underwent cochlear implantation under CS between November 2017 and April 2018. The data collected included demographic information, preoperative clinical characteristics, surgical details, postoperative fitting information and side effects, if any.
Results: Nine patients had 11 cochlear implants (CIs) placed under CS (2 patients received bilateral CIs). One patient's data were excluded from the audiological results because conversion to general anesthesia (GA) was necessary. One patient (11%) vomited just before the end of the procedure. Seven patients had uneventful procedures. Eight (88%) patients were discharged home the same day. There was a statistically significant difference in recovery time between the CS group and the GA group ($t = -2.26$, $df = 12$, $p < 0.05$). In the CS group, there was no statistically significant change in the maximum comfortable loudness level (MCL) for all electrodes from the day of the surgery to the following day. However, there was a statistically significant difference in the threshold (THR) levels of all electrodes from the day of the surgery to the following day ($Z = -2.04$, $N = 120$, $p < 0.05$). Further analysis revealed a statistically significant difference in the 4 most apical electrodes ($Z = -3.496$, $N = 40$, $p < 0.0001$), but not in the middle or basal electrodes.
Conclusion: Cochlear implantation can be performed under conscious sedation with careful patient selection. This approach facilitates same-day fitting and day surgery by minimizing comorbidity.

Keywords : Local anasthesia, Early fitting, Cochlear implant

Oral Presentation 07

OP 07-13

Spatial release of masking in congenitally deaf children after sequential bilateral cochlear implantation

Anita OBRYCKA[1], Artur LORENS[1], Ewelina GRABOWSKA[1], Adam WALKOWIAK[1], Piotr Henryk SKARZYNSKI[1], Henryk SKARZYNSKI[1]

[1]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland

Background: Impaired binaural hearing in children limits their interactions in dynamic environments. Therefore restoration of access to binaural hearing, in particular spatial unmasking, is of great importance for child's development, social interactions and education. The aim of the study is to examine spatial release of masking in congenitally deaf children after sequential bilateral cochlear implantation.
Methods: 46 bilaterally implanted children (sequential procedure) participated in the study. Their mean age at first CI was 1.6 years old and mean age at second CI was 7.5 years. The mean interimplant delay was 5.9 years. Speech perception ability was assessed with Adaptive Auditory Speech Test. The test was performed in noise in bilateral condition at 14 months of bilateral CI use. Speech was presented in front of patient (azimuth 0). In the first step noise was also presented in front of the patient, next it was moved away from the target speech location to azimuths + 90° and – 90°. The spatial release of masking was calculated twice, as the difference of SNRs between condition with speech and noise presented in front of patients and condition with speech in front and noise moved to the first and next to the second implanted ear.
Results: In the group with interimplant delay below 5 years the spatial release of masking did not differ significantly for noise moved to the direction of first and second implanted ear and was respectively 2.0 dB and 2.6 dB. In children receiving their second implant after longer period of time the spatial release of masking for noise moved to the direction of first CI was -0.3 dB and when moved towards second CI was 3.0 dB.
Conclusion: In case of a bilateral cochlear implantation in sequential procedure a short interimplant delay promotes better spatial hearing.

Keywords : Sequential CI, Binaural hearing, Spatial unmasking

Oral Presentation 07

OP 07-14

Outcomes of cochlear implantation in adult with asymmetric sensory neural hearing loss

Eung-Kyung CHO[1], **Myung-Whan SUH[2]**, Sang-Yeon LEE[3], Moo-Kyun PARK[2], Jun Ho LEE[2], Seung-Ha OH[2]

[1]Speech & Hearing Center, Seoul National University Hospital, Korea
[2]Otorhinolaryngology-head and Neck Surgery, Seoul National University Hospital, Korea
[3]Genomic Medicine, Precision Medicin & Rare Disease Center, Otorhinolaryngology-head and Neck Surgery, Seoul National University Hospital, Korea

Purpose
This study aims to find out the speech recognition in asymmetric sensory neural hearing loss adults with cochlear implant and the variables related to bimodal cochlear implant.
Study Design
Retrospective study.
Methods
The subjects are twenty nine adults who underwent cochlear implantation at Seoul National University Hospital form 2013 to 2021 and have binaural difference ≥15dB at any 2 consecutive frequencies in their preoperative pure-tone audiometry. The age of implantation was 18-81years, the duration of auditory deprivation was 1-62 years, and the opposite ear PTA without cochlear implantation was 37-90dB. The performance of 1 year after cochlear implant was evaluated with the cochlear implant(CI) alone or in combination with a contralateral HA(bimodal) and measured speech recognition at the level of words and sentences. It was divided into a cochlear implant only and a bimodal cochlear implant group and was analyzed according to contralateral ear hearing, duration of auditory deprivation, device, and cause.
Results
In the cochlear implant only group, the mean of the contralateral PTA was 67dB (37-80dB) and there were 3 people under 40dB. The bimodal cochlear implant group was 70.18dB(50-90dB). In the 1-year postoperative result, the average word recognition of the cochlear implant only group was 60.07% and the sentence recognition was 68.31%. In the bimodal cochlear implant group, the average word recognition was 55.14% and the sentence recognition was 72.09%. And the performance of the bimodal condition shows better 16.17% in word speech recognition and 16.85% in sentence speech recognition than the CI only condition.
Conclusion
This study demonstrated that the speech recognition after cochlear implantation significantly improved in both groups. The outcomes differed according to preoperative hearing, hearing deprivation period, and cochlear implant performance, and the hearing distinction between 500 and 1000Hz also appeared to affect in the use of contralateral hearing aid.

Keywords : Cochlear implant, Asymmetric hearing loss, Speech recognition

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Abstract Book

Plenary Lecture 03

PL 03

Restoring gait and posture. Neurophysiological correlation with clinical observation in otolith end organ chronic electrical stimulation

Angel RAMOS-MACIAS

Department of Otolaryngology Head Neck Surgery, University of Las Palmas de Gran Canaria, Spain

Introduction: Bilateral loss of vestibular function is a severe disability that leads to permanent imbalance and oscillopsia, severely reduces the quality of life and increases risk of falling. In patients with bilateral vestibulopathy, the regular treatment options, such as medication and/or vestibular rehabilitation are often insufficient. Therefore electrical vestibular stimulation (EVS) has been developed as an alternative approach designed for restoration of the function of the human peripheral vestibular organ. In this presentation is described an innovatory approach based on stimulation of the otolith organs. The rationale of this approach is restoration of the basic sense of gravito-inertial acceleration. Neurophysiological findings and clinical correlation are presented

Material and Methods: Until to-day 15 patients have been implanted with a follow-up period of unless 18 months. In all cases a dual vestibular and cochlear implantation was performed ipsilaterally with 2 different electrode arrays (VI+CI) . For vestibular stimulation a full-band straight electrode array was used with three cylindrical band electrodes with 0.3 mm width and 0.4 mm diameter at the tip. The VI electrode was placed along the anterior wall of the vestibule in the vicinity of the inferior vestibular nerve. Vestibular stimulation involved a constant pulse train delivered in interleaved manner to all 3 inserted electrode contacts.

Results: All patients showed good to excellent improvement of the vestibular function especially in dimmed light and on unsteady surfaces. This was confirmed by a significant improvement in the Dizziness Handicap Index (DHI), the Dynamic Visual Acuity (DVA), the Timed Up and Go Test (TUG), the Dynamic Gait Index (DGI) and the Subjective Visual Vertical (SVV) scores as well as by the results of the posturography. In all cases vestibular electrical responses (vestibular eCAP's and VEMP's) were observed. All patients use their systems during the whole day and show no significant switch-off dizziness.

Conclusions: Otolith VI is feasible and has potential for revalidation of patients with bilateral vestibular dysfunction. This research opens new possibilities for the development of VI's and generation of the gravito-inertial acceleration sensations by electrical stimulation of the otolithic system.

Featured Talk 19

FT 19

Application of genetic information to clinical CI practice

Chen-Chi WU

Otolaryngology, National Taiwan University College of Medicine, Taiwan

Cochlear implantation is currently the treatment of choice for children with severe to profound sensorineural hearing impairment (SNHI). However, cochlear implant (CI) outcomes vary widely among recipients. Genetic diagnosis provides direct clues to the pathogenesis of SNHI, enabling personalized medicine for CI candidates.

In this talk I will present our experience on how genetic information can help to tailor the clinical decision for cochlear implantation. With confirmed genetic diagnoses, clinicians will be able to: (1) delineate the natural history of SNHI and the timing of cochlear implantation; (2) predict the benefit of CI in patients with retrocochlear pathologies of genetic origin; and (3) select appropriate CI devices/electrodes for patients with specific genetic mutations.

Featured Talk 20

FT 20

Outcomes of a further Totally Implantable Cochlear Implant feasibility trial.

Robert James BRIGGS[1,2]

[1]Hearnet Clinical Studies, Audiology and Speech Pathology, The University of Melbourne, Australia
[2]Cochlear Implant Clinic, Royal Victorian Eye and Ear Hospital, Australia

Background: The first investigational study of a prototype Totally Implantable Cochlear Implant device, which had a subcutaneous package-mounted microphone and internal lithium Ion battery, was conducted in three adults and demonstrated limitations of this microphone placement. A second feasibility study, with a pendant-microphone and further-evolved fully implantable cochlear implant technology (Cochlear Nucleus® TI1012), has recently been completed with a cohort of ten participating adults. The study results are described.
Objectives: The primary aim of the feasibility study was to confirm the overall efficacy at 6-months on audiological and patient related outcome measures and safety at 2-years postimplant with the Cochlear Nucleus® TI1012 cochlear implant in hearing impaired adults.
Methods: A single-centre, prospective repeated-measures study design with intrasubject controls was undertaken. Ten adult subjects with bilateral postlingual deafness were implanted. Speech recognition at 6-months postimplant versus preimplant baseline was assessed in two modes of unilateral hearing, Invisible Hearing (IH), without an external sound processor and External Hearing (EH) with an external sound processor. Speech recognition for monosyllabic (CNC) words in quiet and sentences (AuSTIN) in fixed multi-talker noise was assessed. Patient-related outcomes included subjective measures of hearing ability, generic quality of life, perception of tinnitus and patient satisfaction in both listening modes.
Results: Compared to preimplant baseline hearing, significant mean group improvements were demonstrated for the study cohort for speech recognition in both IH and EH listening modes: in the IH mode for words in quiet and sentences in noise ($p<0.001$); and in the EH mode for words in quiet ($p<0.001$) and sentences in noise ($p=0.002$). Patient-related outcomes varied across the small cohort, however group satisfaction was high.
Conclusion: The feasibility of restoring hearing with the Cochlear Nucleus TI1012 totally implantable cochlear implant in an adult cohort was demonstrated. These findings support further development.

Featured Talk 21

FT 21

Considerations for and initial clinical results of a totally implantable cochlear implant. First results of a feasibility study

Joachim MüLLER

Department of Otorhinolaryngology, Head & Neck Surgery, Munich University Hospital, Germany

Joachim Müller, Philippe Pierre Lefebvre, Gerhard Mark, Florian Schwarze, Ingeborg Hochmair

Cochlear implants (CI) are neuroprosthetic devices which restore hearing in severe-to-profound deafness through direct electrical stimulation of the auditory nerve. Current CIs use an external audio processor that is worn behind the ear, which houses the microphone, power source, and signal processing hardware. For users, this external device can be a source of both inconvenience and cosmetic limitations. A long-term goal in the field has been to develop a new generation of implants in which all components are contained within a single subdermal implant. We present clinical results from the one year follow up feasibility study with the totally implantable cochlear implant (TICI). The first six implantations started from September 2020 onwards in two centers. Data collected over the subsequent 52 weeks are presented. In addition own data for 3 years follow up until November 2023 from the Munich Center are shown.
Implantation was carried out via the standard surgical approach, and post-surgical recovery was uncomplicated. Clinical testing showed that the TICI provides high levels of hearing performance early after first fitting, equivalent to that of a conventional CI. The development of the TICI advances the field of audiology and hearing implants.

Keynote Lecture 09

KL 09

CI for SSD: Opportunity or challenge?

Gunesh RAJAN[1,2,3]

[1]Otolaryngology,Head & Neck Surgery, Luzerner Kantonsspital,University of Lucerne, Switzerland
[2]Otolaryngology,Head & Neck Surgery, Medical School,University of Western Australia, Australia
[3]Audiology Department, Fiona Stanley Hospital,Murdoch, Western Australia, Australia

Over the last 15 years single-sided deafness has evolved into a now widely recognised indication for cochlear implantation. Cochlear implantation for single-sided deafness with or without tinnitus enables us to restore the binaural dimensions of hearing which are crucial in everyday's life in adults and children.
We will share our experiences in our prospective single-sided deafness cohort over the last 15 years and discuss the various aspects and challenges in the workup, management and rehabilitation of SSD-CI patients and also dwelve into the developments in this exciting field of cochlear implantation.

Instructional Course 08

IC 08

Intraoperative testing to optimize cochlear implant outcomes

Catherine BIRMAN[1,2,3,4,5]

[1]NextSense Cochlear Implant Program, NextSense, Australia
[2]Medicine and Health, Sydney University, Australia
[3]Medicine and Health Sciences, Macquarie University, Australia
[4]ENT Department, Royal Prince Alfred Hospital, Australia
[5]ENT Department, Children's Hospital at Westmead, Australia

NextSense Cochlear Implant Program started in 1984 by Professor Bill Gibson and since the inception has employed Biomedical Engineers for intraoperative testing to aid the setting of cochlear implant mapping parameters and outcomes. Over the years more electrophysiological tests have become a routine part of each manufacture's suite of available intraoperative support.

The course will be presented by Clinical Professor Catherine Birman (Medical Director) and Dr Farya Golesorkhie (Biomedical Engineer) at NextSense. Dr Halit Sanli, Biomedical Engineer with NextSense Cochlear Implant Program for over 30 years established many of the protocols and Dr WaiKong Lai collated much of the Trans Impedance Matrix experience.

Intraoperative cochlear implant testing can serve three purposes: first to check that each electrode and the cochlear implant device is working; secondly to check the position of the array, including that it is in the cochlea and also checking for tip roll over/ fold over; and thirdly to obtain electrophysiological data to provide data for post-operative mapping parameters.

The intraoperative cochlear implant testing used by NextSense Cochlear Implant Program may involve the following tests:-
- Impedance and Transimpedance Matrix (TIM)
- Electrically evoked compound action potential thresholds such as Neural Response Telemetry (NRT), Auditory Nerve Response Telemetry (ART) and Neural Response Imaging (NRI)
- Electrically evoked auditory brainstem response (EABR)

The instructional course will highlight normal and abnormal results, with practical examples and interpretations of abnormal results. Examples of the more novel TIM testing, with radiological correlations will be shown. The course will highlight the advantages and limitations of the different types of tests and specific patient cohorts that would benefit from more advance testing.
Practical tips will be given regarding methods of testing, both for the manufacturer provided intraoperative tests and more complex testing including electrically evoked auditory brainstem testing.

Instructional Course 09

IC 09

Cochlear implantation in single-sided deafness

Il Joon MOON

Department of Otorhinolaryngology-Head and Neck Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Korea

Cochlear implantation has been the most important and effective treatment for patients with severe to profound hearing loss since its first development. Significant advances in technology and better knowledge of the outcomes has been constantly expanding the criteria for cochlear implant candidacy. Thus, patients with significant residual hearing, children at younger ages or with additional disorders, elderly over 80 years old are good candidates for CI nowadays. Historically, the treatment of patients with single-sided deafness (SSD) can be achieved with conventional (Bi)CROS hearing aids or bone conduction devices. However, cross routing of signal is not enough for restoring binaural hearing and achieving real binaural benefit. Recently, CI gradually emerged as a possible and effective method of rehabilitation in patients with signle-sided deafness. There are only small case series published on the treatment outcomes in SSD patients after CI surgery. In this lecture binaural benefit achieved as well as current updates regarding the surgical outcome following CI in patients with SSD will be discussed. Additionally, personal experience of CI in SSD patients will be also presented

Instructional Course 10

IC 10

Residual Hearing Preservation and How to avoid complications with CI

Piotr Henryk SKARZYNSKI

World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland

Cochlear implantation is a procedure dedicated to patients with total or partial deafness.
Partial Deafness Treatment is performed when there is residual (functional or non-functional) hearing with cochlear implantation. The objective of the course is to present the history, inclusion criteria, surgical steps, electrode selection and follow-up period in the partial deafness cochlear implantation procedure.
The course will focus on qualifying patients and which electrodes should be applied. Additionally, potential mistakes during surgery will be discussed.
Overall presentation on maintaining the program and presenting long-term results from a surgical and audiological perspective will be delivered.

Instructional Course 11

IC 11

Implantation of two generations of bonebridge in children and after mastoid obliteration with bioactive glass s53p4 - tips and tricks

Piotr Henryk SKARZYNSKI

World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland

In patients who underwent radical surgery for chronic cholesteatoma (canal wall down – CWD mastoidectomy), it is possible to surgically reconstruct the posterior wall of the external auditory canal using the S53P4 bioactive glass and later use a bone conduction device.
The demonstrated procedure eliminates some restrictions related to the presence of the postoperative cavity and extends the options for a hearing prosthesis. If classic reconstruction is not possible and a hearing aid is not used, we propose using a Bonebridge implant.
The course will present use of the two generations of Bonebridge with a two-stage surgical procedure - first obliteration of the mastoid cavity with bioactive glass and then Bonebridge implantation. The course will demonstrate the safety and validity of the procedures.

Instructional Course 12

IC 12

Hearing restoration using auditory implants in lateral skullbase lesions

In Seok MOON

Otorhinilaryngology, Yonsei University College of Medicine, Korea

Hearing restoration in lateral skullbase lesions especially in vestibular schwannoma may be a challenge. Tumor control, nerve integrity, MRI surveillance are all challenging issues if auditory implants are used. In recent years, the simultaneous cochlear implantation (CI) and tumor removal has become increasingly popular. The introduction of minimally invasive surgical techniques for tumor removal, securing of cochlear nerve, and improving MRI surveillance have made it possible the use of CI even with tumor condition.

The aims of this instruction course shows our experience of Hearing restoration in lateral skullbase lesions using ausitory implants.

Contents
1. Restoration with Cochlear Implant
1) Simultanoeus tumor removal + CI
- Translabyrinthine approach
- Endoscopic Transpromontorial approach
2) Serial Gamma Knife Radiation + CI
2. Restoration with Bone Conduction Implant
1) Bone bridge
2) OSIA2®

Instructional Course 13

IC 13

Facts and Tricks for Structure Preservation Surgery in Cochlear Implantation

Gunesh RAJAN[1,2,3]

[1]Otolaryngology,Head & Neck Surgery, Luzerner Kantonsspital, LUKS, Switzerland
[2]Faculty of Health Sciences & Medicine, University of Lucerne, Switzerland
[3]Otolaryngology,Head & Neck Surgery, Medical School,University of Western Australia, Australia

Over the last 2 decades the indications for cochlear implantation have expanded progressively. From initially deaf patients we now increasingly treat patients with varying degrees of residual hearing, this calls for improvements in the way we do cochlear implant surgery in order to minimise trauma to the inner ear during and after cochlear implantation.
In this interactive nstructional course we will look at the different factors responsible for inner ear trauma and post-implantation inflammation and highlight how to minimise these through the way we do cochlear implant surgery.

Symposium 23

Genetic Information for CI
SP 23-1

Genetic spectrum of deaf-blindness and its clinical implications in cochlear implantation

Tatsuo MATSUNAGA[1,2]

[1]*Division of Hearing and Balance Research, National Institute of Sensory Organs, National Hospital Organization Tokyo Medical Center, Japan*
[2]*Medical Genetics Center, National Hospital Organization Tokyo Medical Center, Japan*

Background:
A part of patients with hearing loss also have vision loss. The condition is known as dual sensory impairment or deaf-blindness. Because hearing and vision play a major role in communication and access to information, the difficulty of the patients with both senses in life becomes extremely serious. Cochlear implants can be considered for such patients. As the deaf-blindness is rare, heterogeneous, and boundary between otolaryngology and ophthalmology, medical information has been quite limited.
It is valuable for patients with deaf-blindness to recover hearing by cochlear implants, and early intervention results in better outcome. However, significant difficulties exist in clinical diagnosis, hearing tests, auditory rehabilitation, brain function, and surgery requiring general anesthesia. As a result, the ratio of cochlear implantees is very low and timing of the surgery is very late in patients with deaf-blindness. We thought genetic tests in these patients may provide beneficial information to consider medical intervention including cochlear implants.

Materials and Methods:
The subjects of the study were patients who visited the Department of Otolaryngology at NHO Tokyo Medical Center (NTMC) or affiliated facilities for the treatment of hearing loss of unknown causes, and had genetic testing at NTMC. Among these cases, those with the following conditions were extracted in this study; i) cases who consented to national registry of rare and intractable diseases (RADDAR-J) or NTMC registry of hereditary hearing loss, ii) cases with eye disorders, iii) cases who had genetic tests using the hearing loss gene panels, WES, or WGS, including genes responsible for the dual sensory impairment.

Results:
Total of189 cases (88 males and 101 females) were included in the study. The ages of patients at the time of the present study distributed mostly from 0 to 60 with high ratio at 10 years old or younger.
The age of hearing loss diagnosis was most numerous at age 0 and gradually decreased with age. Genetic testing detected the genetic causes in 116 cases (61.4%) and the causes consisted of 36 genes and two chromosomal abnormalities. Perinatal risk factors were present in 9 cases, and postnatal risk factors were found in 2 cases. 172 cases (91.0%) also had diverse range of associated disorders other than eye disorders. Cochlear implant was used in 15 cases, 10 unilaterally and 5 bilaterally.

Discussion and Conclusions:
The present study revealed high detection rate of genetic causes (>60%) as well as diverse and less prominent concentration of genetic causes in patients with deaf-blindness than in patients with only deafness. These results suggests that genetic diagnosis might lead to better understanding of mechanism underlying the symptoms. Distinction of the damages in the central auditory system, the cochlear nerves, and the cochlea would increase the accuracy of the prospect of cochlear implantation before the surgeries. It would also enable auditory professionals to estimate more adequate hearing functions in the patients who cannot conduct ordinary hearing tests or in those with auditory neuropathy whose ABR results are not correlated to real hearing levels. These information would increase the range of indication and promote early decision for the cochlear implantation.
Very high frequency (>90%) and extreme variation of associated disorders other than eye disorders were also revealed. These results suggest that genetic testing has great potential in predicting the phenotypic details such as intellectual disability, epilepsy, etc. which are important to consider indication for the cochlear implant

Symposium 23

Genetic Information for CI
SP 23-2

Cochlear implantation outcomes in patients with auditory neuropathy spectrum disorder

Pei-Hsuan LIN

Department of Otolaryngology, National Taiwan University Hospital, Taiwan

Aim:
With diverse etiologies and clinical features of auditory neuropathy spectrum disorder (ANSD), the management is often challenging and the outcomes with cochlear implants (CIs) are variable. This study aimed to investigate the CI outcomes in auditory neuropathy patients with different etiologies.

Material and Methods:
Thirty-six patients (50 ears) with ANSD who received CI between 2000 and 2021 were included in our cohort. Medical histories were ascertained, and imaging studies and genetic examinations were performed for etiology analyses. Serial behavioral and speech audiometries were performed after the surgery, and CI outcomes were evaluated using both the Categories of Auditory Performance (CAP) and Speech Intelligibility Rating (SIR) scores.

Results:
By etiology analysis, 18 patients (27 ears), 1 patient (1 ear), 1 patient (2 ears), 1 patient (1 ear), and 10 patients (12 ears) were confirmed to have bi-allelic OTOF mutations, WFS1 mutation, OPA1 mutation, prematurity, and cochlear nerve deficiency (CND), respectively. Five patients (7 ears) were found without definite etiologies. The first ears were implanted at 3.9±4.9y. The aided behavioral thresholds improved in all patients after the surgery with an average of 28.9±8.4 dB, and the speech audiometry yielded good results in most of the patients. The median CAP and SIR scores of all patients were 5 and 3, respectively. Patients with OTOF, WFS1, and OPA1 showed good outcomes with CAP and SIR scores 6-7 and 3-5, respectively, while patients with CND revealed suboptimal CAP and SIR scores (2-5 and 1-3, respectively).

Conclusions:
Aided hearing thresholds improved in all patients, however, the speech performance varied. Good CI outcomes were observed in patients with selected etiologies of ANSD, particularly patients with OTOF, WFS1, and OPA1 mutations. Patients with CND have suboptimal outcomes after the surgery. Identifying etiologies in ANSD patients is crucial before surgery and can aid in prognosis prediction.

Symposium 23

Genetic Information for CI
SP 23-3

Comprehensive Prediction Model, Including Genetic Testing, for the Outcomes of Cochlear Implantation

Jae Young CHO

Otorhinolaryngology, Yonsei University, Korea

Objectives: Despite growing interest in the genetic contribution to cochlear implant (CI) outcomes, only a few studies with limited samples have examined the association of CI outcomes with genetic etiologies. We analyzed CI outcomes using known predictors and genetic testing results to obtain a comprehensive understanding of the impact of genetic etiologies.
Design: We retrospectively reviewed the medical records and images of patients who underwent cochlear implantation and genetic testing at a single tertiary medical institution, between May 2008 and December 2020. After excluding those whose speech test results were unavailable, and those in whom the implant was removed due to complications, such as infection or device failure, 203 patients were included in this study. The participants were categorized into adult (≥19 years), child (2-18 years), and infant (<24 months) groups. Outcomes were measured based on categories of auditory perception, monosyllable, disyllable, and sentence scores. For the infant group, the Infant-Toddler Meaningful Auditory Integration Scale score was used.
Results: Among the 203 participants, a causative genetic variant was identified in 117 (57.6%) individuals. The presence of a causative variant was significantly associated with better CI outcomes in the infant group (β = 0.23; 95% confidence interval, 0.01 to 0.47; p = 0.044), but not in the child and adult groups. In the genetically confirmed patients without cochlear malformation, genetic variants involving the spiral ganglion was a poor prognostic factor in the child group (β = -57.24; 95% confidence interval, -90.63 to -23.75; p = 0.004).
Conclusions: The presence of known genetic etiology of hearing loss was associated with better CI outcomes in the infant group, but not in the child and adult groups. A neural-type genetic variant was a poor prognostic factor in the genetically diagnosed child subgroup without cochlear malformation. Careful genetic counseling should be performed before cochlear implantation.

Symposium 23

Genetic Information for CI
SP 23-4

Expansion of use of genetic testing for partial deafness and extreme inner ear anomaly

Byung Yoon CHOI

Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

Symposium 23

Genetic Information for CI
SP 23-5

What can genetic hearing loss teach us about cochlear implant technology?

Jay T RUBINSTEIN

Virginia Merrill Bloedel Hearing Research Center, University of Washington, USA

Cochlear implant performance is bounded by spectral and temporal coding limitations. Spectral limitations are determined by neural survival, electrode array design and current spread. Temporal limitations are determined by signal processing and the electrode-neural interface. Patients with STRC mutations provide an instructive model for hearing with purely spectral defecits. These individuals lack the stereocilin protein which links the outer hair cells to the tectorial membrane and hence have no cochlear amplifier and spectral selectivity provided solely by the passive properties of the basilar membrane. Their inner hair cells are normal however hence their temporal coding should be normal. Psychophysical studies in our laboratory of such patients demonstrate normal temporal resolution and diminished spectral ripple discrimination. As others have found, these patients have normal speech discrimination in quiet but our studies document significantly reduced speech discrimination in noise. All measures, however, are better than seen in cochlear implant recipients. Absent a complete biological regeneration of the cochlea, replacing its detailed function seems out of reach. Psychophysical studies of humans with STRC mutations suggest, however, that significantly higher levels of speech perception than seen today in CI users may ultimately be possible despite the well-known spectral limitations of today's technology.

Symposium 24

Assisted Approach for CI
SP 24-1

EXPERIENCE OF USING SMART NAV IN COCHLEAR IMPLANTATION

Akira ISHIYAMA

Department of Head and Neck Surgery, UCLA School of Medicine, USA

Currently, the most widely accepted gold standard to assess placement of the cochlear implant electrode array and to detect electrode tip foldover is the intraoperative plain film radiograph. Ideally, information related to sub-optimal electrode placement would allow the surgeon to act directly in the operating theatre if required thus avoiding the potential for a poor outcome or revision surgery. The Cochlear™ Nucleus® SmartNav System provides real-time intraoperative measurements providing the surgeon confidence in the placement and function of the electrode array in the cochlea which allows for the best chance for the audiological team to optimize hearing outcomes for cochlear recipients and their families.
In addition to the traditional electrode impedance and AutoNRT® (Neural Response Telemetry) measurements to confirm device functionality prior to leaving the operating room and support initial device activation, the SmartNav system also provides the surgeon information on insertion speed and angular insertion depth in real time, as well as confirmation of final electrode array placement. The electrode array placement analysis, enabled for all Cochlear electrodes, provides actionable information about electrode position issues, such as a tip fold over or kink. This is done by the reliable trans-impedance matrix measurement. Since the false positive rate is negligible, the application of placement check ensures the surgeon that the electrode is appropriately placed, and it is not necessary to obtain an intraoperative imaging to check the electrode placement. Since there is no need to obtain an intraoperative imaging study, it significantly reduces the operating room time. Another significant advantage to use the Smart Nav is the ability to obtain the ESRT threshold intraoperatively and this can be used for the mapping session for the infants.

Material and methods: We will present a review and assessment of our clinical experience with the SmartNav system in 450 patients and how this has influenced our clinical practice, clinical efficiency, and improved confidence in surgical and patient outcomes.
In addition, we also conducted a prospective study on a subset of 32 patients (17 males and 15 female) with ages ranging from 9 months to 38 years old) who had cochlear implantation from 2021 – 2022 at Erebouni Medical Center in Armenia. 16 patients were implanted with Nucleus CI532, 13 patients with CI632 and with CI612, CI622 and CI522 – one patient, respectively. We compared the results from the SmartNav system to the results from the standard clinical computer set-up for cochlear implant intraoperative ECAP (Electrically evoked compound action potentials) measurements and equivalent in measuring electrodes impedances. The ECAP threshold measurements (via AutoNRT algorithm) were performed intra-operatively using both the Cochlear Nucleus SmartNav system and the standard clinical system (CS EP) and compared.

Results: For the purposes of identification of tip foldover, in all 450 patients with normal anatomy, all cases of normal transimpedance matrix measurements, there was no tip foldover or abnormal placement. In our experience, the use of the SmartNav to identify a tip foldover has a 100% sensitivity with no false negatives. It is important to note that there may be false positives in the anomalous inner ear. In our experience, there was one false positive in the 450 cases. In the prospective within patient study on a subset of patients, in all cases ECAP thresholds were measured successfully intraoperatively with both tested systems. The Wilcoxon Signed Ranking Test confirmed that ECAP threshold measurements obtained with SmartNav were equivalent to the Custom Sound system within a clinically acceptable range. ECAP thresholds were measured and found to correlate closely between the two measurement systems.

Conclusions: The new Cochlear Nucleus SmartNav system provides equivalent electrode impedances and ECAP threshold registration results, including demonstrated accuracy of making measurements when compared to the standard clinical set-up. In our experience, the SmartNav system provided accuracy which could then replace the intraoperative plain film radiograph, saving time of the patient under anesthesia. The SmartNav system also provides angular insertion depth measurement, speed of insertion and placement check functions giving more opportunities for successful CI implantation

Symposium 24

Assisted Approach for CI
SP 24-2

Endoscope Assisted Cochlear Implantation

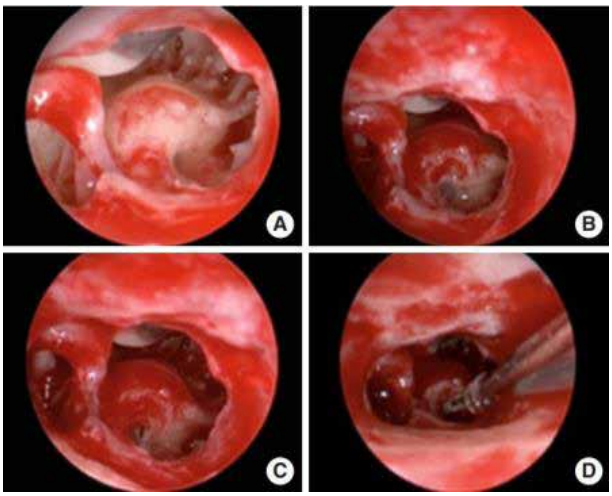
Enis Alpin GUNERI

Dokuz Eylul University Medical School, Otolaryngology Head and Neck Surgery, Türkiye

The efficacy of endoscopic ear surgery (EES) has been validated in an increasing number of studies recently. Endoscopes offer minimally invasive approaches for various procedures including tympanoplasty, stapedotomy, cochlear implantation (CI) and skull base surgery; similar or even better surgical outcomes have been reported with such endoscopic techniques. The main advantage of EES is the endoscopic magnification, which is the growth of the visual field as the endoscope approaches near the object of interest. Also there is the the unique ability to visualize over the corners with the angled endoscopes. Both features contribute to the benefit of obtaining a panoramic view of the anatomical structures, which may not be possible with the direct line of vision of the microscope. Endoscopic ear surgery provides a greater field of view and ease of access to hidden areas, which may may help in performing less invasive surgical procedures.
There are many important variables affecting the outcome after implantation that are tried to be controlled to provide a successful outcome. Adequate exposure of the round window (RW) region through posterior tympanotomy can be obtained in the majority of cases. However, it may not be possible to identify the RW through the facial recess with the microscopic view, especially when there is a significant cochlear rotation and/or anomaly and this this may cause misplacement of the electrode and damage to the vital structures.

According to the St. Thomas classification, 20% of the cases in our series,belong to type IIb and III. There are many alternative techniques in these difficult cases. For type 3 patients, a bony cochleostomy was advocated, in our opinion the better suggestion should be endoscopic exploration through the facial recess and define the RW region and proceed thereafter. In our endoscope-assisted cochlear implantation (CI) technique, the middle ear landmarks are identified through the facial recess by using an endoscopic view without elevating the tympanic annulus. We reported that in 7.8% of the cases, endoscopic examination contributed substantially in identifying the RW membrane correctly. Endoscopic identification of the RW through the posterior tympanotomy enabled to perform a straightforward surgery in all these cases, without the need for switching to a bony cochleostomy or alternative surgical techniques.

The difficult exposure can be anticipated in the preoperative axial CT scan and two issues must be carefully adressed. The first is is the distance (depth) between the mastoid segment of the facial nerve and the round window niche; the second is the upward inclination of the internal auditory canal, which is a sign of cochlear rotation. When the cochlea is oriented normally, the internal auditory canal is almost parallel to the horizontal plane and the external auditory meatus. However, if the cochlea is rotated, the axis of the interal auditory canal become inclined upwards and makes an angle with the horizontal plane. In our report, the difficulty in the surgical exposure was predicted preoperatively by examining the axial CT scans in 42.8% of the cases for which endoscopic assistance was necessary in order to identify the RW correctly.



Figure

The main benefit of endoscope-assisted CI is the improved visibility leading to a panoramic view of the RW region. Transfacial recess endoscopic examination is very helpful when there are problems in surgical orientation. The implementation of transfacial recess endoscopic examination into the conventional CI technique is helpful to avoid problems during surgical orientation. Endoscope assisted surgery not only provides improved visibility, But also ensures lesser risk of injury and correct electode placement and is very useful to identify the landmarks and check the spatial orientation of ST. The difficulty in the surgical exposure of the RW can be predicted by the subjective evaluation of preoperative CT scans.

Symposium 24

Assisted Approach for CI
SP 24-3

Endoscope-Assisted Cochlear Implantation in a Challenging Surgical View

Jong Dae LEE

Department Of Otorhinolaryngology- Head And Neck Surgery, Soonchunhyang University Hospital, Bucheon, Korea

Preserving residual hearing is pivotal in cochlear implantation (CI), particularly for patients with preserved low-frequency hearing thresholds. The round window (RW) approach has gained prominence as it minimizes intracochlear trauma and bone dust entry into scala tympani. However, some anatomical variations can hinder satisfactory RW exposure during posterior tympanotomy, necessitating alternatives like extensive bone drilling or bony cochleostomy. The St. Thomas' Hospital (STH) classification categorizes RW exposure, with Type III denoting the most challenging cases where RW visualization is elusive. Here, we present a case of unilateral endoscope-assisted CI in a patient with a challenging surgical view due to Type III RW exposure.

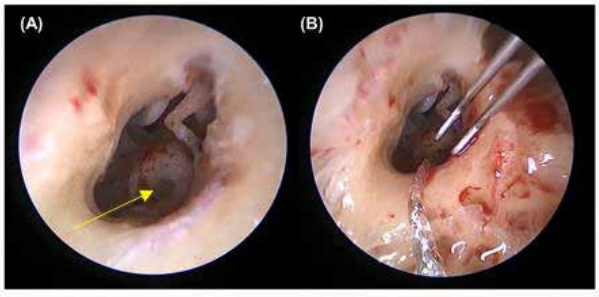


Figure 1

Symposium 24

Assisted Approach for CI
SP 24-4

Aligning the coiling planes of the cochlea and the electrode array

Nozomu MATSUMOTO

Otorhinolaryngology, Kyushu University, Japan

Among recently developed electrode arrays, slim modiolar electrode arrays are prone to folding within the cochlea, a condition known as tip fold-over. One of the mechanisms that cause tip fold-over is a misalignment between the electrode array's coiling direction and the cochlea's curving direction. Thus, surgeons should take care during slim modiolar electrode insertion and should align the coiling planes of the electrode array and the cochlea. However, successful alignment of the electrode array's coiling direction and the cochlea's curving direction largely depends on the surgeon's imagination. We found that there was a surprisingly large variation in how surgeons "think" the cochlea is oriented during surgery, judged by instructional videos on the Internet. Therefore, we reviewed our cochlear implant cases, paying particular attention to the cochlea's orientation in the surgeon's microscopic view. CT dataset and video recordings of the patients who underwent cochlear implantation procedures from January 2010 to December 2021 were collected and analyzed. We analyzed to measure the "slope angle", which is the angle between the cochlea's coiling plane and the horizontal plane.

There were 220 cases that met the criteria. The mean slope angle was 12.1°. However, each surgeon had a favored slope angle range, e.g., a surgeon who preferred a larger pillow had greater slope angle. This meant that 12.1° for one surgeon was not necessarily applicable to another surgeon. In addition, not all surgeons are familiar with preoperative simulations using computers.

Therefore, we searched for a better reference that aid surgeons to understand the cochlea's coiling plane, regardless of the surgeon's preference. We found a plane defined by the long and short processes of incus can be used during surgery. We retrospectively investigated preoperative CT data of 65 ears of patients who underwent cochlear implantation. The preoperative CT dataset was three-dimensionally reconstructed. A plane was defined containing short and long processes of the incus, as "plane of the incus". The angle between the plane of the incus and the coiling plane of the cochlea (incudocochlear angle) were measured and collected. The incudocochlear angle was averaged at 34.6 °. No statistical differences were noted between left and right ears. No statistical differences were noted in different age at the surgery. The 95% confidence interval of the angle was 23.4-45.7 degrees. Thus, once the incus is visualized during surgery, a surgeon can correctly determine the coiling plane of the cochlea. This simple method does not require surgeon's ability of computer simulation.

In conclusion, understanding the coiling planes and making an effort to reduce the chance of misalignment during electrode insertion may help prevent tip fold-over of slim perimodiolar electrode arrays.

Symposium 24

Assisted Approach for CI
SP 24-5

Ideal CI electrode design in creating effective electrode-neural interface

Anandhan DHANASINGH

Research & Development, MED-EL GmbH, Austria

Creating an effective electrode-neural interface (ENI) is the base for a successful cochlear implant (CI) treatment.
To create that effective ENI,
(i) the electrode should match closely to the anatomy of the inner ear,
(ii) as well aim to cover as many neuronal elements as possible and
(iii) most essentially to preserve the intra-cochlear structures even in non-hearing preservation surgery.

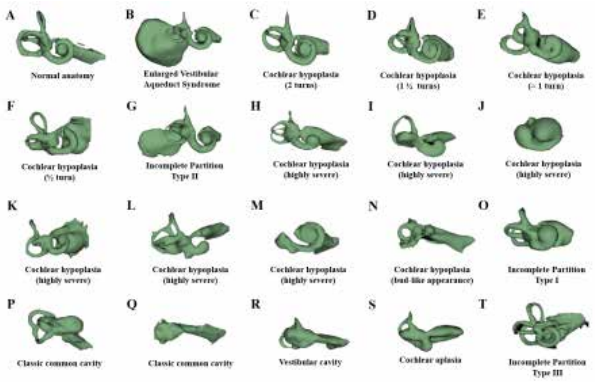


Figure Inner ear anatomical variation

It is known that the neuronal cell bodies are distributed inside the cochlea to an angular depth of 680°, which is equivalent to a linear length of approximately 18mm-30mm, considering the overall variation in human cochlear size. This demands a flexible electrode array in various lengths to match the differences in cochlear size and to cover most of the neuronal cell bodies with electrical stimulation and to minimize the incidence of electrode scalar translocation. The fixed size and the shape of pre-curved electrodes seems a deficit because it prevents the electrode from tightly hugging the modiolus in every cochlea and to reach the 2nd turn of the cochlea with electrical stimulation consistently. Nor does it accommodate the special population of patients with inner-ear malformations, in whom the central modiolus trunk is either fully or partially absent, which demands that electrode contacts are placed proximally to the lateral wall of cochlea. Explantation of electrode array years after implantation should also warrants attention as reports on explantation forces in cochlear models seems to indicate that the force is greater in pre-curved electrode arrays. Most of the literature failed to show superiority of pre-curved electrode type over the straight free-fitting electrode type within a single CI manufacturer, just by its design.

Symposium 25

Future Technology & TICI
SP 25-1

Microelectromechanical system technology for next-generation cochlear implant

Jongmoon JANG

Department of functional ceramics, Korea Institute of Materials Science (KIMS), Korea

In cochlear implants, the daily inconvenience due to extracorporeal components and the residual hearing loss during the electrode insertion are important challenges. In this talk, I will introduce the microelectromechanical system (MEMS) devices to overcome these two challenges to move forward to the next-generation cochlear implant. In particular, I will discuss a micro-scaffold cochlear electrode array (MiSCEA) consisting of a MEMS flexible electrode array and a three-dimensional (3D) micro-scaffold for steroid reservoir. The MiSCEA without loaded drug was tested by measuring the electrically evoked auditory brainstem response of the cochlea in guinea pigs. The scaffold was then coated steroid (dexamethasone)-encapsulated in poly lactic-co-glycolic acid and the continuous release of the steroid into artificial perilymph during 6 weeks is monitored. The steroid-containing scaffolds were then implanted into guinea pigs and threshold shifts were analysed for 4 weeks by measuring the acoustically evoked auditory brainstem response. The threshold shifts tended to be lower in the group implanted with the steroid-containing MiSCEAs. The feasibility of 3D MiSCEA opens up the development of potential next-generation cochlear electrode with improved steroid release dynamics into cochlea

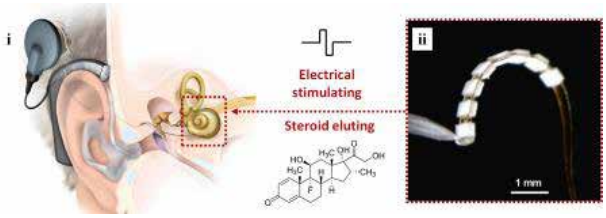


Figure A MEMS 3D microscaffold cochlear electrode array

Symposium 25

Future Technology & TICI
SP 25-2

Cochlear implantation in challenging anatomical conditions: Studies on the force effects and development of a new malleable Cochlear Implant electrode

Rudolf HAGEN

Klinik fuer Hals-Nasen-Ohrenheilkunde, Plastische, Aesthetische und Rekonstruktive Kopf-Hals-Chirurgie und das Comprehensive Hearing Center, Universitaet Wuerzburg, Josef-Schneider-Str. 11, Wuerzburg, D-97080, Germany

After years of illness and sometimes multiple operations, chronic middle ear disease patients often have profound hearing loss that cannot be rehabilitated with hearing aids. Cochlear implantation is the most effective rehabilitation method for sensorineural hearing loss in these cases. The surgical options for these patients are part of an ongoing debate. In these cases, electrode extrusion is a recurring problem that usually leads to revision surgery.

The present study analyzes the mechanical effects of CI electrodes that promote electrode extrusion to develop an optimized concept and electrode design. A temporal bone model with a mastoid cavity was created, and systematic experiments were carried out on electrodes. The most likely cause of potential extrusion was a tangential force resulting from a spring-like effect of the electrodes. In the second step of the experiments, various models of electrode dummies were produced that had a central malleable element of different lengths. Systematic analyses of these specialized models led to almost eliminating tangential spring forces. The dynamic changes in intracochlear pressure conditions during electrode insertion and the "memory element" adjustments were examined with a fiber optic system compared to non-armored electrodes. Investigations were carried out on electrode dummies focusing on pressure differences during insertion and passive retraction forces.

It was shown that the mechanical deformation of the electrodes had no negative influence on the impedance of the conductors, even after supercritical bending tests. The first four patients with mastoid cavities were successfully implanted with electrodes of this type as "custom-made devices".

In summary, a novel design of electrodes with a malleable central fiber was shown to reduce the potential tangential spring forces significantly. After successful clinical application, this new electrode design represents a possible future improvement for patients with challenging anatomical conditions such as mastoid cavities.

Symposium 25

Future Technology & TICI
SP 25-3

Beyond the limit-regeneration of the tympanic membrane

Shinichi KANEMARU

Otolaryngology and HNS, Hearing disturbance and Tympanic Membrane Regeneration Center, Medical Research Institute, Kitano Hospital, Japan

Recent progress in regenerative medicine has provided us with various kinds of scaffolds and growth factors that make it possible to accelerate tissue repair. Applying the principles of modern in situ tissue engineering, we developed a new regenerative treatment for tympanic membrane (TM) perforation using a combination of basic fibroblast growth factor (b-FGF), gelatin sponge, and fibrin glue without the need for conventional surgical procedures and cell transplantation. There are numerous advantages of this regenerative treatment. Skin incisions and the harvesting of autologous tissues are not required. It is possible to fully regenerate normal TM morphology. High success/cure rates and optimal hearing improvements are possible. It can be performed within 20 minutes and is a simple, easy, outpatient procedure.

This regenerative treatment for the TM perforation was approved in November 2019 by the National Health Insurance in Japan. Before its approval, RetympaTM (Norvel Pharma Inc, Tokyo, Japan), as a specialized medicine for regeneration of the TM as a combination kit of b-FGF and gelatin sponge, received pharmaceutical approval in Japan. Two years after the approval, in our hospital, the TM perforation closure rate was 97% (224/231 ears), and favorable hearing improvement was achieved with little air-bone gap. No serious adverse events were observed.

Moreover, we applied this procedure to patients with chronic otitis media, cholesteatomas, or tumors localized to the tympanic cavity. Through the use of this regenerative treatment, it may be possible to reduce the need for some tympanoplasty and most myringoplasty procedures in the near future.

Symposium 26

Speech and Language Outcomes
SP 26-1

"Prediction of Language after Cochlear Implantation in Young Children".

Nancy YOUNG[1,2,3]

[1]Otolaryngology Head and Neck Surgery, Northwestern University Feinberg School of Medicine, USA
[2]Surgery, Ann & Robert H Lurie Children's Hospital of Chicago, USA
[3]Communication Sciences and Disorders, Knowles Hearing Center of Northwestern University, USA

Accurate prediction to improve outcomes after Cochlear implantation (CI) would be a powerful tool to improve language. Although CI has transformed the lives of young congenitally deaf children, language outcomes are more variable than in typical hearing children. Prediction of language would enable targeting of children expected to be lower language improvers for effective behavioral therapy. Prediction based on variables such as age at implant and residual hearing, is accurate in regression analysis of group data and is not accurate on the individual child level. This is because these factors do not explain the majority of variance. Our research group has developed a neural prediction approach using information about brain structure and function from pre-surgical imaging to build machine learning enabled models to predict language after CI.

An overview of our research to build neuro-predictive language models of young congenitally deaf implanted children will be provided. For short-term outcome, our models based on neuroanatomy from pre-surgical MRI have superior predictive ability of children who will be high versus low spoken language improvers compared to traditional predictive characteristics such as age at implant. Brain areas most predictive of outcome are those unaffected by hearing loss and involved in higher level auditory processing. (PNAS 2018 https://doi.org/10.1073/pnas.1717603115) In addition, prediction models have been built using support vector machine learning from diffusion tensor imaging (DTI), which measures brain connectivity, to forecast pre-CI baseline score and improvement at 6-months. Prediction of baseline and for improvement at 6-months post activation was achieved with 72% and 85% accuracy, respectively. Prediction of outcome was more accurate than non-neural factors such as age of implant and residual hearing.

We are evaluating a new theory of "Neural Readiness for Spoken Language Development after CI" to explain how the brain of a CI candidate is prepared to learn spoken language. This theory takes into consideration the neural basis of language in typically developing children as well as the early impact of reduction in auditory and spoken language input on the developing brain. Prediction of long-term language is being evaluated and models for Spanish-Learning in addition to English-Learning children are being developed. In addition, a treatment arm has begun in which Parent Implemented Communication Intervention, an intervention proven effective in improving language outcome of children with hearing loss. We believe that neural prediction will enable development of custom brain-based behavioral therapy to improve language after implantation.

Symposium 26

Speech and Language Outcomes
SP 26-2

Parental linguistic inputs and verbal responses to young children with cochlear implants

Youngmee LEE

Department of Communication Disorders, Ewha Womans University, Korea

Purpose: Parents have a crucial role in the language development of their young children. Parents promote children's language skills by talking to them about what they are seeing or doing. Children with cochlear implants (CIs) are more at risk for language difficulties than children with typical hearing (TH). Despite their use of CIs, most children with CIs have inconsistent access to speech, which may impact their speech and language development. Early intervention programs for children with CIs emphasize the parents' role in optimizing their language development. The current study aimed to investigate the characteristics of parental linguistic input and verbal responsiveness in young children with CIs in comparison with those with TH, and to explore the relationship between the parent variables related to linguistic input and verbal responsiveness and the child variables related to language abilities and volubility in the CI group.

Methods: Fourteen children with CIs and 18 age-matched children with TH, aged 12 to 36 months, participated in this study. The children and their parents engaged in a 20-minute free-play session with standardized toys. Parental linguistic inputs and verbal responsiveness were examined during 20-minute free-play activities. This study compared the amounts of parental linguistic inputs and the proportion of facilitative language techniques between the CI and the TH groups. In addition, this study compared the parental verbal responsiveness between the two groups.

Results: Parents of children with CIs used significantly more utterances and shorter mean length of utterance than parents of children with TH. However, children with CIs were exposed to a similar number of different words compared to children with TH. Parents of children with CIs used significantly less facilitative language techniques than parents of children with TH.
Parents of children with CIs used less verbal responsiveness, which was positively associated with children's language development, than parents of children with TH. In the CI group, the frequency of the parental verbal responsiveness to children's focus of attention was significantly correlated with the frequency and time of children's vocalization.

Conclusion: These results suggested that children with CIs were exposed to a different quantity and quality of parental linguistic input compared to children with TH. In addition, parents of children with CIs responded less frequently to their children's communicative intentions and behaviors than did parents of children with TH. These findings can be used to develop the parent coaching program in the early intervention for children with CIs. These findings suggest that early intervention professionals should coach the parents of children with CIs to promote high-quality parental responsiveness.

Symposium 26

Speech and Language Outcomes
SP 26-3

Preventive Education Program for Parents (PEPP): a starting engine for parents and infants who are hard of hearing or deaf

Ulrika LÖFKVIST[1,2]

[1]*Department of Public Health and Caring Sciences, Uppsala university, Sweden*
[2]*Department of CLINTEC, Karolinska Institute, Sweden*

Every year 1-2 of 1000 newborn Swedish children are identified with a permanent sensorineural hearing loss or deafness, thanks to the universal newborn hearing system (UNHS). Besides early identification of hearing loss and fitting of hearing technology, it is crucial to provide parents with family-centered early intervention (FCEI). Newborn hearing screening was first implemented in Sweden in 2008, which means that most children born with hearing loss are nowadays identified before 1 month and can therefore be diagnosed early, at around 2-4 months of age, which enables early adaptation of hearing technology (hearing aids and/or cochlear implants), from around 3-6 months. Swedish families are usually offered to meet a speech-language pathologist and/or teacher of the deaf for guidance early in the process. However, it does not always happen before 6 months of age, as international guidelines recommend (Joint Committee 2000; 2007; 2019), and the guidance offered might look different, depending on where you live. Namely, there is a lack of equal, national and evidence-based guidelines related to interventions that is offered to parents of infants with newly identified permanent hearing loss/deafness. The Preventive Education Program for Parents (PEPP) is a newly developed 12-week program within a national study approach, that is created by a group of experienced clinicians and senior researchers. There are two main processes within the PEPP-coaching: to increase parental engagement, and to increase their use of natural audio-verbal communication strategies in everyday communication with their child, from day one. One hypothesis is that the Language ENvironment Analysis (LENA) technology (www.lena.org) might be a powerful tool for guidance of the parents' quantitative use of verbal language, together with audio-visual feedback from video analysis. Furthermore, it is hypothesized that parents' awareness and knowledge about optimal listening and language stimulation can be promoted through the use of a new mind map technique related to one-to-one strength-based guidance. The aim of the present pilot-study was to evaluate if PEPP coaching and the data-driven feedback tools can affect the initial dyadic communication patterns (between infant-parents). Another aim was to explore how parents experienced to participate in a PEPP intervention setting.

Method: The current study design has a mixed method approach. The PEPP model theoretically builds on current research evidence and best clinical practice. The purpose of PEPP is to coach and support parents of newly diagnosed infants, by using motivational interview techniques and data-driven measures: all-day Language Environment Analysis (LENA) recordings, short video-analysis to evaluate qualitative aspects of parent-child interaction patterns, and parent questionnaires, including a new mind map technique model. Ten families of infants with moderate- profound hearing loss where invited and participated in the initial pilot study. All families received one-to-one weekly coaching, either at the clinic or remotely. The families received 12 weeks of PEPP (coaching in combination with data-driven evaluation) by experienced clinicians, and were afterwards invited to share their PEPP experiences in a digital focus group interview. Evaluations and feedback were conducted with three LENA recordings and two short video-analyses, besides a pre- and post-evaluation, without feedback. Five parents agreed to participate in the focus-group interview, which was analysed with content analysis (Elo & Kyngäs, 2008).

Results: Quantitative LENA results showed that the participating infants were involved in more audio-verbal turn-takings after the PEPP intervention, and in parallel parents also changed their own communicative behavior, and expressed that they became more aware of their own use of for instance parentese, which is a known important predictor of a child's early language development. In addition, parents expressed that they felt more empowered after PEPP, and that they were happy to receive very early intervention immediately after their child had received a hearing loss diagnosis. Some parents wished that they could have had more one-to-one guidance around the LENA graphs.

Conclusions: The preliminary pilot results are promising for further development of the PEPP model, which is a starting engine for early language development and parental engagement. Next step is to conduct an efficacy study, with a longitudinal approach, in a larger, population-based cohort. Data-driven tools like the LENA technology are appreciated by parents, and should be used to motivate and affect parents to change their communicative behavior, from the start.

Symposium 26

Speech and Language Outcomes
SP 26-4

Speech, language and quality-of-life outcomes in children with hearing loss and additional disabilities: effect of cochlear implant dynamic range

Teresa CHING[1,2,3]

[1]*Macquarie School of Education, Macquarie University, Australia*
[2]*NextSense Institute, NextSense, Australia*
[3]*School of Rehabilitation Sciences, University of Queensland, Australia*

Speech, language and quality-of-life outcomes in children with hearing loss and additional disabilities: effect of cochlear implant dynamic range

Teresa YC Ching, Paola Incerti, Sanna Hou, Linda Cupples

This study examined speech, language and quality-of-life outcomes in a population-based cohort of 9-year-old children with hearing loss and additional disabilities who received cochlear implants before 3 years of age. Speech perception, receptive and expressive vocabulary were assessed through direct administration, and quality-of-life outcomes were measured using self-report. Demographic information and audiological information including cochlear implant mapping characteristics were collected. Multiple regression analyses were used to address two questions: 1) Do cochlear implant characteristics change over time? 2) Do cochlear implant programming characteristics at age 3 years predict speech perception, language, and quality-of-life outcomes at age 9 years? The results are interpreted in light of current research on this population. Implications for clinical management will be discussed.

Symposium 26

Speech and Language Outcomes
SP 26-5

Selection of communication mode after pediatric cochlear implantation and its problems

Yasushi NAITO

Department of Otolaryngology, Comprehensive Ear and Hearing Center, Kobe city medical center general hospital, Japan

Children with prelingual deafness can basically acquire spoken language by using cochlear implants. However, even with rehabilitation using cochlear implants, not all children are able to use spoken language as their primary mode of communication, and in some cases, adequate language development cannot be achieved without the use of visual language such as sign language. In this symposium, we will report our experience with the principles of communication mode selection in our center's pediatric cochlear implant rehabilitation program and the results of long-term follow-up and its problems.

In our cochlear implant program, we have achieved good language development in children with prelingual deafness by performing bilateral implant surgery as early as possible and using the auditory-verbal approach postoperatively. However, this principle cannot be applied to all children with hearing loss. For children with pervasive developmental disorders other than hearing loss, intellectual disabilities, severe inner ear malformations, or cochlear nerve hypoplasia, total communication using both auditory and visual means is chosen because spoken language alone can cause language development delays.

Our department started a cochlear implant program in November 2004 and has performed 815 cochlear implant surgeries to date, of which about 70%, or 555 are pediatric cases. Of the 243 pediatric cochlear implant recipients who have reached school age to date, 202 (83%) selected spoken language as their communication mode and 35 (14%) selected total communication. The reasons and backgrounds for choosing total communication were 15 inner ear malformations with CND, 12 inner ear malformations, 7 cases with older age for surgery, 6 cases with developmental or intellectual disabilities, and 2 deaf family members. The remaining six patients had severe multiple disabilities that made evaluation difficult. Children who use spoken language as their primary communication choose regular schools, while all children who use total communication choose to be educated in deaf schools.

Reflection is needed on the cases in which total communication was selected because of cochlear implant surgery age despite the absence of additional disabilities. These children were followed up at local otolaryngology and rehabilitation facilities with hearing aids, but despite their delayed speech and language development, the decision to proceed to cochlear implant surgery was delayed. We also believe that even in cases of severe cochlear malformations, better speech-language development may be achieved by earlier bilateral surgery, and that the surgical indications for our cochlear implant program need to be continuously revised

Symposium 26

Speech and Language Outcomes
SP 26-6

Using Listening Development to Guide Cochlear Implantation Evaluation in Moderate-Severe Hearing Loss

Aleisha DAVIS

Department of Hearing Services, The Shepherd Centre, Australia

Aim: Early intervention is essential in supporting the developmental impact of hearing loss. For children with severe-profound losses there is both evidence and consensus relating to the timing of cochlear implantation to support age-appropriate speech and language development. However, in cases of bilateral hearing loss with residual hearing, such as moderate to severe hearing levels, determining the optimal timing for cochlear implantation remains challenging. In this cohort standard language assessment measures vary significantly between time points and may not be representative of a child's progress. It is likely that listening trajectories which have been shown to have greater sensitivity may be a more robust indicator.

Listening measures such The Functional Listening Index – Paediatric® (FLI-P) can be used to test this hypothesis and explore the relationship between the development of listening milestones for children with hearing loss and language development through standardized assessment measures. Analysis and comparison of the listening and language trajectories of this cohort may provide insight into both the sensitivity of current measures and establish assessment configurations that can guide the timing of cochlear implantation more accurately.

Objectives: The aim of this study was to identify the most appropriate timing for cochlear implantation in children with moderate to severe hearing levels to optimize communication development.

Methods: Through a longitudinal retrospective study, listening and language development was tracked in children with bilateral moderate-severe hearing loss compared to their typically hearing peers. The FLI-P was administered at regular intervals to measure the progress of the children's listening trajectories analysed comparative to annual standardised speech and language (PLS, CELF-5). assessment data.

Results: The results of this study suggest that majority of children are within the average range for standardised assessments at one year of age. The number within the average range reduces to 66% at three years of age. The listening trajectories for this group indicate concerns at a much earlier stage. The results are three-fold; a) listening trajectories using the FLI-P are sensitive to early access to sound and over time, b) analysis of standardised assessments support predictive categorisation of at-risk children and serve as a marker for service delivery modification, and c) that the combination of functional and standardised assessment lead to improved clinical guidance and management.

Conclusion: The findings from this study contribute to evidence-based decision-making in cochlear implant evaluation. By utilizing the listening trajectories alongside other standardized assessments, clinicians can identify optimal candidacy for cochlear implantation while addressing the developmental needs of the child. This approach can lead to improved communication outcomes and enhanced quality of life for children with bilateral hearing loss and residual hearing. The implications extend to the broader field of paediatric audiology, offering valuable insights for personalized hearing rehabilitation.

Symposium 26

Speech and Language Outcomes
SP 26-7

From Silence to Speech: Unraveling the Factors that Drive Language Success in Mandarin-speaking Children with Cochlear Implants

Pey Yu CHEN[1,2]

[1]Department of Otolaryngology, Mackay Memorial Hospital, Taiwan
[2]Department of Audiology and Speech-language Pathology, Mackay Medical College, Taiwan

Purpose
Cochlear implant (CI) is important in the establish of auditory perception and language skills in children with profound hearing loss. Mandarin, which is spoken by over 800 million people as their native language, is known for its tonal nature where the meaning of a word depends on its pitch variation. Despite this unique feature of Mandarin, few studies have described the correlation between speech perception and language outcome in deaf children with CI in this population. The aim of our study is to identify the prognostic factors for language development and investigate the correlation between auditory performance and language outcomes in Mandarin-speaking population.

Methods
We retrospectively collected children underwent cochlear implant before the age of 18 at MacKay Memorial Hospital. Those patients who had completed both auditory perception battery, which included vowel discrimination, consonant discrimination, spondee words discrimination, and Mandarin monosyllable recognition test (MMRT), and language assessment using either the preschool language scale or Language Scale, Chinese Version, based on the patient's age. All statistical analyses were performed using SPSS 25 (IBM SPSS Inc., Chicago, Illinois).

Results
We enrolled 34 patients, including 14 boys and 20 girls; the average age at implantation was 2.8±1.8y. Of them, 25 children received bilateral implants with an interval of 9.1±4.1y. Earlier age at implantation is the most significant prognostic factor for both auditory and language development ($p=0.002$ and $p=0.013$, respectively). Gender or number of implantation dose not relate to CI outcomes. However, there is only weak to moderate correlation between auditory perception battery and language outcome.

Conclusion
Earlier age at implantation is the most significant prognostic factor for both auditory perception and language development. Nevertheless, there is only a weak to moderate correlation between auditory perception and language outcome, suggesting more socio-economic factors may be related to language development

Symposium 27

CI Vision 2023:
Leveraging Big Data for Future Insights
SP 27-1

History of cochlear implantation in Korea; from 1988 to 2023

Jae Young CHOI

Otorhinolaryngology, Yonsei University, Korea

To conduct a longitudinal national survey of cochlear implantation (CI) in Korea from 1988 through 2023.A retrospective analysis of adult and pediatric CI cases from 1988 to 2023 using Korean otologic society database was conducted. Surgical statistics were obtained, including number of surgeries, age, implanted side, facilities, and preoperative threshold levels for CI.
Since 1988, more than 15,300 CI surgeries have been conducted in korea. Since 2011, pediatric cases consistently surpassed adult cases. More facilities meet criteria for conducting CI as determined by Ministry of Health and Welfare and have now reached more than 45. Adult patients over 70 years old have become proportionally higher. Age at implantation steadily reduced in accordance with modifications of Japanese CI guidelines for children but is still not comparable to that in other developed countries.

Symposium 27

CI Vision 2023:
Leveraging Big Data for Future Insights
SP 27-2

Changes in CI indications in Korea

Yong-Ho PARK

Otolaryngology-Head and Neck Surgery, Chungnam National University, Korea

Since the cochlea implant(CI) surgery first began in Korea in 1998, although about 2000 patients had undergone CI surgery until 2004, it was not covered by national health insurance in Korea. It was not until 2005 that national health insurance coverage began, cochlear implant surgery began to actively increase, and various strict standards were expanded, especially in children he age limit was raised, and bilateral surgeries were supported. However, support for external devices is required on a regular basis, and support is still limited to only once in a lifetime. In particular, support for many hearing loss patients who may benefit with cochlear implant surgery is insufficient. In this topic, we will discuss changes in insurance coverage standards for cochlear implant surgery in Korea and the possibility of it's expansion.

Symposium 27

CI Vision 2023:
Leveraging Big Data for Future Insights
SP 27-3

Hearing Big Data center in South Korea; Making a worldwide platform

Young Joon SEO

Otorhinolaryngology, Yonsei University Wonju College of Medicine, Korea

1) Korean Hearing Big Data Center As an organization of Korean Hearing society, this Korean Hearing big data center have developed the standard protocols and collected the hearing data in separate hospitals for hearing big data. We have over 100,000 hearing data of 5 big hospitals as a foam which can be used by company or researchers without security problems. And we combined this data with National health insurance data individually. We have a purpose to collect all of dispersed hearing data in hospitals, so we will make feasible Korean Hearing big data in the future. 2) Korean Hearing standard data Center As an official National center, this center has made the standard protocols for standard hearing collection including pure tone audiogram, impedence, and auditory brainstem response. We designed how to calibrate the audiometry, how to calibrate audiologist, and hot to control the bias of collecting data. We have a purpose to standardize the audiometric data in each hospital and hearing center. It will make the researchers to have high quality of hearing data in the future.

Symposium 28

Development of Living Guidelines:
For Cochlear Implantation in Adults
SP 28-1

The CI living guidelines: Inspiration and aspiration

Catherine BIRMAN

Department of Otolaryngology Head & Neck Surgery, NextSense/ Macquarie University/Univesrity of Sydney, Australia

Symposium 28

Development of Living Guidelines:
For Cochlear Implantation in Adults
SP 28-2

How can the CI living guidelines be applied in accordance with the circumstances of each country?

Angel RAMOS-MACIAS

Department of Otolaryngology Head Neck Surgery, University of Las Palmas de Gran Canaria, Spain

Symposium 28

Development of Living Guidelines:
For Cochlear Implantation in Adults
SP 28-3

Living guidelines: improving the standard of care of adults with hearing loss and the role of cochlear implantation

Seung-Ha OH MD[1], Leo DE RAEVE[2,3,4], Meredith HOLCOMB AU.D[5], Ángel RAMOS MACÍAS MD[6]

[1]Seoul National University Hospital, Seoul, Korea
[2]Director, Independent Information and Research Centre On Cochlear Implants, Belgium
[3]Acting Chair, Cochlear Implant International Community of Action, UK
[4]Scientific Advisor, European Association of Cochlear Implant Users, UK
[5]Director, Hearing Implant Program, University of Miami, USA
[6]Otolaryngology, University of Las Palmas, School of Medicine, Spain

Purpose of study
Guidelines with defined care pathways to cochlear implantation for adults are limited and vary across countries. This leads to disparities in cochlear implant access and underutilisation amongst those who are eligible and most likely to benefit. There is an important need to develop a transparent standard of care framework that facilitates consistent and equitable access to the right hearing intervention, at the right time and for the right patient, irrespective of their social, geographic, and demographic profile.
Methods
Development of these "living" guidelines is being led by an independent Task Force of 52 members across 20 countries consisting of cochlear implant users, hearing experts with surgical and audiological backgrounds, in conjunction with the Cochlear Implant International Community of Action (CIICA) patient advocacy group. The first step in this process was to define the key clinical questions, followed by the development of a research protocol and publication via PROSPERO to formalise the systematic literature search and criteria. Over 14,000 publications were identified, screened, and evaluated as per the GRADE methodology. Where no evidence was identified to inform a recommendation, consensus was reached based on the expert opinion of the Task Force.
These guidelines are 'living' on a digital authoring and publication platform. This accessible, web-based program enables new evidence to be incorporated into the existing literature base without the need to repeat literature reviews. Updates to the guidelines will be published online annually.
Results
Nine recommendations accompanied by twenty-nine good practice statements have been formed across six clinical pillars associated with the patient's hearing treatment journey, from screening, audiological referral and specialist evaluation, to surgery, rehabilitation and patient-reported outcomes and measures.
Conclusion
These guidelines mark the first step towards developing a universal standard of care for hearing loss and cochlear implantation.

Keywords : Cochlear implant, Standard of care, Guidelines

Roundtable 12

Revision Surgery
RT 12-1

Revısıon Cochlear Implant Surgery and Reimplantation

Levent OLGUN[1,2]

[1]*Baskent university ENT Clinic, Zubeyde hanim Research Center, Türkiye*
[2]*Bozyaka Teaching Hospital ENT Clinic&CI Center, University of Ministry of Health, Türkiye*

Cochlear implant surgery is a well defined procedure and surgical complication rates are quite low in standart cases.However in chalenging cases such as temporal bone abnormalities,chronic otitis media cases and syndromic cases surgical complications mayreach up to 10 %.Moreover even years after some late complications can occur.Some complications can be solved with medical treatment but in general either a revision surgery or reimplantation may be necessary.Although not very often soft and hard device failures may also require either a revision surgery or reimplantation.
In this study 254 cases requiring revision surgery and/or reimplantation will be presented and factors leading to interventions,problems during or after the surgical procedures and outcomes will be discussed

Roundtable 12

Revision Surgery
RT 12-2

Analysis of cochlear implant surgeries

Il Joon MOON

Department of Otorhinolaryngology-Head and Neck Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine Seoul, Korea

The indications, technology, and surgical technique for cochlear implantation have evolved over decades, and number of receiving cochlear implant has also increased rapidly. Subsequently, cochlear implant revision is becoming increasingly common. Understanding the risk of cochlear implant revision (CIR) is important for patient counseling. Thus, the authors analyzed the rate and reasons for CIR and the failure pattern in terms of the manufacturer and device model in our tertiary referral center. The Kaplan-Meier curve was used to examine the cumulative and device survival curves. In addition, the cumulative and device survivals were further analyzed based on age group, time period of primary CI, and manufacturer. Cox proportional hazards model was used to evaluate the association between RCI and manufacturers. Among 1,430 CIs, 73 RCIs were conducted (5.1%). Device failure remained the most common cause of RCI (40 of 73 RCIs [54.8%]), with an overall device failure rate of 2.8%, followed by flap-associated problems and migration (9 of 73 RCIs each [12.3%]). When evaluating manufacturers, MED-EL showed the highest revision rate (5.9%), followed by Advanced Bionics (5.3%) and Cochlear (4.7%), and Advanced Bionics showed the highest device failure rate (4.1%) followed by MED-EL (3.6%) and Cochlear (2.1%). After excluding the recalled models, the 10-year and 15-year overall cumulative survival rates were 94.9% and 91.7%, respectively, and device survival rates were 97.2% and 95.6%, respectively. The overall survival rate of RCI has remained steady; however, the features and pattern of failure have changed, particularly for the most recently released implant models. Due to the clinical significance of device failure and re-operation, clinicians should be aware of and respond to these rapid changes

Roundtable 12

Revision Surgery
RT 12-3

Electrode Kinking in Cochlear Implantation

Gi Jung IM

Department of otorhinolaryngology, Korea University College Of Medicine, Korea

Less traumatic electrode insertion along the basal turn of cochlea is essential to cochlear implantation. However, immoderate attempts to insert the electrode beyond the point of resistance can result in electrode kinking within the basal turn of cochlea. Electrode kinking tends to occur (1) in the use of contour or hugging type of electrode, (2) in the cochlear ossification or fibrosis, and (3) in wrong angle insertion in the approach of round window membrane or cochleostomy near the round window. The schematic diagram shows three types of electrode kinking. First, when the electrode enters the cochlea, the apex of the electrode becomes dysfunctional due to the resistance of the opening (basal part). Second, as the electrode goes deeper into the cochlear incision, the resistance counteracts the movement, causing a twist in the midsection of the electrode. Third, the resistance of the passage through the narrow part of the cochlear ossification results in damage to all or part of the electrode. Intra-operative radiologic evaluation and intra-operative measurement of the neural response telemetry (NRT) or auditory nerve response telemetry (ART) during cochlear implantation is essential to check the status and proper insertion of electrode.

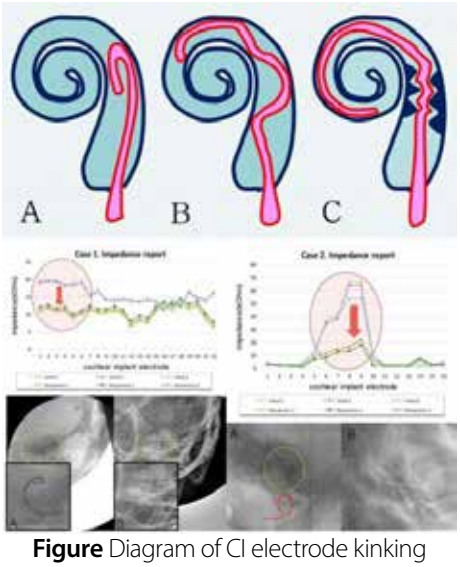


Figure Diagram of CI electrode kinking

Roundtable 12

Revision Surgery
RT 12-4

Management of challenging cochlear implanted cases

Jiunn-Liang WU[1,2]

[1]Otolaryngology Head & Neck Sugery, National Cheng Kung University Hospital, Taiwan
[2]Otolaryngology, College of Medicine, National Cheng Kung University, Taiwan

Although surgical technique of cochlear implantation (CI) has been well established, managing patients with inner ear malformations, craniofacial anomalies or chronic suppurative otitis media (CSOM) remains surgically challenging and may yield uncertain auditory outcomes. Cochleovestibular anomalies such as common cavity, incomplete partition (IP), cochlear hypoplasia (CH), large vestibular aqueduct syndrome (LVAS) with Mondini malformation, and hypoplasia of the internal auditory canal (IAC) are rare but unneglected in congenital deaf children. Since challenging cases are becoming more common as we are expanding selection criteria, comprehensive preoperative imaging evaluation and surgical planning are crucial when managing these implantees. Surgeons should be familiar to cochlear implant devices and electrode arrays selection, be capable of modifying technique according to the surgical finding, be aware of possible intra- and post-operative complications like cerebrospinal fluid (CSF) gushers and facial nerve injury. Here, we would like to share the key points and pitfalls in dealing with challenging cases.

Roundtable 12

Revision Surgery
RT 12-5

REVISION SURGERY - ELECTRODE ISSUES

Neelam VAID

ENT, K.E.M. HOSPITAL, India

Proper electrode positioning into the scala tympani and complete insertion is critical for good outcomes after cochlear implant surgery. Literature has reported numerous publications related to issues with electrode placement. The electrode arrays may be misplaced either intralabrynthine or extralabrynthine. Electrode migrations and intracochlear electrode issues like tip fold over are also a surgical challenge.

Aim

To estimate the incidence of complications associated with the surgicalplacement of cochlear implant (CI) electrode arrays and to discuss theimplications and management of these complications.

Methods and material

Study design - Retrospective study
Study duration - 2006- present
Setting - Tertiary hospital
All patients operated since 2006

Results

Electrode related complications were seen in about 4.16 % but very few of them needed revision surgery.

Roundtable 12

Revision Surgery
RT 12-6

CI reimplantation in SNUH

Jun Ho LEE

Department of Otorhinolaryngology-Head and Neck Surgery, Seoul National University College of Medicine, Seoul National University Hospital, Korea

Since Dr. House first introduced the single-channel cochlear implant in 1961, cochlear implantation (CI) has seen groundbreaking advancements. Today, CI stands as a cornerstone in hearing rehabilitation for those with profound hearing deficits, and its clinical applications continue to diversify. With an increasing number of CI procedures, reimplantation rates are also on the rise. To put it in perspective, even if a cochlear implant's lifespan is two decades, a child may require 3 or 4 implantations throughout their lifetime. Predominantly driven by device failures, other factors of reimplantation range from wound infections and electrode misplacements, magnet translocation, and the drive to CI upgrade. The reimplantation rates vary between studies, reported as 3.8 - 9.3% for adults and 4.5 - 15.5%.

When approaching CI reimplantation, several key considerations emerge. First, the use of monopolar electrocautery is contraindicated, given its potential to damage both the cochlear nerve and the implant system. Second, when transitioning from an old to a new implant, the electrode should remain in place until the new one is ready, and the electrode size in reimplantation should ideally align with the previous one. Third, consideration should also be given to implant on the opposite side if complications arise. Notably, literature review suggests that reimplantation does not have negative effect to speech perception performance. Instead, predictive factors for reimplantation remain poorly understood.

Today, I will discuss CI reimplantation in SNUH. We have documented reimplantation rates at a cumulative 2.9%, with children accounting for 3.2% and adults at 1.9%. The causative etiologies encompass hard failures, soft failures, electrode displacements, magnet relocations necessitating reimplantation, and patients' elective preference for CI upgrade. A staggering 80% of cases were attributed to hard failures. The median interim between the first implantation and its replacement was approximately 51 months. While outcomes post-reimplantation are predominantly favorable, they do not guarantee significant improvements across all cases. It is imperative to note our results that reimplantation carries no additional risks, thus emphasizing its safety profile. However, otologists are compelled to judiciously appraise the indications and the prospective advantages of such procedures overall. I will conclude my talk with illustrative cases on reimplantation.

Roundtable 12

Revision Surgery
RT 12-7

Our experience with cochlear implant revision surgery

Mahmut Tayyar KALCIOGLU[1,2]

[1]Department of Otorhinolaryngology, Istanbul Medeniyet University, Istanbul, Türkiye
[2]ENT Clinic, Goztepe Prof. Dr. Suleyman Yalcin City Hospital, Istanbul, Türkiye

M. Tayyar KALCIOGLU[1 2], Serdal CELİK[1 2], Nazim Eymen TURAN[1 2], Numan Kokten[2], Julie KOSANER[3]

[1]Department of Otorhinolaryngology, Istanbul Medeniyet University, Istanbul, Türkiye
[2]ENT Clinic, Goztepe Prof. Dr. Suleyman Yalcin City Hospital, Istanbul, Türkiye
[3]MED-EL Company

Today, as the frequency of cochlear implant surgery increases, so does the rate of revision surgery. After nearly 500 cochlear implant surgeries, all performed by the same surgeon at our clinic, we have gained insight into the reasons for revision surgery and solutions. Since December 2008, the outcomes of patients who required revision after cochlear implant surgery at our clinic and patients who underwent cochlear implant surgery at different centres but were sent to our clinic for revision have been evaluated.

Of the 25 patients who required revision, 11 had undergone primary surgery at other centres. Revision cochlear implant surgery was performed in 22 of these patients. Re-implantation was performed in 19 patients. In the remaining 3 cases, in one patient the problem was solved by replacing the magnet i because the magnet had been displaced during magnetic resonance imaging (MRI). In the second case of implant housing migration, the problem was resolved by changing the position of the receiver in the scalp and reimplantation was not required. This patient's revision surgery will be shown in the video presentation during the roundtable. In the third patient, who underwent a partial petrosectomy where the external auditory canal was closed with a cull de sac, the electrode became visible in this area and the problem was resolved by strengthening the area with a cartilage graft without re-implantation. One patient with bilateral implants refused revision surgery in one ear. In one patient, where the magnet of the implant was displaced after MRI imaging, the problem was resolved by changing the pole of the magnet in the transmitter without the need for surgery. Revision surgery was performed in 2 of the 19 patients who underwent reimplantation due to receiver migration after recurrent infections. These patients were reimplanted. Two patients were found to have active electrode-related device failure, while 7 patients were found to have trauma-related damage. Device damage assessments for the remaining patients have not yet been completed. In all patients with traumatic damage, revision surgery revealed that new bone formation had almost completely covered the mastoidectomy site and the lead had passed through a tunnel in this new bone and advanced into the mastoid region.

The mean time from initial surgery to revision was 35.1 months (range 7-101 months). The revision rate was 2.9% (14/482) in patients who underwent primary surgery in our clinic. Similar to the literature, trauma and infection are the main causes of re-implantation in our clinical series.

In order to reduce the need for reimplantation due to trauma, it is predicted that research to reduce the possibility of traumatising the electrode by preventing new bone formation at the mastoidectomy site may help to solve the problem. Periosteal-preserving techniques may be useful to minimise local flap and infection problems.

Oral Presentation 08

OP 08-1

The Presence of Profibrotic Markers TGFβ-1 and CTGF following Cochlear Implantation

Adam Y XIAO[1], Ivan A LOPEZ[1], Gail ISHIYAMA[2], **Akira ISHIYAMA[1]**

[1]Head & Neck Surgery, University of California Los Angeles, USA
[2]Neurology, University of California Los Angeles, USA

Implantation of cochlear implants (CI) can cause insertion trauma and foreign body reaction resulting in intra-cochlear new tissue formation leading to increased impedance and spiral ganglion neuron death. Better understanding of this process can provide an opportunity for early intervention. Transforming growth factor beta-1 (TGFβ-1) plays an important role in fibrosis as well as osteogenesis and stimulates the expression of connective tissue growth factor (CTGF) which is involved in cell proliferation and fibrosis. Given the importance of TGFβ-1 and CTGF in fibrosis, the present study aims to characterize the expression of these proteins in the human implanted cochlea.

Human temporal bones (HTB) samples with CI and age-matched controls were used to characterize fibrosis and osteoneogenesis using H&E and expression of TGFβ-1 and CTGF using immunohistochemistry (IHC). qRT-PCR and IHC was also performed on intra-cochlear scar tissue and normal fascia collected from patients undergoing CI explantation and re-implantation.

A fibrous sheath with adjacent osteoneogenesis was found to surround the electrode path. The capsule was more prominent towards the modiolus. TGFβ-1 and CTGF were upregulated in CI HTB samples while there was minimal expression in healthy age-matched controls. Increased RNA and protein expression of TGFβ-1 and CTGF was also seen in intra-cochlear scar tissue compared to normal fascia. TGFβ-1 was diffusely expressed within the fibrous capsule of CI HTB while CTGF was primarily expressed in the region towards the modiolus. Finally, there was strong expression of both TGFβ-1 and CTGF at the junction between fibrosis and new bone formation.

To our knowledge, this is the first study to characterize the expression pattern of TGFβ-1 and CTGF in HTB and patient surgical samples with CI implantation. Increased expression of both profibrotic markers suggest their importance in new tissue formation and are promising candidates for future targeted therapy studies.

Keywords : Fibrosis, Neo-osteogenesis, Cochlear implant

Oral Presentation 08

OP 08-2

Individualized cochlear implantation – a new, longer electrode array to meet the need for patients with very long cochleae: first experience with a new 34 mm electrode

Andrea SCHREIER[1], Carmen MOLENDA[1], Sarah DRAUT[1], John-Martin HEMPEL[1,2], Veronika VOLGGER[1,2], Daniel POLTERAUER[1,2], Lena MERZ[3], Joachim MÜLLER[1,2]

[1]Otorhinolaryngology, Head & Neck Surgery, Lmu Klinikum, Munich University, Germany
[2]Section Otology and Cochlear Implants, Lmu Klinikum, Munich University, Germany3Clinical Engineering, Med-el, Germany

Introduction:
In cochlear implantation choosing the ideal electrode for each individual patient is crucial. It has been shown that there is a broad variation of the morphology of the cochlea, which can be estimated by the cochlear duct length (CDL). From our patients a relevant proportion is having a relatively long CDL. For better electrical coverage and matching, these patients would need a longer electrode than our "standard" electrode. To overcome imprecise tonotopic mapping, a 34 mm long electrode array was designed by MED-EL.
Purpose of the Study:
This study describes the first experience with the new FLEX34, including surgical experience, i.e. surgical handling, patients' characteristics and outcomes.
Methods:
At the time of writing, ten patients received a super long electrode. Patient characteristics, including audiometry results, were collected and CDL, angular insertion depth (AID) and cochlear coverage was calculated with the OTOPLAN software. Statistical analysis was conducted by computing the median and the interquartile range of the variables, mean and standard deviation respectively.
Results:
Based on the surgical techniques which are described with video clips, all patients had a full insertion. The median CDL was 38.4 mm with an interquartile range of [38.1 mm;40.2 mm]. The median cochlear coverage was 73,8% [71,2%;75,2%], the median AID was 663,8° [640,8°; 676,8°]. Postoperative vertigo was observed in one patient with simultaneous endolymphatic sac surgery. No other postoperative complications were observed (incomplete insertion, tip-foldover, kinking, vestibular symptoms). Speech understanding showed mean 65% monosyllables (SD +/- 20%).
Conclusion:
The FLEX34 is a logical step towards a more personalized cochlea implantation addressing the known variation of the CDL. When complying to landmark-based surgery it is an easy to handle, seemingly less traumatic electrode with good postoperative speech understanding.

Keywords : Personalized cochlea implantation, Cochlea duct length, FLEX34

Oral Presentation 08

OP 08-3

New Method to Estimate Cochlear Duct Length

Asma ALAHMADI[1], Yassin ABDELSAMAD[2], Anandhan DHANASINGH[3], Fida ALMUHAWAS[1], Abdulrahman ALSANOSI[1]

[1]Otolaryngology Head & Neck Surgery, King Abdullah Ear Specialist Center (kaesc), College of Medicine, King Saud University, Saudi Arabia
[2]Research Department,, Med-el Gmbh, Riyadh, Saudi Arabia, Saudi Arabia
[3]Translational Science Communication, Med-el Elektromedizinische Geraete Gesellschaft M.b.h., Innsbruck, Austria, Austria

Estimating insertion depth, cochlear duct length (CDL), and other inner ear parameters is vital to optimizing cochlear implantation outcomes. Most current formulas use only the basal turn dimensions for CDL prediction. In this study, we investigated the importance of the second turn in predicting CDL. Two experienced neuro-otologists blindly used segmentation software to measure cochlear parameters, including basal turn diameter (A), basal turn width (B), second-turn diameter (A2), second-turn width (B2), CDL, first-turn length, and second-turn length (STL). These readings were taken from 33 temporal bone computed tomography images of normal ears, collected at a tertiary center. We constructed regression models using A, B, A2, and B2 values fitted to CDL, STL, or two-turn length and five-fold cross-validation to ensure model validity. CDL, A value, and STL were longer in males than in females. The mean B2/A2 ratio was 0.91 ± 0.06 mm. Adding A2 and B2 values improved CDL prediction accuracy to 86.11%. Therefore, we proposed a new formula for accurate CDL prediction using A, B, A2, and B2 values. In conclusion, adding the second-turn parameters improve CDL and STL prediction and calculation, which may be detrimental to patient outcomes.

Keywords : Cochlear Implant, Cochlear Duct, Second turn

Oral Presentation 08

OP 08-4

Quantification of Brain-Derived Neurotrophic Factor in Human Spiral Ganglia Neurons Following Cochlear Implantation

Emily C WONG[1], Ivan A LOPEZ[1], Akira ISHIYAMA[1], Gail ISHIYAMA[2]

[1]Head and Neck Surgery, University of California Los Angeles, USA
[2]Neurology, University of California Los Angeles, USA

Background: Brain-derived neurotrophic factor (BDNF) is an important factor in the neuroprotection of afferent auditory pathways. In this study, we examined the quantification of BDNF following cochlear implantation (CI), hypothesizing that electrical stimulation following CI stimulates BDNF expression.
Methods: Archival human temporal bones from seven patients (ages 67-92 years) with a history of CI and five patients with hearing loss without CI (ages 38-92 years) were studied. Temporal bone specimens were immunoreacted (IR) with rabbit polyclonal antibodies against BDNF. In cases of unilateral CI, the contralateral unimplanted ear served as a control. Micrographs were acquired using a high-resolution digital camera coupled to a light microscope. Quantitative analysis of BDNF-IR in the SGN was made using ImageJ software. Statistical comparisons of IR in the SGNs between groups were made as follows: CI-IR vs. non-CI-IR (contralateral side), CI-IR vs normal-IR, and non-CI-IR vs normal-IR.
Results: BDNF IR localized to the SGN somata and the surrounding satellite cells in all specimens. Comparisons of BDNF-IR between CI and non-CI temporal bones showed that the protein expression of BDNF in the SGN was significantly increased in the implanted ear compared with the unimplanted ear ($p < 0.05$) and the cochlea from normal specimens ($p < 0.05$). Non-CI-IR vs. normal-IR was not statistically different ($p > 0.05$). BDNF protein expression in the SGN also increased in CI despite complete loss of the organ of Corti hair cells and supporting cells. Even in cases of CI with a 6 mm first generation electrode, BDNF expression was upregulated throughout the cochlea.
Conclusions: BDNF protein expression in the SGN appears to be upregulated by the electrical stimulation from CI. This study provides evidence that electrical stimulation from CI may stimulate BDNF upregulation, which may play a neuroprotective role in rehabilitating hearing in the deafened ear.

Keywords : Neurotrophins, Histology, BDNF

Oral Presentation 08

OP 08-5

Inner ear drug delivering

Manuel MANRIQUE[1], Raquel MANRIQUE[1], Marta ALVAREZ[1], Daniela PARELLI[1], Jose Antonio RODRIGUEZ[2], Diego BORRO[3], Freddy DUEK[4], Daniel SMYTH[4], Alec SALT[5]

[1]Otorhinolaryngology, Clínica Universidad De Navarra, Spain
[2]Physiopathology, Universidad De Navarra, Spain
[3]Engineering, Ceit, Spain
[4]Bioengineering, Cochlear, Belgium
[5]Otorhinolaryngology, Washington University School of Medicine, USA

Background: The method of drug delivery directly into the cochlea with an implantable pump connected to a CI electrode array ensures long-term delivery and effective dose control.
Purpose :Develop a model of inner ear pharmacokinetics of an implanted cochlea, with delivery of Fluorescein isthiocyanate-Dextran, in non-human primate model.
Methods: Design a preclinical cochlear electrode array (CI HL14DD, manufactured by Cochlear Ltd.) attached to an implantable peristaltic pump filled with FITC-Dextran was implanted unilaterally in 15 Macaca fascicularis (Mf). Three groups were created (5 Mf in each group), according to three different drug delivery times: 2 hours, 24 hours and 7 days. Perilymph (10 samples, 1µL each) was sampled from the apex of the cochlea and measured after extraction with a spectrofluorometer. After scarifying the specimens, x-Rays and histological analysis were performed.
Results: FITCDextran quantification showed different patterns, depending on the delivery group. In the 2 hours group, an increase in FITC-Dextran concentrations over the sample collection time, reaching maximum concentration peaks (420-964µM) between samples 5 and 7, decreasing in successive samples, without returning to baseline. The 24-hours and 7-days groups showed even behavior throughout the 10 samples obtained, reaching a plateau with mean concentrations ranging from 2144 to 2564 µM and from 1409 to 2502µM.
Conclusions: An infusion time ranging from 2 to 24 hours is required to reach a maximum concentration peak at the apex. It establishes then an even concentration profile from base to apex that is maintained throughout the infusion time in Mf. Flow mechanisms during injection and sampling may explain such findings may involve cochlear aqueduct flow and the possible existence of substance exchange from scala tympani to extracellular spaces, such as the modiolar space or the endolymphatic sinus, acting as substance reservoir to maintain relatively flat concentration profile from base to apex during sampling.

Keywords : Inner ear, Cochler implant, Macaca fascicularis

Oral Presentation 08

OP 08-6

Cochlear implantation: Predicting the scala tympani volume of the pediatric recipients

Marzouqi SALAMAH[1], Yassin ABDELSAMAD[2], Asma ALAHMADI[1], Abdulrahman ALSANOSI[1]

[1]Bdullah Ear Specialist Center (kaesc), College of Medicine, King Saud University, Riyadh, Saudi Arabia, Saudi Arabia
[2]Rresearch Department, Rresearch Department, Med-el Gmbh, Riyadh, Saudi Arabia, Saudi Arabia

Objectives: The main aim of this study was to estimate the volume of the Scala Tympani (ST) of our pediatric cochlear implant (CI) recipients from the computed tomography (CT) images. Then, to study the association between ST volume and both demographic characteristics and cochlear parameters.
Methods: A retrospective study on the CT scans of pediatric CI patients at a tertiary referral CI center. Congenital or acquired cochlear defects were excluded. Two reviewers, with the same level of experience, blindly measured the main cochlear parameters and studied its anatomy. Then, the interrater reliability was tested to measure any differences between the two readings. After that, the ST volume of the included patients was calculated and analyzed. Furthermore, the correlations between the main cochlear parameters and ST volume were studied to propose a formula for estimating the ST volume from the cochlear duct length (CDL).
Results: The mean predicted ST volume among our pediatric CI recipients was 38.51 ± 5.54 µl (range; 24.47–52.57 µl). The statistical analysis revealed that all cochlear parameters (A, B, H, and CDL values) could be significant predictors of the ST volume (p=<0.0001).
Conclusion: The main cochlear parameters along with the CDL are positively linked to the ST volume. There are considerable differences in cochlear size and scala tympani volume among our pediatric population. These findings confirm the importance of pre-operative planning for proper electrode array selection.

Keywords : Cochlear implant, Scala tympani, Cochlear duct length, Cochlear volume, Temporal bone

Oral Presentation 08

OP 08-7

Evaluation of intracochlear pressure and distribution rate during fluid application in cochlear models and human petrous bone

Rayoung KIM[1], Matthias SCHUERMANN[1], Holger SUDHOFF[1], Ingo TODT[1]

[1]*Department of Otolaryngology, Head and Neck Surgery, Medical School Owl, Bielefeld University, Campus Mitte, Germany*

distribution in the cochlea, including formation of a concentration gradient. Furthermore, atraumatic performance is a particular challenge when applying substances in the context of inner ear therapy, as the volume of the perilymph is limited and intracochlear pressure change may affect residual hearing. The aim of this study was to compare different techniques of substance application and their effects on intracochlear pressure and substance distribution in different models.

Material and Methods: Substance distribution rate was evaluated and intracochlear pressure was measured using fiberoptic pressure sensors in artificial cochlear models (unfolded cochlear model and cochlear model) and in human temporal bone. In all models, substance application was performed using an Inner Ear Catheter (MED-EL) via the round window with methylene blue-stained saline and with and without a second access to the cochlea (helicotrema / oval window). Pressure measurement was performed via an additional burr channel or the lateral arcade. Perforation for connection of a catheter and pressure sensor as well as for creation of a second access was performed by a 0.4 mm perforator.

Results: The application of substances showed a significant difference in the distribution rate under same application velocity between the two-hole and single-hole technique. Furthermore, there was a significant difference in intracochlear pressure between the single-hole technique and the two-hole technique. Additional optimization of application sealing led to a homogenization of the results.

Conclusion: In addition to a faster homogeneous distribution, a lower intracochlear pressure is shown when using a two-hole technique.

Keywords : Inner ear therapy, Intracochlear application, Inner ear catheter

Oral Presentation 09

OP 09-1

Geometric Analysis of Cochlear Scalae Using Synchrotron Radiation Phase-Contrast Imaging

Ashley MICUDA[2], Hanif LADAK[2], **Sumit AGRAWAL**[1]

[1]*Department of Otolaryngology - Head & Neck Surgery, Western University, Canada*
[2]*Department of Medical Biophysics, Western University, Canada*

Background: The geometry of cochlear scalae is highly important to cochlear implantation. However, previous measurements and analyses have been limited in their ability to measure cochlear scalae accurately in intact cochleae, particularly in the apical most regions. By utilizing synchrotron radiation phase-contrast imaging (SR-PCI) to produce computed tomography (CT) scans of intact cadaveric cochleae, detailed discernment of both bone and soft tissue can be achieved in three-dimensions. The objective of this study was to obtain measurements of cochlear scalae using SR-PCI scans, and to relate these measurements to cochlear implant geometry.

Methods: SR-PCI CT scans were obtained of 35 fixed, intact cadaveric human cochleae. In each SR-PCI scan, the cochlear scalae were segmented (i.e. labelled) and reviewed by an expert observer. Using a semi-automated algorithm developed to automatically rotate through reformatted mid-modiolar CT slices, measurements of the scala tympani and scala vestibuli were obtained at each angular depth from the centre of the round window to the helicotrema. At each angular depth, the largest inscribed circle and the cross-sectional area of the respective scalae were measured.

Results: At 180°, 360°, 540°, and 720°, the mean diameter of the largest inscribed circle in the scala tympani was 0.88 mm, 0.85 mm, 0.70 mm, and 0.58 mm, respectively.

Conclusion: SR-PCI CT scans were used to obtain accurate measurements of cochlear scalae through the entire length of cochleae. The resulting measurements can be related to cochlear implant insertions at each angular location.

Keywords : Scala tympani, Cochlear implant, Imaging

Oral Presentation 09

OP 09-2

Dexamethasone-Eluting Cochlear Implant Electrode - Final Results of the First-in-Human Study

Thomas LENARZ[1], Rolf SALCHER[1], Andreas BUECHNER[1], Daniel KLEY[1], **Nils PRENZLER[1]**

[1]Department of Otolaryngology and Head and Neck Surgery, Hannover Medical School, Germany

Objectives
The development of dexamethasone (DEX)-eluting cochlea implant (CI) electrodes may provide an option to achieve prolonged local exposure of the cochlea to the substance along the entire scala tympani. The current focus of the use of dexamethasone (DEX) is to suppress the inflammatory reaction and foreign body response in order to minimize fibrous tissue growth.
Methods
A total of 9 patients were implanted with a dexamethasone - eluting cochlea implant electrode and then followed up over the postoperative course, the first fitting and for 9 months afterwards (n=8). The primary objective of this study was to investigate the safety profile through the analysis of adverse events. Furthermore, electrode impedances, unaided pre- and post-op pure tone audiograms, speech intelligibility in noise and the surgeon's subjective feedback were evaluated.
Results
Handling and insertion properties were considered almost identical compared to non-eluting electrodes of the same manufacturer by experienced surgeons. No serious device or procedure-related adverse events occurred throughout the complete follow-up period. Final results show remarkable low and stable impedance values across all areas of the electrode (basal, medial and apical). Very good preservation of residual hearing (≤15 dB hearing loss) was achieved in the majority of patients.
Conclusions
The use of the new dexamethasone - eluting electrode was safe and led to considerably lower impedances and better hearing preservation compared to results of our clinic from this electrode without a dexamethasone coating.

Keywords : Cochlear Implant, Drug-Eluting Electrode, First-in-Human Study

Oral Presentation 09

OP 09-3

The Impact of Patient Factors on Objective Cochlear Implant Verification Using Acoustic Cortical Auditory-Evoked Potentials

Caris BOGDANOV[1,2], Wilhelmina H.a.m. MULDERS[1], Helen GOULIOS[1], Dayse TÁVORA-VIEIRA[2,3]

[1]School of Human Sciences, University of Western Australia, Australia
[2]Department of Audiology, Fiona Stanley Fremantle Hospitals Group, Australia
[3]Division of Surgery, Medical School, University of Western Australia, Australia

Hearing loss has a significant impact on quality of life, communication, cognition, social participation, and mental health. Cochlear implants (CIs) are the most effective treatment for severe-to-profound hearing loss. However, outcomes vary widely among CI users. Our previous research showed that subjective CI programming is not consistent in producing optimal stimulation for speech perception, limiting the potential for maximum device benefit. We found that measuring auditory-evoked cortical responses to speech stimuli objectively improved speech perception performance. In this study, we investigated the impact of patient- and device-specific factors on the use of acoustically-evoked cortical auditory-evoked potential (aCAEP) measures as an objective clinical tool to verify CI mapping in adult CI users with bilateral deafness (BD).We recorded aCAEP responses to four speech tokens using binaural peripheral auditory stimulation in adult BD CI users. Participants were classified into groups according to subjective or objective CI mapping procedures to elicit present aCAEP responses to all four speech tokens. We investigated the impact of patient and device-specific factors on the presence of aCAEP responses and speech perception between participant groups. The cohort of adult CI users (n=132) demonstrated no significant correlation between patient and device-specific factors and the presence of aCAEP responses or speech perception scores.This study highlights that aCAEP measures offer an objective, non-invasive approach to verify CI mapping, irrespective of patient or device factors. These findings contribute to our understanding of personalised CI rehabilitation through CI mapping to minimise the degree of speech perception variation post-CI and allow all CI users to achieve maximum device benefit.

Keywords : Cochlear Implant, Cortical Auditory-Evoked Potentials, Objective Mapping Procedures

Oral Presentation 09

OP 09-4

Music List for Rehabilitation of Cochlear Implant Users: A Practical Guide for Clinicians

Jonghwa Jeonglok PARK[1], Wonwoo LEE[1,2], Jiyeon HA[1], Jeong Mi PARK[1,3], **Byung-Yoon CHOI[4]**

[1]Research Institution, Bell Therapeutics Inc., Korea
[2]Music Technology, Korea National University of Art, Korea
[3]Department of Musicology, Seoul National University, Korea
[4]Otorhinolaryngology, Seoul National University Hospital, Korea

Traditional clinical practice encourages patients with cochlear implants (CIs) to experience a diverse range of sounds, including music, after surgery. Yet, specific guidance on the types of music that would best aid rehabilitation has been absent. This study suggests a 'Music List', specifically designed for the auditory rehabilitation of CI users, based on characteristics of their auditory perception mechanisms. This list's composition is arranged based on previous studies on music and speech perception in CI users. We hypothesized that the progression from simpler to more complex musical pieces enhances CI users' accessibility to musical experiences and appreciation. This 'Music List' could be used as a tool for clinicians and therapists, and provide frameworks for rehabilitation. While evaluation of the impact of this list remains for future investigation, its development marks a substantial advancement towards offering practical tools and guidelines for musical experiences in clinical sites. Consequently, it holds the potential to amplify auditory enjoyment and overall quality of life for individuals using cochlear implants.

Keywords : Music lists, Aural rehabilitation, Open source

Oral Presentation 09

OP 09-5

Prediction of Early Lexical Development on Later Language Outcomes in Children with Cochlear Implants

Min WANG[1], Jianfen LUO[1], Jinming LI[1], Xianqi LIU[1], Dianzhao XIE[1], Xiuhua CHAO[1], Ruijie WANG[1], Zhaomin FAN[1], Haibo WANG[1], **Lei XU[1]**

[1]Department of Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital, Shandong University, China

[Objective] This study intends to investigate whether the lexical development of Mandarin-speaking children with cochlear implants (CI) at one year post activation can predict their later language outcomes by tracking their language development after the activation of CI.
[Methods] In this study forty-one CI children were selected as subjects, and the age of CI activation was (1.39±0.38) years. The receptive and expressive vocabulary were assessed using the Infant Checklist of the Early Vocabulary Inventory for Mandarin Chinese (EVI) at one year post-activation(T1). In addition, the expressive vocabulary sizes were assessed using EVI- Toddler Checklist, and the syntactic ability was measured by the Mean length of three longest utterances (M3L) and the Grammatical Complexity test of the Mandarin-Chinese Communicative Developmental Inventory for Infants and Toddlers at two years post-activation (T2).
[Results] Results showed that the CI children's receptive vocabulary size was 151.51±54.92, and the expressive vocabulary size was 82.07±65.35 at one year post-activation. The expressive vocabulary size was 447.88±177.41, the M3L was 5.93±2.49 words and the Grammatical Complexity score was 35.76±13.26 at two years post-activation. Correlation analysis shows that there was significant positive correlations between the receptive or expressive vocabulary at T1 and each scores at T2 ($P < 0.01$). In multiple regression analysis, T1 receptive vocabulary size had significant predictive effects on T2 vocabulary size, M3L, and Grammatical Complexity ($P < 0.01$), but T1's expressive vocabulary size had no significant predictive effect on the three tests at T2.
[Conclusion] The CI children's lexical level at one year post-activation can predict their later language abilities, which including vocabulary size, M3L, and Grammatical Complexity. Therefore, intervention efforts should be strengthened for children whose early language development lags behind, to prevent further delay of their language development.

Keywords : Cochlear Implant, Children, Language ability

Oral Presentation 09

OP 09-6

Can 1-3-6 principals be real?: Results in South Korea

Son A CHANG[1], Sujin SHIN[2], Ji Min KIM[1], Ye Rim SHIN[1], Young-Myoung CHUN[1]

[1]Soree Rehabilitation Center, Soree Ear Clinic, Korea
[2]Department of Communication Sciences and Disorders, University of Redlands, USA

Infant hearing protection protocol has been known as 1-3-6 benchmark: screening completed by 1 month, audiological diagnosis by 3 months, and enrollment in early intervention by 6 months. This timeline has not been met worldwide even though it is advocated by many countries. In Korea, newborn hearing screening started at 2009 and has been nationally implemented since 2018. Choi et al., (2022) reported that about 97% of total birth completed new born hearing screening within one month, however, only 4.3% performed audiologic diagnosis within three months nationally. This leads to some research questions: how long audiologic diagnosis would be delayed to after three months? what would be complete rate for enrollment in early intervention by 6 months? What are the challenges and possible solutions to the current situations? In this study, we studied the achievement of Soree Ear clinic in Korea and analyzed hearing related factors affecting this timeline.

The average age of audiological diagnosis was 4.9 months and 32% of the babies completed audiological testing by 3 months. The average age of intervention initiation was 6.4 months and 37.7% of the babies started intervention by 6 months. Additional Pearson's correlations between hearing related factors and timelines (audiological testing age, hearing aids fitting age, Auditory Verbal (AV) rehabilitation age, AV rehabilitation decision) showed that earlier audiological testing is significantly correlated with earlier hearing aids fitting ($r=0.74$, $p<0.001$) and earlier AV age ($r=0.36$, $p=0.03$). Also, location of hearing testing was correlated with hearing aids fitting age ($r=41$, $p=0.01$), AV age ($r=0.48$, $p=0.004$), and types of hearing loss ($r=0.33$, $p=0.01$). AV rehabilitation decision was related to AV location ($r=0.59$, $p<0.001$).

1-3-6 infant hearing protocol timeline can be realistic with systematic infant hearing care program with skillful early interventionists specialized in otology, hearing, listening and spoken language, and music.

Keywords : Infant hearing, 1-3-6 principals, Early intervention

Oral Presentation 09

OP 09-7

Parent Coaching in Telepractice: "What Questions Are We Asking Our Parents?"

Kai Shuo CHO[1], **Basyariatul Fathi OTHMAN[2]**

[1]Hospital Tunku Ampuan Besar Tuanku Aishah Rohani, National University of Malaysia, Malaysia
[2]Faculty of Health Science, National University of Malaysia, Malaysia

An essential part of parent coaching is the therapist asking the parent the right questions to elicit responses that help enhance the coaching process. However, in the context of listening and spoken language intervention for children with hearing loss, there is limited research on defining and identifying the questions used by therapists during parent coaching. This study delves into the issue of questions posed to parents by their therapist and is aimed at identifying and analyzing the coaching questions during tele practice sessions. A total of 10 tele practice sessions conducted by a therapist were analyzed. Analysis included quantifying the frequency of questioning and identifying the questions asked. Coders were qualified speech-language therapists (SLTs) who were trained to code videos specifically for this study. Rush (2014) Reflective Coaching Questions were adopted to guide the viewing and identification of the coaching questions. For questions that did not fit the criteria of any of Rush's question types, the authors generated their own coaching question types.

The video analyses revealed that several types of questions more regularly occurred during the coaching sessions. Questions that were regarded as "more engaging" and other Rush's highly recommended questions occurred less. These findings are not entirely surprising given that past studies on parent-professional relationship in Malaysia have shown a more family-allied model of practice, rather than a family-centered one. Therefore, in the country's context, parent coaching and more specifically coaching questions may not have been the standard practice within the therapy sessions. This study highlights the need for more targeted training of parent coaching for SLTs to deliver effective intervention. The importance of parent coaching knowledge and skills is beyond the realm of tele practice alone and is likewise needed in 'offline' or physical listening and spoken language intervention. The implications of these findings are discussed.

Keywords : Professional-parent interaction, Tele practice, Parent coaching

Oral Presentation 10

OP 10-1

The Healthy Hearing Ears Initiative - Changing the treatment paradigm for patients with chronic otitis media related hearing loss

Byung-Yoon CHOI[1], Rafael JARAMILLO[1], Kelvin KONG[1], Jaydip RAY[1], Alok THAKAR[1], Myrthe HOL[1], Douglas BACKOUS[1], Thomas LENARZ[1]

[1]*Steering Committee, Healthy Hearing Ear, Korea*

Study Purpose
Chronic otitis media (COM) is a leading cause of acquired hearing loss and hearing rehabilitation strategies must accompany infection control in surgical planning. To evaluate current state of clinical evidence an international Steering Committee of eight ENT surgeons were gathered in the Healthy Hearing Ears Initiative. A systematic literature review and a registry study have been conducted to assess the current success rates and cost of tympanoplasty in closing the air-bone gap in patients with COM. Additionally, a narrative review was published providing direction of future research efforts.
Materials and Methods
A systematic literature review of publications from 2008-2018 identifying 1175 publications of which 39 met the inclusion criteria. A registry study of patients with COM-related hearing loss in western Sweden identifying 656 patients followed from 2014-2018. A narrative review uncovering several barriers to optimal care in patients with COM.
Results
The systematic literature review showed that tympanoplasty was successful in closing the air-bone gap to within 20 dBHL in 70% of patients, with 443 complications in 3162 patients resulting in an overall complication rate of 14%. Our registry study show that 656 patients made 13,783 health care contacts at a total cost of 60 million EUR between 2014 and 2018. Further review uncovered no standardized pathway for planning hearing restoration after surgery for COM with or without cholesteatoma, and that AAO-HNS reporting guidelines are not routinely followed.
Conclusions
Our review of the aural rehabilitation paradigm including hearing outcomes and cost utility measures reveals a non-standardized treatment pathway. Generating clinical evidence supporting evidence-based best practices in patients with COM-related hearing loss with or without cholesteatoma should be prioritised.

Keywords : Chronic Otitis Media, Hearing loss, Treatment pathway

Oral Presentation 10

OP 10-2

Analysis of Newborn Hearing Screening Results in South Korea after National Health Insurance Coverage: A Nationwide Population-Based Study

Kyu Young CHOI[1], Su-Kyoung PARK[1], Sun CHOI[1], **Jiwon CHANG**[1]

[1]*Department of Otorhinolaryngology-head and Neck Surgery, Hallym University Kangnam Sacred Heart Hospital, Korea*

Newborn hearing screening (NHS) has been covered by national health insurance since October 2018 in Korea. However, the results of the NHS are not reported due to the absence of a follow-up tracking system. This study analyzed the status and the predicted referral rates of NHS after the Korean national health insurance coverage by analyzing the National Health Insurance Service database in 2019 and 2020. The NHS coverage was 91.7% of total birth in 2019 and 92.1% in 2020. The predicted referral rate of NHS calculated by the duplicated NHS cases was 1.05% in 2019 and 0.99% in 2020. However, another predicted referral rate calculated by the number of diagnostic auditory brainstem responses (ABRs) performed was 1.44% in 2019 and 1.43% in 2020. The first NHS was performed within one day of birth for 96.5% of the babies and within three days of birth for 97%. However, diagnostic ABR was adequately performed within three months of birth for only 4.3%, while 82.3% performed the test after six months which delays appropriate intervention for hearing loss. National support such as national coordinators, follow-up tracking, and data management systems are needed for early hearing detection and intervention of newborns and infants in Korea.

Keywords : Hearing, Neonatal screening, Newborn

Oral Presentation 10

OP 10-3

Difficult Situations in Cochlear Implantation

Rohit MEHROTRA

Otorhinolaryngology, Mehrotra Ent Hospital, Kanpur, India

Cochlear implantation is a relatively new procedure, which has already had significant impact on the lives of many profoundly deaf children and adults, in providing useful hearing to those unable to benefit significantly from hearing aids. Expanding selection criteria and increasing numbers of cochlear implantations have revealed several challenging cases with regard to surgery and medical point of view. Cochlear implantation of congenitally deaf children with inner-ear malformations may involve difficulties in preoperative evaluation, surgical approach and postoperative follow-up. In the earlier days of the field of implantation, cochlear malformations and ossification were considered a contraindication to surgery. However, subsequent refinements in the understanding of microanatomy and pathophysiology, earlier ages of diagnosis, refinements in radiographic evaluations, electrode design, processing strategies, and advanced surgical techniques have allowed cochlear implantation to significantly benefit patients previously considered inoperable.

Keywords : Congenitally deaf children, Cochlear malformations, Ossification

Oral Presentation 10

OP 10-4

Evaluation of the impact of cochlear implantation on patients' working life: a cross-sectional study

Yüksel OLGUN[1], Mehmet Emin ARAYICI[2], Armağan INCESULU[3], Ülkü TUNCER[4], Enis Alpin GÜNERI[1], Hülya ELLIDOKUZ[5], Levent OLGUN[6]

[1]*Department of Otorhinolaryngology, Faculty of Medicine, Dokuz Eylul University, Türkiye*
[2]*Department of Preventive Oncology, Institute of Health Sciences, Dokuz Eylul University, Türkiye*
[3]*Department of Otorhinolaryngology,, Faculty of Medicine, Osmangazi University, Türkiye*
[4]*Department of Otorhinolaryngology,, Acıbadem Hospital, Adana, Türkiye*
[5]*Department of Preventive Oncology, Institute of Oncology, Dokuz Eylul University, Türkiye*
[6]*Department of Otorhinolaryngology, Faculty of Medicine, Başkent University, Türkiye*

Purpose: This paper aimed to evaluate the employment, workplace adaptation, productivity, and professional success of individuals who have hearing loss and whose hearing loss is rehabilitated with a cochlear implant.
Methods: A total of 142 participants with severe hearing loss who were rehabilitated with a cochlear implant were included in this cross-sectional study. The ethical approval of the study obtained from Dokuz Eylul University Non-Intervational Research Ethics Commitee. Data were collected between November 2022 and February 2023. The survey method was used to collect data for the study. The questionnaire consisted of 32 questions and was distributed to the participants online. In the first part of the questionnaire (1-10 questions), general characteristics of implant patients were investigated. In the second part (11-32 questions), the positive or negative effects of implantation on the work life of the participants were evaluated. The chi-square test and Fisher exact test were used in the analysis of the data.
Results: Almost half of the research group (49.3%, n = 70) consisted of women, and the mean age of the participants was determined to be 35.89±14.80. There was no significant difference between gender, educational status, implanted side, working time, working style (physical, desk), and factors affecting work life ($p > 0.05$). Professional satisfaction and success at work increased significantly more in those with acquired hearing loss ($p = 0.010$). Post-implantation workplace compliance, success, and productivity were found to be higher in those with acquired hearing loss ($p = 0.013$). It was observed that hearing loss had a greater negative impact on the work life of married people ($p = 0.006$).
Conclusions: Cochlear implantation greatly enhances work place satisfaction, increases self-confidence, and positive expactation for the future of profoundly deaf individuals.

Keywords : Cochlear implants, Work-life, hearing-loss

Oral Presentation 10

OP 10-5

CIICA Conversations: Learning from people with CI and families on the Living Guidelines Project

Helen CULLINGTON[1], Sue ARCHBOLD[2], Leo DE RAEVE[2], Brian LAMB[2]

[1]Auditory Implant Service, University of Southampton, UK
[2]Cochlear Implant International Community of Action, Association Internationale Sans But Lucratif (aisbl), Belgium

Objectives
There is a huge global gap between the numbers of people who have cochlear implants (CI) and those who need them. CIICA, the Cochlear Implant International Community of Action, was established in 2021 as a network focussed on advocacy for the provision of CI and lifelong services. CIICA was asked to provide the user and family voice to influence the Living Guidelines project, which is aimed at addressing the significant under-provision of CI for adults. The guidelines will help ensure that those who need CI have a consistent pathway for access and care.
Methods
Four CIICA Conversations were held between September and December 2022. CIICA Conversations are one hour long, with a maximum of 20 participants, are not recorded, and are live captioned. The transcripts of the facilitated Conversations were analysed, summarised, and circulated for agreement.Results 37 people from 20 countries took part. Some key themes for people with CI and families were:
- CI needs to be part of the lifelong hearing journey
- Family and person-centred care is vital for best outcomes
- Regular mapping and rehabilitation is necessary for progress and often not provided
- Ongoing funding is a major issue, which is often not made clear prior to CI
- Peer groups have a key role prior to and after CI
- Outcome measures need to reflect functioning and changes in everyday life. For adults with CI, impact on quality of life is more important than speech perception.

Conclusion
Participants in the Conversations were enthusiastic about the potential of the Living Guidelines to improve CI services and about looking at how they could use the guidelines to improve awareness, access, and provision. They were keen to support their implementation and wanted accessible resources to use in advocacy work.

Keywords : Adults, Advocacy, Awareness

Oral Presentation 10

OP 10-6

Cochlear implantation in Australia: annual number of implants in children and adults since 2021, and uptake rate.

Catherine SUCHER[1,2], **Robert EIKELBOOM[1,2,3,4]**, Sandra BELLEKOM[1,2,3], Marcus ATLAS[1,2,3]

[1]Brain and Hearing, Ear Science Institute Australia, Australia
[2]Medical School, The University of Western Australia, Australia
[3]Curtin Medical School, Curtin University, Australia
[4]Department of Speech Language Pathology and Audiology,, University of Pretoria, South Africa, Australia

Background and purpose: All episodes of cochlear implantation surgery have been routinely reported by public and private hospitals in Australia since 2020. This study reports on these data by age and year, and an estimate of the uptake of cochlear implants.
Data sources: (i) Australian Institute for Health and Welfare's Procedure Codes for implantation data (by age, sex and year). (ii) Australian Bureau of Statistics population data to determine the rate of implantation per age group. (iii) Population data of prevalence of the severity of hearing loss in Australia for estimates of implant uptake rate. Adults were defined as those over the age of 14 years.
Results: Overall implantations increased from 162 adult and 127 paediatric implantations in 2000/2001, to 1260 and 365 respectively in 2020/2021. The greatest growth in implantations were in those in the 75 to 84 years age group. However, there has been a plateauing in the annual number of adult implantations since 2015/2016. Furthermore, a peak of 458 paediatric implantations in 2012/2013, was followed by a noticeable steady reduction to about 365 in 2020/2021.The 20-year uptake rate of cochlear implants by individuals with severe to profound hearing loss is estimated to be between 11.1% and 13.3%, based on two available estimates of bilateral implantation (22.2% and 6.7%).
Discussion and conclusion: The annual increase in number of cochlear implants could be expected as cochlear implantation became normalised in clinical practice and as the criteria for implantation in Australia broadened over time. The plateau in numbers of adults implanted, despite the uptake rate still being low, may be due to barriers in the referral process, and funding in some states. The plateau and drop in number of children being implanted may be due to a reduction in children born with or developing severe to profound hearing loss.

Keywords : Uptake rate, Public health, Epidemiology

Oral Presentation 11

OP 11-1

Long-term educational and occupational status of prelingually deaf children who have received a cochlear implant and the effect of speech perception ability on these outcomes

Yeonjoo CHOI[1], Yun Ji LEE[1], Hye Ah JOO[1], Woo Seok KANG[1], Joong Ho AHN[1], Jong Woo CHUNG[1], **Hong Ju PARK[1]**

[1]Department of Otorhinolaryngology Head & Neck Surgery, Asan Medical Center, Korea

Cochlear implants (CI) in deaf patients not only improve hearing, but also help build an educational and professional career. Few studies however have reported on the education and occupation status of prelingually deaf children with a CI. We wanted to investigate the long-term educational and occupational status of prelingually deaf children who received a CI before the age of 7, and to identify factors that influence these outcomes.

This retrospective cohort study included 71 prelingually bilateral deaf young children. Primary outcomes included the latest education and occupation status, and the latest word recognition score (WRS). The mean age at the time of surgery was 3.9 years and the mean current age was 22.4 years. The age at the time of surgery showed a negative linear correlation with the WRS. All the study subjects had graduated from high school or obtained an equivalent educational qualification. General high school graduates (n=54) showed a higher WRS than those who attended a special education high school (n=7). The college entrance rate of the CI patients (74.6 %) was comparable to that of the general population (70.4 % in 2019 and 72.5 % in 2020) and the subjects who went to college had a significantly better WRS than those who did not (51.4% vs 19.3%). Excluding the 30 subjects currently enrolled in college, 26 of the remaining 41 were currently employed and engaged in various vocational activities, of which most were employed through vocational training institutes, or via special recruitment policy for the disabled. The remaining 5 subjects obtained employment through general recruitment.

The long-term use of CI in prelingual deaf children enables not only speech perception but also produces comparable levels of education and employment to those of the general population. A good WRS and supportive policy were related to these successful outcomes.

Keywords : Pediatric, Education, Occuptation

Oral Presentation 11

OP 11-2

CSF leak etiology and management: our experience

Andrei LILENKO[1], Vladislav KUZOVKOV[1], Serafima SUGAROVA[1], Victoria TANASCHISHINA[1]

[1]Hearing Restoration, St. Petersburg Ent Research Institute, Russia

Objective: to share our experience in CSF leak etiology and management in pediatric patients. Methods: in the period from 2018 to 2022, 1965 patients underwent CI, of which 83 were patients with cochlea malformations (65 intraoperative CSF leaks), 14 with the temporal bones fractures (2 intraoperative CSF leaks), while 3 spontaneous intraoperative CSF leaks were noted in patients with normal cochlea anatomy and hyperpnumotized temporal bone pyramid and enlarged vestibular aqueduct.

Results: on the preoperative stage the type of electrode was chosen according to the individual features of the CT findings.

Surgical tactic in most cases was as following: wide posterior tympanotomy, wide opening of the round window membrane if it could be visualized (or cochleostomy, if not), electrode insertion, automuscle packing, intraoperative Rg if needed (all IP-III cases and ambiguous ARTs).

The highest risk of intraoperative CSF leak was observed in patients with inner ear malformations (common cavity – 10/10, IP-III - 15/15). Moderate risk of intraoperative CSF leakage was typical for patients with IP-I (15/22 patients) and IP-II (25/36 patients).

In cases of frank facial nerve interposition or labyrinth rotation combined approach was applied (5 cases). In 4 patients electrodes with seal-technology was chosen to pack the cochleostomy. In cases of spiral canal ossification standard rigid electrodes were used to ease obliteration bypassing and achieve complete insertion.

Conclusion:

CSF leak is quite challenging intraoperative feature of CI. Despite being commonly spread in patients with inner ear malformations it could be also revealed in cases of temporal bone fractures and even in patients with normal cochlea anatomy and hyperpneumotized temporal bone pyramid and enlarged vestibular aqueduct.

Keywords : CSF leak, Inner ear malformation, Temporal bone CT

Oral Presentation 11

OP 11-3

Study of Migration of Cochlear Implant Device Using Tight Pocket Technique

Rayan Kamal ALHUSSINI

Orl Ngha, Pmbha, Saudi Arabia

Objectives: To investigate stability of cochlear implant using sub-periosteal tight pocket fixation technique. Methods: A retrospective chart review was performed on 66 implanted ears (34 unilateral, 16 bilateral patients) randomly selected for a second postoperative mastoid X-ray. The position of the internal receiver was compared with the original position from the X-ray taken on the second day postoperatively. Patients were assessed at least six months postoperatively by means of mastoid X-rays. The imaging results were first evaluated by two experienced otologist & cochlear implant surgeons followed by an otologist who was blinded to the aim of the study.
Results: The majority of implanted ears (61/66 or 92.4%) demonstrated no migration of the implanted receiver. Minor changes in position did not affect the postoperative speech rehabilitation program (no issues with device use or attachments to the implant). Five cases showed severe posterior migration which was not associated with severe complication of the external component of the device and its function.
Conclusion: Using a method to create a tight sub-periosteum pocket fixation is a safe way to ensure the correct and stable positioning of a cochlear implant's internal receiver in pediatric age group.

Keywords : Cochlear implants, Surgical technique, Sub-periosteum pocket

Oral Presentation 11

OP 11-4

Implantation in ossified cochlea - surgeon's groundwork and clinical outcomes.

Rajika RAMAKRISHNAN[1], Mohan KAMESWARAN[1], Sathiya KAMALESAN[1]

[1]*Otorhinolaryngology, Madras Ent Research Foundation, India*

Introduction: A frequent surgical challenge faced by an Implantation otologist is in an ossified cochlea. It is neo-ossification within the cochlea following initial insult due to infection, otosclerosis, autoimmune disease, trauma. It is now well accepted that the implantation benefits such patients. We share our experience with cochlear implantation in ossified cochlea, the surgical techniques in different severity of ossification and the postoperative performance results.
Aim: To study the etiology of ossification in our patients, review the surgical techniques and postoperative performance of implantation in patients with the ossified cochlea.
Methods and objectives: A retrospective study done in Tertiary hospital. Patients who underwent cochlear implantation for profound hearing loss due to ossified cochlea between 1997-2022 were included in the study. Computerized tomography and magnetic resonance imaging were used to diagnose ossification. Surgical choice such as standard procedure for CI, second turn cochleostomy, double electrode array insertion out was chosen based on individualized needs of cases. Intraoperative impedance, auditory response, electrically evoked stapedial reflex testing was done in all cases, brain stem response assessment was done as and when required. Post operative patients underwent intensive functional habilitation program during which they were evaluated for their postoperative performance.
Results: Total of 61 cases were included in the study. The most common cause of ossification was post meningitis labyrinthine ossification followed by otosclerosis. Scala tympani insertion by standard approach was possible in 52 cases. Other techniques of second turn insertion were done in 6 cases, split electrode insertion done in 2 cases. Intraoperative ART, EESR was done, which were confirmatory of intracochlear position of the electrodes. The post operative performance after CI was satisfactory.
Conclusion: Implantation has to be individualized based on preoperative imaging and intraoperative findings. Early implantation has to be stressed upon and counselling regarding realistic expectation is vital.

Keywords : Cochlear implantation, Cochlear ossification, Surgical technique

Oral Presentation 11

OP 11-5

Feasibility of Round window exploration in normal and abnormal anatomy for cochlear implant surgery – Our Experience

Subbarayudu YARLAGADDA[1], **Sailaja TIMMARAJU[2]**

[1]Ent, Rr Specialty Hospital, India
[2]Education & Training, Med-el, India

Introduction:
A crucial step of cochlear implant (CI) surgery is to arrive at round window (RW) while preserving critical structures - facial nerve and chorda tympani. Anatomical variations in different individuals pose different challenges in locating RW in normal and abnormal cases. Our goal is to outline route explored by us for arrival at RW easily in different cases with same precision.
Objectives:
1. To present our experience in RW exploration during CI surgery.
2. To highlight three major triangular landmarks which guide during RW exploration
3. To highlight importance of visual axis to identify RW position

Method:
Patients with bilateral severe to profound hearing loss with functional auditory nerve that underwent CI surgery at our hospital were selected for this study.

Position of patient and exploring triangular spaces during mastoidectomy and posterior tympanotomy are important steps to delineate RW.
1. Shoulder pillow placed to get extension of neck between 20–30-degree. Rotation of head towards opposite side 90 degree for optimal visual axis.
2. Triangular landmarks: Exploration of mastoid cortex done in triangular fashion - modified drilling technique.
3. Posterior epitympanic triangle: Space lateral to body of incus is explored for facial recess size estimation. Patient's head is again adjusted to 60-70 degree away from surgeon to drill triangular space in facial recess.
4. Triangular Facial recess: Once herald cell is identified, facial recess is drilled to identify the promontory. The visual axis is then adjusted to see RW niche through the facial recess by angling the head of patient.
5. Total RW area is visualized with stapedius tendon with IS joint superiorly and sub cochlear area inferiorly, base of pyramid posteriorly, medial end of posterior bony wall of EAC anteriorly.

Results & Conclusion: Following these steps gave us surgical precision for RW exploration in our cases.

Keywords : Round window exploration, Facial nerve, Structure preservation

Oral Presentation 11

OP 11-6

COCHLEAR IMPLANTATIONS IN INNER EAR MALFORMATIONS

Sudhir Sakharam KADAM

Ent, Yashashri Ent Hospital & Cochlear Implant Centre, India

Dr. Sudhir S Kadam ; Yashashri ENT Hospital Cochlear Implant Centre, Miraj, India.
Aim - To report surgical challenges during cochlear implant surgery in children with Inner Ear malformations Setting - Tertiary referral ENT Hospital
Study design - Retrospective case series
Materials & Methods : 235 cochlear implant surgeries done at Yashashri ENT Hospital, Miraj from January 2018 to June 2022. Types of inner ear anomalies, intra - operative findings, surgical management strategies and choice of electrode were analyzed.
Results : Out of 235, inner ear malformations were seen in 25 (10.7 %) children. The anomalies included isolated enlarged vestibular aqueducts in 2 (8%), isolated semicircular canal dysplasia in 3 (12%) children, classical Mondini malformation (IP II) in 11 (44%) , and other cochlear malformations in 9 (36%) children. No difficulty was encountered in location of round window and cochlea. Fifteen (60%) children exhibited intraoperative cerebrospinal fluid (CSF) gushers, which were sealed completely. One child was considered for prophylactic lumbar drain. One child had recurrence of minor CSF leak on 3rd day, which was completely subsided on 10th with medical line of management. One child had abnormally located facial nerve on promontory. We used electrodes from three manufacturers (Med El ,Cochlear, Advanced Bionics) with Form Electrodes from Med El for IP I/II/III. Thirteen (53%) insertions were done via round window while rest twelve (47 %) were managed via cochleostomy. Complete electrode insertion was achieved in all cases. NRT were satisfactory in all except in two children with IP I.
Conclusion Cochlear implantation for inner ear anomalies can be performed safely. Radiological evaluation, surgical expertise, various electrode options along with parental counselling for expected complications and limited outcomes is must.

Keywords : Cochlear implant, Inner Ear malformations, Surgical challenges

Oral Presentation 11

OP 11-7

A SUMMARY OF 24 YEARS OF COCHLEAR IMPLANT SURGERY AT EAR NOSE THROAT HOSPITAL HO CHI MINH CITY

Tu Quang NGUYEN[1], Minh Tran Quang LE[1], Vinh Thanh NGUYEN[1], Thai Minh KHUU[1], Phu Duc NGUYEN[1], Thuy Thi Thanh NGUYEN[1], Huy Thanh PHAM[1], Vu Anh DUONG[1]

[1]Neurotology & Audiology Departments, Ho Chi Minh City Ear Nose Throat Hospital, Viet Nam

Objectives: Evaluation the outcomes and sharing clinical experiences of cochlear implant surgeries from 1998 to 2022.
Methods: Retrospective case series, 659 patients receiving cochlear implantation from 1998 to 2022 at Ear Nose Throat Hospital, Ho Chi Minh City.
Results: 659 patients receiving cochlear implantation with no gender difference; the majority of patients (58.4%) are at the age from 2 to 5; 76 cases with anatomical abnormalities of the inner ear, accounting for 11.5%; 86.5% of patients receiving cochlear implantation for one ear (right > left). After surgery, all patients achieved good results (75.7% patients with CAP > 4 points).
Conclusions: Cochlear implant surgeries which are indicated in patients with severe and profound hearing loss, including those with anatomical abnormalities of the inner ear, provide access to the world of sound and social communication.

Keywords : Cochlear implant surgery, Sensorineural hearing loss, Abnormalities

Oral Presentation 12

OP 12-1

Difficult visualization of round window in cochlear implantation

Hassan Ali ALSHEHRI

Ear Nose and Throat, King Salman Hospital, Saudi Arabia

The first effective cranial nerve stimulator that is used to restore hearing in adults and children with sensorineural hearing loss, and hence , the cochlear implant is most widely implantable hearing device.The advances in cochlear implant technology reflected on surgical approach (electrodes , receiver , coating , material)
The approach for cochlear implantation often depends on individual patient anatomy and surgeon preferencefacial recess approach for cochlear implant (CI) surgery (stander technique), as described by House, has been the most used worldwide
Current reports of facial nerve injury during facial recess surgery for CI show a consistent rate of less than 1%, with several studies reporting a rate of 0.7%
Many alternative approach proposed to over come fear of facial nerve complications
Examples of these alternative approach:
Suprameatal approach
Transcanal wall approach
Stander mastoidectomy with trans-facial recess approach turn to be the safest and less complications compare to other approaches
Both round window insertion and cochleostomy are widely used for implantation, however, debate exists on the optimal approach
There are variability in the anatomy of the round window.(shape, height, width, bony overhang)This may create difficulty for round window visualization.
I will discuss in my presentation how to overcome this difficulty and how to make visualization more , and how to predict difficulty preoperatively.

Keywords : Round window, Cochlear implantation, Visualization

Oral Presentation 12

OP 12-2

Intra Operative and Post Operative Complications and its Management in Cochlear Implant Surgery-Review of 600 Cases

Rajesh Yogeshwar VISHWAKARMA[1], Kalpesh Bhagubhai PATEL[2], Krishna POTDUKHE[2]

[1]*Ent and Head - Neck Surgery, Apollo Hospital International, India*
[2]*Ent, B.j.medical College, India*

Objective: To study and analyze the Incidence of intra Operative and Post Operative surgical complications and their management.
Method: Retrospective Review 600 cochlear implantations was done for the study. The age rangewas between 18 months and 60 years.
Result: Of the 600 patients taken in study 57 (9.9%) had Cochleo-Vestibular Malformations. Cytomegalovirus (CMV) being the most common non genetic cause of congenital hearing loss accounting to 60%.
The Intra operative complication observed were - Intraoperative CSF Leak being 2%, Incomplete Insertion 0.83 %,Chorda Tympani Injury 0.5 %, Dural Tear 0.16 % and Button Hole in Posterior Canal Wall 0.33 % And the Post Operative Complications Observed were Facial Palsy 1.16%, Haematoma 1%, Wound Infection and Gapping 0.5 %, Retraction Pocket/Cholesteatoma 0.33%
All these Complications were managed Medically/Surgically and their Outcomes & limitations discussed
Conclusion: The analysis of the results shows that in the best of hands there is possibility of Complications But the Complications can be managed and the patient can benefit the Cochlear Implant.
The Complications can be minimized with regular Pre Operative Planning with Radiological Findings and Surgical training on Temporal Bones

Keywords : Cochlear Implantation, Facial Nerve, Complications

Oral Presentation 12

OP 12-3

Mycobacterial ear infections and cochlear implantation

Wong-Kein Christopher LOW

Novena Ent Head Neck Surgery, Mount Elizabeth Novena Medical Centre, Singapore

Although ear infections caused by mycobacterium are uncommon, it has great relevance in the context of cochlear implantation.
Firstly, mycobacterial otitis media can cause sensori-neural hearing loss. Cochlear hair cell damage may result from the disease itself or from ototoxic side effects of the medications used to treat the infection. The disease can potentially destroy bony structures or involve the cochlear lumen causing luminal obliteration, especially in advanced disease. These sequelae can negatively impact cochlear implantation should one be indicated. Early diagnosis is therefore important but unfortunately, the disease is frequently diagnosed late. The pitfalls in the management of mycobacterial otitis media will be discussed with examples.
Secondly, cochlear implantation may be complicated by a post-operative mycobacterial wound infection. Controlling such an infection is indeed challenging which ultimately, will likely require an explantation. Prevention is therefore key in the management of this complication. A case study of a patient with post-cochlear implant wound infection caused by mycobacterium abscessus will be presented to highlight the challenges in its management and how it can be prevented.

Keywords : Cochlear implant, Surgical issues, Infection

Oral Presentation 12

OP 12-4

Parents' Language Does Matter for Young Children with Cochlear Implants: Focus on The Quantity and Quality of Parental Linguistic Input

Dayea LEE[1], Youjin LEE[2], **Youngmee LEE[3]**

[1]Speech Language Therapy, Won Psychology Development Center, Korea
[2]Department of Psychiatry, Prume Foundation Nexon Children's Rehabilitation Hospital, Korea
[3]Department of Communication Disorders, Ewha Womans University, Korea

Purpose:
Children with cochlear implants (CIs) have an auditory deprivation period before implantation and inconsistent access to speech, which may impact their language development. Given that children with CIs are more at risk for language difficulties than children with normal hearing (NH), parents must efficiently provide their linguistic input to enhance their child's language development. Therefore, this study aimed to investigate the effects of parental linguistic input on children's language skills in children with CIs and to identify the relationship between the quantity and quality of parental linguistic input and language skills in children with CIs.
Method:
Sixteen children with CIs, between 12 and 33 months of age, participated in this study. The children were median split into children with faster and slower language development groups based on their language development. We collected parents' utterances through a parent-child interaction task. We analyzed the quantity of parental linguistic input (number of total words, NTW; number of total utterances, NTU) and the quality of parental linguistic input (number of different words, NDW; mean length of utterances, mlu-m).
Results:
NTW was significantly correlated with expressive scores in children with CIs. NDW was significantly correlated with expressive and receptive scores in children with CIs. Moreover, NDW was a significant factor in language skills in children with CIs. Additionally, there was a significant difference in NDW between the faster language development and the slower language development groups.
Conclusion:
Parents with the faster language development group tended to use more diverse words with their children than those with the slower language development group. For children with CIs, parental vocabulary diversity is vital in developing vocabulary skills. These findings suggest that early intervention programs should be designed to enable parents to use more diverse vocabulary in daily routines to build their child's language skills.

Keywords : Parental linguistic input, Young children with cochlear implants, Language development

Oral Presentation 12

OP 12-5

A Multicentre Paediatric Implanted Recipient Observational Study (P-IROS): A unified approach to gather evidence to support cochlear implant decision making

Dell KINGSFORD SMITH[4], Lei XU[1,2], Chongxian YU[3], Ruiji WANG[1,2], Jianxin QUI[3], **Colleen PSARROS[4]**

[1]Department of Otolaryngology and Head and Neck Surgery, Shandong University, China
[2]Department of Auditory Implantation, Shandong Ent Hospital, China
[3]Department of Otolaryngology and Head and Neck Surgery, The First Affiliated Hospital of Anhui Medical University, China
[4]Medical Affairs, Cochlear Asia Pacific, Australia

Purpose
The Paediatric Implanted Recipient Observational Study (P-IROS) provided a unified platform to evaluate the impacts of cochlear implantation (CI) on children with severe to profound hearing loss. The multinational study aimed to identify factors influencing educational placement, quality of life and speech reception following CI.
Method:
This prospective, longitudinal observational study included children aged <10 years from multiple sites worldwide. Clinicians and parents/caregivers entered data directly to a multi-lingual e-platform. Data included evaluations of auditory performance (Category of Auditory Perception -CAP II; Speech Spatial Qualities – SSQ). Health utility and quality of life measures were standardised and non-standardised. Data were collected up to 2 years post implantation, and optionally up to 5 years.
Results:
Baseline data was collected for 1138 subjects from 31 clinics across 9 countries. In this voluntary registry, patient follow-up was 55% (631) at 1 year, and 22% (250) of the baseline sample remaining at 3 years. Children were mainly bimodal devices users. Mean age at implant was 3.2±2.2 years (range 0-10).Auditory performance (CAP II) was superior post implant with continued improvement for up to 3 years ($p<0.001$). SSQ scores improved specifically, Speech ratings increased incrementally over 3 years ($p=0.03$). Overall quality of life scores improved and the impact of hearing loss on the family was reduced up to year 3 ($p\leq0.001$). The proportion of children in full time mainstream school with no additional support increased overtime. By year 3, 52% of children were in mainstream school with no support.
Conclusion:
Mainstream educational placement with no support was achievable for most of the children, including those implanted at an older age. Quality of life for the child and the wider family improved. Future research could focus on the impact of mainstream school placement on children's academic progress, including measures of academic attainment and social functioning.

Keywords : Longitudinal observations, Mainstream education, Quality of life

Oral Presentation 12

OP 12-6

Shifting from family to child-centred practice - Flexible models of implant programming to facilitate independence and agency in children with hearing loss.

Katie NEAL[1,2], Joanna MCADAM[1], Pia WATKINS[1,2]

[1]Reseach and Clinical Innovation, The Shepherd Centre, Australia
[2]Linguistics, Macqaurie University, Australia

Background: One aim of intervention for children and adolescence is to maximize their independence and participation in the community, yet the goals for intervention are commonly driven by caregivers and the therapy team. The current structure of clinical appointments such as cochlear implant programming provides limited opportunity for children and adolescence to play an active role. Other professions such as Occupational Therapy focus on client-centred practice, which has been linked to improved rapport, outcomes and the establishment of stable relationship between the therapist and the client. Understanding the implications of current therapy and intervention models on social and emotional development is critical.
Methods: Mixed-method qualitative and quantitative pilot of guided cochlear implant programming (n=50). Thematic analysis of focus groups and interviews data from participants, parents and clinicians combined with review of standard listening and assessment data.
Results: Changes to programming methods provided unique and valuable insights into the capacity and ability of children and adolescence to contribute and guide programming. The data analysis illuminates the potential benefits to outcomes and quality of life for paediatric clients and families and professionals when a shift to a more client-centred approach is introduced.
Conclusions: Paediatric clients, ranging from birth to 18 years of age all have a range of strengths and insights into their experience and require strategies for care that respect them as such. As such, the intervention and care should include them in a "working alliance" with the rest of the clinical team and the family. It also highlights the need for capacity building of professionals to have the confidence in engaging in a partnership with paediatric clients and not only the adults in the care team.
Learning Outcomes: To understand the benefits flexible models of clinical care in supporting independence and agency in children and adolescents with hearing loss.

Keywords : Person Centred, Implant Programming, Flexible care

Oral Presentation 12

OP 12-7

The Marvel Sound Processor in everyday life situations

Martina BRENDEL[1], Anne MUELLER[1],
Laure ARNOLD[2], **Patrick BOYLE[1]**

[1]European Research Center, Advanced Bionics Gmbh, Germany
[2]Clinical Research, Advanced Bionics Sarl, France

Background
New sound processors are introduced onto the market periodically by cochlear implant (CI) manufacturers. When this happens it is useful to conduct a clinical evaluation that involves: new CI recipients, CI recipients experienced with an older generation sound processor and the clinicians who fit the new processor. Such an evaluation was made for the Marvel CI sound processor through a multi-national study that focused on real-life listening situations.
Method
Three groups were formed across 10 different countries. There were 372 recipients with at least 3 months of Marvel experience, 73 upgraded within the past 6 weeks and 79 experienced audiologists. All completed an online questionnaire, Parents completed paediatric questionnaires. The experienced group focused on their hearing impression while the upgraded group made a comparison with their previous sound processor. The clinicians shared their thoughts on both hardware and fitting software.
Results
Participants used a rating scale of 0 to 10, with 10 being the best rating. For 351 complete responses from experienced users (94%), the median rating for conversation in a car was 8, in a small group was 8, in noise was 7 and in quiet was 9. Overall median satisfaction (N=347) was rated at 9. The recently upgraded group, N=73, reported significantly more use of streaming when listening to phone calls ($p=0.005$) and to music ($p=0.037$). Hearing ability for N=70 (96%) was rated as significantly better compared to the previous sound processor ($p<0.01$).The top three system features for 74 (94%) clinicians were from first to third: NoahLink wireless fitting, bimodal fitting in the same TargetCI software and a training mode. The Autosense automatic classification program was fitted for 89% of adult and 68% of paediatric recipients.
Conclusion
Speech understanding in various environments was rated strongly for the Marvel CI, as was wireless steaming and wireless fitting.

Keywords : Sound processor, Real-life evaluation, Multi-center survey

Oral Presentation 12

OP 12-8

Initial outcome measures of anatomy-based fitting method among experienced, adult cochlear implant users.

Pelden WANGCHUK[1,2], **Cila UMAT**[1], Foong Yen CHONG[1], Faizah Mohd ZAKI[3], Asma ABDULLAH[4], Nur Baizura SALAHUDDIN[5]

[1]Center For Rehabilitation & Special Needs Studies, Faculty of Health Sciences,, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia
[2]Audiology Unit, Department of Otorhinolaryngology,, Jdwnr Hospital, Moh, Thimphu, Bhutan
[3]Department of Radiology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia
[4]Department of Otorhinolaryngology-head & Neck Surgery, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia
5Hearlife Centre Sdn. Bhd, Med-el Office, Kuala Lumpur, Malaysia

Objective:
Anatomy-based fitting (ABF) is a relatively new cochlear implant fitting method, introduced to minimize frequency-to-place mismatch due to electrode insertion placement. This study aimed to quantify the initial outcome measures of the ABF maps as compared to normally used default conventional-based fitting (CBF) maps, among experienced, adult cochlear implant (CI) users.
Methods:
Eight experienced, adult MED-EL CI systems involving nine ears, with a mean of 3.20 ± 1.20 (range:1.08 to 4.41) years of CI experience participated in the study. All participants underwent a post-operative computed tomography scan to calculate the angular insertion depths (AID). The ABF method adjusts the center frequency of the electrode bands based on the AID information. Participants were tested with CBF maps before providing an ABF map. Outcome measures included vowel identification scores in quiet and 5dB signal-to-noise ratio, frequency discrimination thresholds at 500 to 4000 Hz, and subjective maps ratings for speech understanding, listening comfort, and map preferences. The outcome assessments of ABF maps were taken at an average of 24.4 ± 11.28 (range:17 to 54) days after fitting the new experimental ABF map.
Results:
Paired sample t-test revealed that vowel identification scores were significantly higher ($p<0.05$) in ABF than CBF maps in both test conditions, with ABF showing more advantages for speech in noise. Frequency discrimination thresholds (Δf) showed no significant difference, however, smaller Δfs at 1kHz and 2kHz for ABF maps were observed. Changes in Δf at 2kHz were negatively correlated with vowel identification scores in noise ($p<0.01$). Subjectively, preference ratings for ABF maps were significantly higher ($p=0.01$) than CBF. Correlation analysis revealed that larger shifts in the frequency table resulted in less preference for the ABF maps.
Conclusion:
Initial results suggest ABF map could potentially be an option to improve speech in noise, at least among experienced adult CI users.

Keywords : Anatomy based fitting (ABF), Conventional based fitting (CBF), Center for Rehabilitation & Special Needs Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, MalaysiaSpeech in noise

Oral Presentation 12

OP 12-9

Cochlear Implant initial Fitting: Anatomy-based versus Standard Frequency Map

Uwe BAUMANN[1], Marten GEISEN[1], Tobias WEISSGERBER[1], Timo STOEVER[2], Silke HELBIG[2]

[1]*Ent - Audilogical Acoustics, Goethe-university Frankfurt, Germany*
[2]*Ent, Goethe-university Frankfurt, Germany*

Background: Potential reason for poor sound quality of CIs is the current "one size fits all" allocation of frequency bands to electrode contacts. Therefore, a customized mapping of frequency has been developed (anatomy-based fitting, ABF) that relies on determination of exact electrode position post surgery. To exclude habituation effects, a prospective study on ABF with randomized cross-over design was initiated.
Material & Methods: Participants are randomly assigned to two study arms. One group is initially fitted with the manufacturer's standard map (SMP) and the other group with an ABF approach. After 3 months of experience, a change is made to either the standard or ABF map for a further period of 3 months. After 6 months, all participants receive programming with both mapping alternatives for another period of three months. During this time, patients are allowed to switch between the two mappings to determine their preferred setting. At the different test intervals, speech perception in quiet (Freiburg Monosyllables, FMS) and with background noise (Matrix Sentence Test, MST) are performed. Subjective hearing quality is evaluated with the SSQ questionnaire. Participants were implanted with Synchrony 2 devices (MED-EL, Innsbruck, Austria). Currently, 3 Flex26, 22 Flex28 and 11 FlexSoft cases have been recruited.
Results and observations: FMS was 55% and 47,5%, MST SRT 2,0 dB and 1,6 dB in the SMP-group (N = 12) and ABF-group (N = 10). SSQ total score was 3,92 (SMP) and 5,41 (ABF), 3 months interval. After 6 months, median FMS was equal 65% in both groups, median MST SRT was 1,95 dB and -0,6 dB in the SMP- and ABF-group.
Conclusion: With the results collected so far, no clear advantage of the ABF in speech perception scores could be observed after 3 months of experience. A tendency towards better quality scores in the ABF group was observed.

Keywords : Mapping, Anatomy based fitting, Individualized rehabilitation

Oral Presentation 12

OP 12-10

Cochlear implantation in patients with advanced otosclerosis

Piotr Henryk SKARZYNSKI[1,2,3,4], Marek POROWSKI[1], Andrzej PASTUSZAK[1], Lukasz PLICHTA[1], Aleksandra KOLODZIEJAK[1], Henryk SKARZYNSKI[1]

[1]*World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland*
[2]*Heart Failure and Cardiac Rehabilitation, Faculty of Dental Medicine, Medical University of Warsaw, Poland*
[3]*Institute of Sensory Organs, Institute of Sensory Organs, Poland*
[4]*University of Maria-curie Sklodowska, University of Maria-curie Sklodowska, Poland*

Background:
Severe forms of otosclerosis can lead to profound hearing loss, in which stapedotomy will not be effective. Cochlear implantation should be considered in these cases. In far-advanced otosclerosis it could be a challenge because of the alteration of anatomy of cochlea. The aim of the present study was to assess the effectiveness of cochlear implantation in patients with far-advanced otosclerosis one year after surgery.
Material and Methods:
The study group was 17 patients (15 women, 2 men) with far-advanced otosclerosis who had cochlear implantation. Their mean age was 52 years, mean duration of deafness was 23 years. All of them had undergone at least one operation on the implanted ear. All patients had computed tomography before surgery. Pure tone audiometry and speech audiometry were performed before and after surgery.
Results:
Pre-operative hearing threshold for air conduction (0.5, 1, 2, 4 kHz) was on average 109.6 dB HL (SD=12.3), for bone conduction it was 71.4 dB HL (SD=4.4). Tinnitus was perceived by 76.5% of the patients before surgery. Post-operative speech recognition score was on average 66.2% in quiet and 42.3% in noise. Facial nerve stimulation was present in one patient.
Conclusion:
Cochlear implantation in far-advanced otosclerosis may be effective method of treatment. Satisfactory auditory outcomes and low rate of surgical complications support the use of cochlear implantation for those patients.

Keywords : Otosclerosis, Cochlear implants, Adults

Oral Presentation 12

OP 12-11

Telmesani Radiological Classification of the Location of the Vertical Segment of the Facial Nerve: Impact on Surgical Approach in Cochlear Implant Surgery

Laila Mohamed TELMESANI

Ent, Iau, Saudi Arabia

Objective:
This study was conducted to establish a radiological classification of the location of the vertical segment of the facial nerve (VSFN) and to see if this has implications on the surgical technique needed to access the round window niche (RWN) in cochlear implant (CI) surgery.
Study Design:
Observational case series study.
Setting:
Tertiary referral center.
Patients:
One hundred twenty seven patients underwent CI surgery, and high resolution computed tomography (HRCT) of 140 temporal bones was studied. The data that were collected consisted of the patient's age, sex, radiological inner ear malformations (IEM), and the surgical technique used to access the RWN.
Main Outcome Measures:
The radiologic location of the VSFN in relation to the lateral semicircular canal in the coronal plane of HRCT and its implication on the surgical approach used to access the RWN in CI surgery.
Results:
A statistically significant association is present between the radiological location of the VSFN and the surgical approach used ($p < 0.001$).
There was insignificant correlation between the locations of the VSFN and the patient's age, sex, and IEM as the $p > 0.05$.
Conclusions:
On HRCT (0.6 mm) in the coronal plane, the position of the VSFN in relation to the lateral semicircular canal is correlated with the alternative approaches that must be taken during CI surgery.

Keywords : Facial nerve, Cochlear implant surgery, CT scan temporal bone

Oral Presentation 12

OP 12-12

Preoperative CT imaging for the prediction of difficult round window access in cochlear implant surgery - A systematic review

Dhana Senthil KUMAR[1], Jun Wei SIA[1], Heng Wai YUEN[2], **Jia Hui NG[3]**

[1]Yong Loo Lin School of Medicine, National University of Singapore, Singapore
[2]Department of Otorhinolaryngology, Changi General Hospital, Singapore
[3]Department of Otorhinolaryngology, Singapore General Hospital, Singapore

INTRODUCTION: Temporal bone computed tomography (CT) imaging is commonly performed before cochlear implant (CI) surgery. Other than evaluation of the inner ear structures, preoperative imaging allows surgeons to anticipate cases where anatomical variations and pathologies may result in difficult round window access. At present, numerous studies describing various methods to predict for difficult round window access via pre-operative CT have been published. This study aims to perform a systematic review of these methods.
METHODOLOGY: Online databases MEDLINE, Embase, Cochrane, and PubMed were screened for relevant peer-reviewed journal articles. Inclusion criteria were designed to capture studies that explored use of pre-operative CT imaging in the assessment of round window accessibility in CI surgery. Of 593 studies reviewed across 4 databases, 25 studies met the inclusion criteria (4.22%). Studies were screened by two reviewers and unique methods for pre-operative assessment were extracted, collated and reviewed.
RESULTS: 45 unique methods were collated from 25 independent studies. Methods were classified into 5 categories based on means of prediction: A: Distance/Width/Length (n=18) , B: Angle (n=12), C: Relative location/prediction line (n=7) D: Direct observation (n=6) E: Others (n=2). 38 described methods have one or more existing studies all demonstrating statistical significance in the prediction of difficult round window access, whilst 7 methods have differing conclusions across studies and 7 methods showed no statistical significance.
CONCLUSION: There is an abundance of preoperative assessment methods available in literature but there has been no prior studies evaluating these methods together in a systematic review. There may be utility in a hybrid approach whereby multiple methods are used in conjunction to increase validity and accuracy in predicting round window accessibility pre-operatively with CT, as no one method appears to yield superior results across all studies.

Keywords : Round Window Access, Cochlear Implant, Computer Tomography

Oral Presentation 12

OP 12-13

Cochlear Implantation in Pediatrics: The Effect of Cochlear Coverage

Noura ALOTHMAN[1], **Fida ALMUHAWAS[2]**,
Reem BADGHAISH[2], Al Hanouf ALOTAIBI[2],
Salman ALHABIB[2], Farid ALZHRANI[2], Abdulrahman HAGR[2]

[1]Health Communication Sciences, College of Health and Rehabilitation Sciences-audiology, Princess Nourah Bint Abdulrahman University, Saudi Arabia
[2]King Abdullah Ear Specialist Center (kaesc), College of Medicine, King Saud University., Saudi Arabia

The effect of insertion depth and position of cochlear implant (CI) electrode arrays on speech perception remains unclear. This study aimed to determine the relationship between cochlear coverage and speech performance in children with prelingual hearing loss with CI. Pure tone audiometry (PTA) and speech audiometry, including speech reception threshold (SRT) using spondee words and speech discrimination score (SDS) using phonetically balanced monosyllabic words, were tested. The Categories of Auditory Performance (CAP) and Speech Intelligibility Rating (SIR) scales were also used. Thirty-one ears were implanted with the FLEX 28 electrode array, and 54 with the FORM 24 were included in the current study. For the studied ear, the mean cochlear duct length was 30.82 ± 2.24 mm; the mean cochlear coverage was 82.78 ± 7.49%. Cochlear coverage was a significant negative predictor for the mean pure tone threshold across frequencies of 0.5, 1, 2, and 4 kHz (PTA4) ($p = 0.019$). Cochlear coverage was a significant positive predictor of SDS ($p = 0.009$). In children with cochlear coverage ≥ 82.78%, SDS was significantly better than in those with coverage < 82.78% ($p = 0.04$). Cochlear coverage was not a significant predictor of the SRT, CAP, or SIR. In conclusion, the cochlear coverage of the CI electrode array has an impact on the users' SDS. Further long-term studies with larger sample sizes should be conducted to address the most critical factors affecting CI recipients' outcomes.

Keywords : Cochlear implantation, coverage, speech perception, speech discrimination test, Pure tone audiometry

Oral Presentation 12

OP 12-14

Management of cochlear implant site infection and extrusion without implant removal

Ghanaym Sultan ALMAZROUEI[1], Mondy HAMMAD[1],
Rana ALKATHEERI[2]

[1]Otolaryngology, Ssmc-mayo Clinic, United Arab Emirates
[2]Otolaryngology, Tawam Hospital, United Arab Emirates

Intro: We report our experience in the management of patients with cochlear implants complicated by cochlear implant site infection. Wound infection after cochlear implant surgery is the most common non-device related complication.Infection in presence of foreign body can lead to biofilm formation.The presence of biofilm is thought to be responsible for the failure of medical and surgical treatment that necessitates implant removal to control infection . The management of cochlear implant site infection using the novel method mentioned in the article can constitute an effective and reliable option to salvage cochlear implants without having to remove the implant as a first line management.
Method: Over 800 cochlear implants surgery have been done in our center. We had a total of 5 cases of wound breakdown and implant exposure and infections.All of them had functioning implants prior to surgery. Surgery was indicated for all the cases due to skin necrosis and tissue loss, which is likely due to implant exposure.These cases rarely heal without surgery. The aim of the surgery was to remove and debride the infected skin and deep tissue, perform an implant translocation far from the incision line, create a vascularized flap to cover the implant and removal of the biofilm by replacing the old magnet with a new one and partially filling the socket with antibiotic powder (vancomycin powder in our cases) to prevent recurrence of infection. After that, the whole implant surface including the receiver stimulator and magnet areas would be filled with the antibiotic powder.
Results: All the patients did well without any signs of reinfection of the implant site. Patients continued to use the implant postoperatively without any decrease in performance. Most patients were followed up for more than 3 years post surgery and are still doing well with no signs of reinfection.

Keywords : Cochlear implant site infection, Post cochlear surgery infection, Cochlear implant

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Posters

Abstract Book

Genetics: Diagnosis/ Prediction

PP 001

Bilateral cochlear implants in a MELAS patient

Yung-Chen SUN[1,2], Xiang-Xiang CHEN[1,2], Pey-Yu CHEN[1,2], Chia-Huei CHU[1,2], **Hung-Ching LIN[1,2]**

[1]Otorhinolaryngology Head and Neck Surgery, Mackay Memorial Hospital, Taiwan
[2]Audiology and Speech-language Pathology, Mackay Medical College, Taiwan

Introduction: Mitochondrial encephalopathy, lactic acidosis, and stroke-like episodes (MELAS) is a mitochondrial disease that is completely inherited maternally and affects many systems in the body, especially the brain, nervous system, and muscles. Among them, sensorineural hearing loss is a common additional symptom with a prevalence of 30%-75%.
Case presentation: This paper mainly presents a 40 Y/O MELAS female patient with bilateral profound deafness receiving bilateral cochlear implants.
Discussion: The patient showed good post-1st CI results, with speech perception test for spondee words score of 95% and MMRT monosyllable word score of 76% in three months after CI. Furthermore, she underwent a 2nd CI for the other ear after the 1st CI two months later.
Conclusion: Consequently, she demonstrates that cochlear implants in MELAS can get well speech perception and improvement of communication in daily life very soon.

Keywords : MELAS syndrom, Cochlear implants, Mitochondrial disease

Genetics: Diagnosis/ Prediction

PP 002

Precision medicine of hereditary hearing loss – the diagnostic rate of whole-exome sequencing

Yi-Lu LI[1,2], Peng-Chieh CHEN[2], **Jiunn-Liang WU[1]**

[1]Department of Otolaryngology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Taiwan
[2]Institute of Clinical Medicine, College of Medicine, National Cheng Kung University, Taiwan

Purpose: Hereditary hearing loss (HHL) is the most common inherited sensory deficit in newborns and children. The genetic causes of HHL can be identified efficiently through next-generation sequencing (NGS). Given that the phenotype of HHL varies widely and the efficacy of cochlear implant (CI) depends on the causative gene of hearing loss, the genotype-phenotype mapping enables physicians to predict disease progression and to plan treatment. Here we aim to establish a multidisciplinary genetic testing platform for patients with HHL.

Methods: We conducted whole exome sequencing (WES) to identify the causative genes of HHL cosegregated with the disease phenotype in non-consanguineous families. After conducting variant calling of bioinformatics, the results were validated with Sanger sequencing and in silico analyses for functional prediction. The diagnostic rate of WES between prelingual and postlingual HHL were also compared.

Results: From 2020 November to 2023 March, 36 pathogenic variants were identified in 40 probands and their relatives from 26 families, including novel variants in MYO15A, CDH23 and TMC1. 22 probands were prelingually deafened and 18 developed hearing loss postlingually. 10 patients who received CI had all discovered their pathogenic genes, and all showed good efficacy of CI related to their etiology. The most common type of mutation was missense (73.6%), followed by frameshift (11.3%) and splicing (11.3%), and nonsense (3.8%). 15 patients had compound heterozygous mutations, while 6 patients carried homozygous and 11 carried heterozygous mutations. Autosomal recessive inherited gene variants accounted for 90% of prelingual HHL, while most of postlingual HHL were inherited autosomal dominantly. The overall diagnostic rate was 82.5%, and prelingual HHL yielded higher diagnostic rate compared to postlingual HHL (95.5% and 66.7%, $p < 0.001$).

Conclusion: WES provides the advantage in accurate diagnosis of HHL. Such genetic investigating tools should be integrated into the selection for CI candidacy.

Keywords : Hereditary hearing loss, Whole-exome sequencing, Cochlear implant

Genetics: Diagnosis/ Prediction

PP 003

Different Phenotypes in Pendred Syndrome Caused by the Homozygous SLC26A4 Gene Pathogenic Variant

Fong-Cain JHONG[1], Yung-Hsuan CHEN[1], Meng-Han TSAI[2], **Chao-Hui YANG[1]**

[1]Otolaryngology, Kaohsiung Chang Gung Memorial Hospital, Taiwan
[2]Neurology, Kaohsiung Chang Gung Memorial Hospital, Taiwan

Background: Pendred syndrome is an autosomal recessive disorder that features a combination of hearing impairment and thyroid goiter. It is mainly related to the pathogenic variants of the SLC26A4 gene, which encodes the protein named pendrin. However, the phenotypes of the patients with Pendred symptom may vary.
Materials and Methods: We present a Taiwanese family of four congenital hearing loss patients with the same homozygous SLC26A4 variation and compare the phenotype in each patient by the audiogram and computed tomography of the temporal bone.
Results: Although the genotype of SLC26A4 variation is the same in the family, the hearing levels of each patient are different. In addition, the proband and her sibling revealed Mondini malformation, but their parents showed normal cochlear morphology.
Discussion and Conclusions: Our report emphasizes the importance of genetic testing and consultation for the family in the proband with typical Pendred syndrome. Phenotypic divergence may occur in the infrafamilial subjects with the same SLC26A4 variation of Pendred syndrome.

Keywords : Pendred syndrome, SLC26A4, Hearing loss

Genetics: Diagnosis/ Prediction

PP 004

A Case Study on Hearing Loss in a Patient with Turner Syndrome: Diagnosis, Findings, and Treatment Approach

Mohd Fadzil Nor RASHID[1],
Ain Mimi Maryam ARBAEN[1], Suzana MANSOR[2]

[1]Audiology Proramme, School of Health Sciences, Health Campus,, Universiti Sains Malaysia, Malaysia
[2]Audiology and Speech Pathology Unit, Hospital Universiti Sains Malaysia, Universiti Sains Malaysia, Malaysia

Introduction: This case study evaluates the hearing profile of a 22-year-old patient with Turner Syndrome (TS) and presents the diagnosis, findings, and treatment plan. The patient was initially diagnosed with TS in 2013 at the general hospital, where she received hormonal treatment before being transferred to Hospital USM for follow-ups.

Audiological Findings: The ear and facial characteristics associated with TS were observed, including external auditory canals that incline upwards, short stature, low-set ears, and small jaw bones. The latest pure tone audiometry (PTA) revealed mild-to-moderate hearing loss with a cookie-bite configuration. Tympanometry revealed that the right ear had a type C tympanogram, and the left had a type B tympanogram. Three audiograms revealed that the configuration of PTA was insignificant. Based on these results, a hearing aid trial was planned to treat the patient's hearing loss and enhance auditory perception and communication skills. Regular monitoring and follow-ups will be conducted to evaluate the efficacy of the hearing aid and ensure optimal results.

Discussion and conclusion: Turner Syndrome may manifest as conductive, sensorineural, or mixed hearing loss. Recurrent otitis media, caused by abnormal Eustachian tube structure and function, is common in individuals with TS, resulting in tympanic membrane scarring and conductive hearing loss. Also susceptible to progressive sensorineural hearing loss associated with premature ageing is the TS population. This case study demonstrates the significance of assessing and treating hearing loss in patients with Turner Syndrome. Understanding the anatomical and hearing characteristics of TS allows for early detection and intervention. Auditory rehabilitation, such as hearing aids, can substantially improve the quality of life for patients with Turner Syndrome and hearing impairments.

Keywords : Turner Syndrome, Hearing loss, Auditory rehabilitation

Genetics: Diagnosis/ Prediction

PP 005

Cochlear implant for mitochondrial disease at our hospital.

Kiyoshi SAKASAI[1], **Yasuhiro ARAI[1]**, Kentaro TAKADA[1], Takashi WADA[1], Daiki MORISHITA[2], Nobuhiko ORIDATE[1]

[1]Ent, Yokohama City University Hospital, Japan
[2]Ent, Yokohama Sakae Kyosai Hospital, Japan

In this report, we conduct clinical investigations and provide insights on cochlear implantation for two cases with the m.3243A>G mutation and one case with the m.1555A>G mutation.

Case 1: 58-year-old female
Experiencing progressive sensorineural hearing loss since her twenties, she was referred to our hospital. Genetic testing confirmed the m.3243A>G mutation. Her speech discrimination scores with hearing aids were 50% in the right ear and 40% in the left ear (at 65dB SPL). She underwent left cochlear implantation. After one year, her cochlear implant thresholds ranged from 30-40dB, and using CI2004 (65dBSPL), word recognition was 96% and sentence recognition was 98%.

Case 2: 53-year-old male
Genetic testing performed at another institution revealed the m.3243A>G mutation. Due to progressive hearing loss, he sought our department's assistance at age 44. Speech discrimination scores were 65% in the right ear and 35% in the left ear (at 80dB SPL) with hearing aids. He received left cochlear implantation. Three years post-surgery, his cochlear implant thresholds were 40.8dB. Using CI2004, word recognition was 52%, which decreased to 40% after seven years.

Case 3: 44-year-old female
Genetic testing identified the m.3243A>G mutation at age 36. Noticing progressive hearing loss, she visited our department at age 41. Standard pure-tone audiometry showed 63.8dB in the right ear and an upper limit on the left ear. At age 46, there was a sudden worsening of right-sided hearing loss. Speech discrimination scores were 0% in both ears with hearing aids. She underwent right cochlear implantation. After six months, her cochlear implant thresholds ranged from 30-40dB. CI2004 word recognition was 77%, and sentence recognition was 93%.
【Discussion】
In Case 2, the long-term decline in auditory capacity necessitates careful observation for the future. For the m.3243A>G mutation, challenges include conducting long-term follow-ups post-cochlear implantation and accumulating postoperative results from various facilities.

Keywords : MELAS, Mitochondrial, Case reports

Audiological Examination

PP 006

Psychosocial Impact of the COVID-19 Pandemic on Teenage with Cochlear Implants

Merve TORUN TOPCU[1], Mahmut Tayyar KALCIOGLU[2]

[1]Audiology, Istanbul Medeniyet University, Türkiye
[2]Otorhinolaryngology, Professor Doctor Suleyman Yalcin Goztepe City Hospital, Türkiye

Objective:The purpose of this study was to describe the hearing health and educational experiences of school-age teenage with cochlear implants (CIs) during the COVID-19 pandemic and the potential psychosocial effects of the pandemic on these individuals.
Material and methods: The study used a cross-sectional survey design. The sample of the study was school-age teenages with CI between the ages of 14-21 (study group, n= 22, age (mean)= 17.2 ± 3.9 years) and their peers with normal hearing (control group, n= 28, age (mean)= 16.5± 4.1 years) formed two groups. The study group completed the Perceived Stress Scale (PSS), the Coronavirus Anxiety Scale (CAS), the Psychosocial Perspective Profile (PPP) form and the Demographic Information (DI) form. The control group completed the Perceived Stress Scale (PSS) and Coronavirus Anxiety Scale (CAS) and Demographic Information forms.
Results: The PSS scores of the study group were higher than those of the control group (p= .001). However, there was no statistically significant difference between groups in the CAS scores (p= .875). According to the PPP form, more than half of the adolescents with cochlear implants stated that the pandemic process affected their educational life, especially in questions about education and hearing health services, and nearly half of them stated that it had a negative impact on questions about psychological attitudes and behaviors.
Conclusion: The findings of the study reveal that teeanages with CIs experienced more stress com-pared with the control group during the pandemic period, but there is no difference between the groups in terms of anxiety due to coronavirus. Providing psychosocial support and special educational conditions to help them overcome their difficulties can help.

Keywords : Cochlear implant, Covid-19, Psychosocial effect

Audiological Examination

PP 007

Evaluation of hearing loss in patients with fibromyalgia syndrome

Hanife CAGLAR YAGCI[2], **Osman Ilkay OZDAMAR**[1], Ozlem ERTUGRUL[3], Cansu TOSYALI SALMAN[3], Ilker YAGCI[4]

[1]Otorhinolaryngology, Head and Neck Surgery, Prof. Dr. Suleyman Yalcin City Hospital, Türkiye
[2]Physical Medicine and Rehabilitation, Prof. Dr. Suleyman Yalcin City Hospital, Türkiye
[3]Audiology, Prof. Dr. Suleyman Yalcin City Hospital, Türkiye
[4]Physical Medicine and Rehabilitation, Marmara University School of Medicine, Türkiye

Purpose of study: There have been various symptoms in patients with fibromyalgia (FM) related to central sensitization. We aimed the find rate of hearing loss in newly diagnosed patients with FM
Materials and methods: In this cross-sectional controlled study, patients with FM and gender/age matched controls were compared with pure-tone audiometric (PTA), and transient evoked otoacoustic emissions (TEOE) tests. The subjects were questioned for NSAID uptake and scored with ASAS-NSAID score.
Results: The study was completed with 33 patients with FM and 32 healthy volunteers. Subjective tinnitus, dizziness and hearing loss rate in the FM group were 12%, 18%, and 15%. PTA air and bone conduction studies yielded significant differences between the control and FM group ($p<0,05$) . The statistical difference was pronounced in higher frequencies. TEOE studies showed the FM group had significantly lower scores when compared to the control group at 3000 Hz and 4000 Hz ($p<0,05$). The median ASAS-NSAID scores were 0 for the control group and 7,78 for the FM group ($p < 0.001$).
Conclusions: Patients with FM have a high rate of sensorineural hearing loss when it is compared with healthy control group. The sensorineural hearing loss was remarkable especially in higher frequencies

Keywords : Fibromyalgia syndrome, Hearing loss, Audiometry

Audiological Examination

PP 008

Audiological outcomes of the Universiti Kebangsaan Malaysia Pediatric Implanted Recipient Observational Study

Cila UMAT[1], Wan Nur Hanim MOHD. YUSOFF[1], Nur 'izzati MD. YUSOFF[1], Mohamad Firdaus LATIP[2], Hanif Farhan MOHD RASDI[1], Bee See GOH[3]

[1]Center For Rehabilitation & Special Needs Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Malaysia
[2]Center For Ear Hearing & Speech, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Malaysia
[3]Department of Otorhinolaryngology-head & Neck Surgery, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia

Objective:
This paper aimed to examine the longitudinal outcomes of the Pediatric Implanted Recipient Observational Study (P-IROS) using the Speech Spatial Qualities Parents' version (SSQ-P) and Categories of Auditory Performance version II (CAP-II).

Methods:
The Universiti Kebangsaan Malaysia (UKM) Cochlear Implant Program enrolled 40 children in the P-IROS study from 2017 to 2022. Data were collected from clinicians and parents at consistent time intervals set at baseline, 6-, 12-, 18- and 24-months post implantation. Parents of these 40 children contributed to the SSQ-P data, while only 27 children had complete CAP-II data reported by audiologists in this study. The age of CI ranged from 14 to 100 months with a mean of 38.7± 21.1 months. A total of 20 out of 27 children were bilateral CI users. 48% of these children used auditory-oral communication mode.

Results:
For the overall SSQ-P data (N=40), Friedman's Two-way Analysis of Variance revealed significant change over time ($p=0.001$) with scores at 12 months relative to the baseline contributed to the significance ($p<0.01$). This result was also true for Speech-hearing and Qualities of Hearing-sub items in the SSQ-P. As for the Spatial-hearing items, a significant difference in scores were observed at six months post-CI activation. No significant associations between the difference in overall SSQ-P scores or its subsections with the age of CI. As for the CAP-II (N=27), significant increment in scores at 12, 18 and 24 months ($p<0.001$) relative to the baseline. A significant increment was also seen in between six and 18 months, six and 24 months and 12 and 24 months.

Conclusion:
For the cohort of children in this study, significant improvement in various functional auditory skills relative to the baseline was observed at 12 months except for spatial hearing, which showed faster rate of skill development at six months hearing age.

Keywords : Pediatric, Speech Spatial Qualities Parents Version (SSQ-P), Categories of Auditory Performance version II (CAP-II)

Audiological Examination

PP 009

Temperature-sensitive recurrent, reversible auditory neuropathy in two Iranian siblings

Mohsen AHADI[1,3], Nasrin YAZDANI[2,4]

[1]*Department of Audiology, Iran University of Medical Sciences, Iran, Islamic Republic of*
[2]*Department of Otorhinolaryngology, Tehran University of Medical Sciences, Iran, Islamic Republic of*
[3]*Rehabilitation Research Center, Iran University of Medical Sciences, Iran, Islamic Republic of*
[4]*Otorhinolaryngology Research Center, Tehran University of Medical Sciences, Iran, Islamic Republic of*

Two sibling cases with a temperature-sensitive form of auditory neuropathy from a consanguineous family of Iranian descent have been described. they complained about the temporary loss of hearing and compromised speech comprehension after a slight fever or elevating the body temperature by vigorous exercises. A series of tests including brain MRI, pure-tone audiometry, speech audiometry in quiet and noise, Tympanometry, reflexometry, TEOAEs, cochlear microphonic, and ABR were performed in a 24-hours interval at both febrile and afebrile states, and results are reported here. This report is the first example of temperature-sensitive auditory neuropathy in our geographical region (Middle East, and west Asia).

Keywords : Auditory neuropathy, Consanguineous marriage, Temperature-sensitive

Audiological Examination

PP 010

Influences of Aided Audiometry Performance to Category of Auditory of Performance II (CAP II) Score Among Pediatric Cochlear Implant Recipient

Mohamad Firdaus Bin LATIP[1], Noor Dina HASHIM[1,2], Fatimah SAZARI[3], Goh Bee SEE[1,2]

[1]*Centre For Ear, Hearing and Speech, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Malaysia*
[2]*Department of Otorhinolaryngology-head & Neck Surgery, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia*
[3]*Department of Medical Rehabilitation Services, Canselor Tuanku Muhriz Hospital, Ukm Medical Centre, Universiti Kebangsaan Malaysia, Malaysia*

Background
Category of Auditory of Performance-II (CAP-II) is an established assessment of rating scale for auditory performance while aided audiometry is to determine the patient's detection level. Both tests have been utilized for measuring auditory performance for cochlear implant (CI) patients.

Objectives
To assess the correlation between aided level and CAP-II. Good aided level will lead to a higher score of CAP-II over time.

Methods
A prospective longitudinal study from 2017-2022 in CI recipients below 10 years with minimum of 2 years follow up were recruited. The aided audiometry and CAP-II were done for all patients postoperatively at 1 year and 2 years of follow up.

Results and Discussion
23 children were recruited ranging from 14 to 100 months with a mean of 38.7 ± 21.1 months. 15 of the subjects have cochlear and/or retrocochlear pathology. Nonparametric Spearman's correlations indicated a significant negative relationship between aided level and CAP-II score for 1 year follow up [R(23) = -0.573, p = 0.04]. In addition, there was also a non-significant negative relationship between aided and CAP-II for 2 years follow up [R(23) = -0.378, p = 0.111]. In general, the study revealed that aided level does not determine a good CAP-II score among subjects in this study even though the mean score for CAP-II improved from level 4 to level 6 across 2 years.
Conclusions
The study revealed a negative correlation of aided level to a high score of CAP-II. It is suggested that aided audiometry will provide information of auditory detection but couldn't determine auditory performance of recipients over time. CAP-II score might also be affected by multiple factors such as cochlear abnormality or parents' commitment. However, aided audiometry is still a good practice to monitor patients' responses at least for sound detection information.

Keywords : Pediatric, Aided audiometry, Category of Auditory Performance II (CAP-II)

Audiological Examination

PP 011

Systemic cisplatin increases the number of patients showing positive off-frequency masking audiometry

Harukazu HIRAUMI[1], Shin-Ichi OIKAWA[2], Kiyoto SHIGA[2], Hiroaki SATO[2]

[1]*Otolaryngology, Tenri Hospital, Japan*
[2]*Otolaryngology, Head-and-neck Surgery, Iwate Medical University, Japan*

Objective: The study aimed to evaluate the effect of systemic cisplatin administration on off-frequency masking audiometry.
Methods: Among 26 patients receiving systemic cisplatin, 48 ears were included in the analysis. All patients underwent pure-tone audiometry with ipsilateral narrow-band masking noise (off-frequency masking audiometry). In the off-frequency masking audiometry, 70 dBHL band-pass noise (center frequency 1000 Hz, 1/3 octave bandwidth) was administered to the tested ear. The acquired thresholds were compared to those of standard pure-tone audiometry, and threshold elevations greater than 10 dB were regarded as significant. The number of patients showing abnormal threshold elevation was compared between before and after the cisplatin administration.
Results: Before cisplatin administration, 91.7, 93.8, 97.9, and 93.8% of ears showed normal off-frequency masking audiometry outcomes at 125, 250, 6000, and 8000 Hz, respectively. After cisplatin administration, a higher number of patients showed abnormal off-frequency masking audiometry outcomes. This change was more prominent with increasing doses of cisplatin. After the cisplatin administration of 100~200 mg/m2, the prevalence of patients with normal off-frequency masking audiometry outcomes was 77.3, 70.5, 90.9, and 88.6% at 125, 250, 6000, and 8000 Hz, respectively. At 250 Hz, the change was statistically significant (p = 0.01, chi-squared test).

Keywords : Off-frequency, Masking, Cisplatin

Audiological Examination

PP 012

Artificial intelligence at predicting hearing levels after myringoplasty: A pilot study

Kenneth Wei De CHUA[1], Hazel YEO[1], Heng Wai YUEN[1], David LOW[1], Conrad CHUNG[1], Savitha KAMATH[1]

[1]*Otorhinolaryngology Head and Neck Surgery, Chanig General Hospital, Singapore*

ABSTRACT

Introduction
There are approximately 13,000 basic hearing tests (audiometry) performed annually at the specialist outpatient Ear-Nose-Throat (ENT) clinic, and this number is expected to increase with the ageing population. Since audiometry is an essential test for the diagnosis of ear-related diseases, results must be carefully and accurately interpreted to provide good diagnostic and prognostic information. However, with an increasing patient load, some results may be misinterpreted due to differences in skill level or fatigue amongst the professionals. There is hence a need to use an automated classification model.

Methods
Retrospective analyses of 125 patients who underwent surgical repair of the eardrum with available pre- and post-operative audiograms were included in this study. The aims of the research study: (1) classify hearing loss severity and type using 125 patients' data, (2) predict post-operative audiometric results using 99 patients' data, using decision-tree algorithm and trained neural network respectively.

Results
Decision tree algorithm can automatically classify hearing loss type and degree based on numerical values as an input with an approximate accuracy of 70%. Regression neural network was able to successfully predict post-operative air-bone gap within ±20dB. The top three predictors were age, size of perforation and pre-operative air-bone gap.

Conclusion
The algorithm can be integrated with our medical system through a graphical user interface (GUI) where clinicians can also key in the pre-operative variables to predict post-operative outcomes. Clinicians can then counsel patients on post-operative hearing outcomes and empower patients to make a more informed decision on surgery.

Keywords : Artificial Intelligence, Myringoplasty, Hearing Loss

Audiological Examination

PP 013

A STUDY OF PREVALENCE FOR HEARING IMPAIRMENT IN MONGOLIAN NEONATES

Saruul CHULUUNBAATAR[1],
Delgermaa BATAAKHUU[1], Bayalag MUNKHUU[2]

[1]Pediatric Otorhinolaryngology, National Center For Maternal and Child Health, Mongolia
[2]Department of Surveillance, National Center For Maternal and Child Health, Mongolia

Background: Significant bilateral hearing loss is the most common congenital disorder of the newborn, occurring 2-3 times per 1000 live infants. In December 2012, for the first time in Mongolia, neonatal hearing screening was introduced at the National Center for Maternal and Child Health. We aimed at investigated the outcomes of neonatal hearing screening and diagnostics of type and degree of hearing loss in neonates.
Materials and methods: During the study period, 2019-2020, a total of 70,614 infants born in Urguu, Khuree, Amgalan maternity hospitals, Baganuur district health center, Intermed hospital, and the National Center for Maternal and Child Health were included in the prospective cohort study. The study was performed in three phases, following the clinical guidelines for neonatal hearing screening. The hearing loss was classified according to the degree and type.
Result: A total of 94.1% of 70,614 children eligible for screening were included. A prevalence rate of bilateral hearing loss 2.3 per 1000 children was found. A prevalence rate of bilateral severe and profound hearing loss 1 per 1000 children was found. The mild sensorineural hearing loss 28 (26.0%) was most common in children, followed by moderate 19 (17, 6%), severe 21 (19.4%), profound 19 (17.6%) and deaf 21 (19.4%).
Conclusion: The coverage of hearing screening in maternity hospitals in Ulaanbaatar is relatively good (94.1%), but there is a repeat screening (62.1%) and follow-up and diagnostic tests (49.9%) shows that neonatal hearing screening and follow-up system needs to be improved.

Keywords : Neonatal hearing screening, hearing loss, Prevalence

Audiological Examination

PP 015

Distortion Product Otoacoustic Emissions (DPOAE) in Children with Tinnitus

Afiq Ikmal SAHAK[1], Wan Syafira ISHAK[2],
Rafidah MAZLAN[3], Nashrah MAAMOR[3]

[1]Audiology Unit, Department of Medical Rehabilitation Services, Canselor Tuanku Muhriz Hospital, The National University of Malaysia, Malaysia
[2]Audiology Program, Centre For Healthy Ageing and Wellness, Faculty of Health Sciences, The National University of Malaysia, Malaysia
[3]Audiology Program, Center For Rehabilitation and Special Needs Studies, Faculty of Health Sciences, The National University of Malaysia, Malaysia

Introduction: Tinnitus is the perception of sound in the ear or brain without external stimulation, and it can occur at any age. Damage to the outer hair cells of the cochlear may be a pathophysiological trigger for acute tinnitus. However, the pathology is not usually evident on the audiogram but can be detected using a more sensitive method such as the distortion product otoacoustic emissions (DPOAE). Objective: The current study aimed to compare the DPOAE finding among tinnitus group and non-tinnitus group. Method: A total of 172 children between the age of 7 and 12 years old were recruited for the study. An interview, otoscopic examination, tympanometry and DPOAEs tests were conducted during the study. Results: 18% of the participants have reported experiencing tinnitus. The Mann-Whitney U analysis revealed that the DP amplitude at 8000 Hz is significantly lower in the tinnitus group compared to the non-tinnitus group. Conclusion: The finding suggests the majority of tinnitus ears had an altered functional status of the outer hair cells (OHCs).

Keywords : TInnitus, Children, DPOAE

Audiological Examination

PP 016

Self-report measures of listening and communication: Are we measuring what matters?

Katie NEAL[1], Sarah HUGHES[2,3,4], Isobelle BOISVERT[5]

[1]Lingustics, Macquarie University, Australia
[2]Cpror, University of Birmingham, UK
[3]National Institute For Health Research (nihr), Applied Research Collaboration (arc), West Midlands, Birmingham, UK
[4]Birmingham Centre For Regulatory Science, Birmingham, UK
[5]Speech Pathology, University of Sydney, Australia

Background: Natural communication requires the ability to perceive and understand language in a real-world context, and the capacity to interpret and respond to information in a manner that is dynamic, reflexive, and collaborative. The requirements of everyday communication interactions contrast with the representation of listening as passive (one directional) and individual (without a communication partner). The conceptualisation of listening as passive and individual means existing self-report measures of listening and communication may not capture the complexity of the underlying processes involved in the comprehension and functional use of auditory input for oral communication.

Method: This study identified and classified the linguistic and contextual concepts relevant to everyday listening and communication evaluated in existing self-report instruments used with adults with hearing loss. Using a scoping review methodology, 891 studies were identified, which used a total of 139 self-report instruments. Questions within these self-report instruments (n=2525) were classified according to a pre-specified framework to map the conceptual coverage of self-reported instruments.

Results: The linguistic and communication constructs represented within the included instruments was narrow. Many of the concepts considered necessary for functional listening and communication as defined by the framework were underrepresented or absent. Items focussed on basic sound perception with limited coverage of the interactive and adaptive skills required for communication.

Conclusion: A self-report assessment is only as comprehensive as the constructs represented by the instrument's items, yet relevancy and comprehensiveness are core to ensuring the content validity of these instruments. Without items that measure the broader linguistic, cognitive, interactive and identifiable skills required for communication, it is difficult to understand how these constructs affect listening and communication. Instruments that lack these constructs have limited application and provide justification for the construction of new instruments that measure the broader listening skills required for everyday communication.

Keywords : Self-Report, Functional measurement, Communication

Audiological Examination

PP 017

Comparison of Loudness Discomfort Level by the Pure Tone and Narrow-Band Noise in Adults with Normal Hearing and Patients with Hearing Loss

Yong-Hwi AN[1], Dong Hyuk JANG[1], Jung Ho CHOI[1], Seung Yeon JEON[1], Hyojung CHOI[1], Hyun Joon SHIM[1]

[1]Department of Otorhinolaryngology-head and Neck Surgery, Nowon Eulji Medical Center, Eulji University School of Medicine, Seoul, Korea

Objectives: There are several variations on the technique for measuring loudness discomfort levels (LDL), but no consensus or standardization has been established. The aim of this study was to evaluate LDL by pure tone and narrow-band noise (NBN) in adults with normal hearing and patients with hearing loss.
Methods: A total of 35 normal listeners with pure tone average of bilateral 17 dB and 39 patients with hearing loss with pure tone average of bilateral 44 dB were enrolled. Subjects with hyperacusis, tinnitus or asymmetric hearing were excluded. Pure tone audiometry and LDL test by pure tone and by NBN were performed at every frequency of 250, 500, 1k, 2k, 3k, 4k, 8k Hz. LDLs of patients with hearing loss were compared with those of normal controls. LDLs by pure tone were compared with those by NBN in both groups.
Results: The LDL test showed inter-subject variability with the mean of 109.8±8.0 dB at right ear and 110.6±7.4 dB at left ear by pure tone, and 102.8±5.8 dB at right ear 102.4±6.3 dB and at left ear by NBN in normal hearing group. There were no significant differences of LDL means by pure tone and NBN between normal and hearing loss group. There was no difference of LDL between the two groups by each frequency. Mean LDL by pure tone was significantly higher than that by NBN in normal group while there was no difference in hearing loss group. There was no overall difference of LDL among individual frequencies, but there was a tendency to show differences between some high and low frequencies in both groups.
Conclusion: LDL by pure tone and by NBN is consistent with or without hearing loss in this study population; LDL test by pure tone might be more clinically useful than that by NBN.

Keywords : Loudness discomfort level, Hearing, Pure tone audiometry

Audiological Examination

PP 018

Infant hearing: comparison among electrophysical and behavioral tests

Son A CHANG[1], Sujin SHIN[2], Ji Min KIM[1], Ye Rim SHIN[1], Young-Myoung CHUN[1]

[1]Soree Rehabilitation Center, Soree Ear Clinic, Korea
[2]Department of Communication Sciences and Disorders, University of Redlands, USA

Electrophysical hearing test has been widely used to predict hearing thresholds in infants and toddlers and to decide early cochlear implantation. Auditory Brainstem Response (ABR) has been investigated compared to behavioral hearing test (BHT) (Werner et al., 1994; Tharpe & Ashmead, 2001). However, Auditory Steady State Response (ASSR) has been studied much yet. In this study, we investigated how ASSR and BHT are related in each testing frequencies and how ABR, ASSR, and BHT average thresholds are related in the age groups up to 3-year-olds.
We excluded babies with conductive hearing loss and included results of babies SNHL and MHL who has more than 80% of ABR, ASSR, and BHT in over 500 test results of ABR, ASSR, and BHT in 0, 1, 2, 3 years-old babies from 2016 to 2021 in Soree Ear Clinic were analyzed. In each 500, 1k, 2k, and 4kHz, ASSR and BHT thresholds in both ears were significantly similar($p<.001$) in all age groups. Rt. Ear results were better related to each other than Lt. ear results especially in low frequencies. The average test results were compared and it is shown that ASSR was better corelated to BHT thresholds than ABR to BHT thresholds. The ABR results is highly corelated to the ASSR results. The ABR results were getting less corelated to BHT thresholds as the babies got older. The BHT at age 0 were as reliable as the BHT at age 2.
ASSR produced frequency-specific thresholds and was highly corelated to BHT that means ASSR can be a useful prediction for the babies' hearing thresholds. ABR was also a good tool to predict the thresholds, however, it gets less reliable as the babies gets older. These results bring the importance of behavioral conditioning to get hearing thresholds up in the babies as young as 0-year-old.

Keywords : Electrophysiological hearing test, Behavioral hearing test, Infants and toddlers with hearing problems

Audiological Examination

PP 019

The ICF and cochlear implant indications

Ilona ANDERSON[1], Ellen ANDRIES[2], Artur LORENS[3], Griet MERTENS[2], Anja KURZ[4], Miryam CALVINO[5], Dayse TAVORA-VIERA[6], Edda AMANN[1]

[1]Clinical Research Department, Med-el, Austria
[2]Department of Otorhinolaryngology, Head and Neck Surgery, Antwerp University Hospital, Belgium
[3]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[4]Department of Otolaryngology, University Clinic of Würzburg, Germany
[5]Department of Otolaryngology, La Paz University Hospital, Spain
[6]Department of Otolaryngology, Head & Neck Surgery, Fiona Stanley Fremantle Hospital Group, Australia

Background and aim
The International Classification of Functioning, Disability and Health (ICF) core set was developed for adult CI users by an experienced group of audiologists, speech-language pathologists, psychologists, and engineers. This was then evaluated in a study to define outcomes using these ICF categories as a group and per CI indication.

Method
The expert group determined which categories were need for CI candidates and users. They then defined relevant tests that would apply to each category, also determining quantified ICF qualifiers. A study was conducted to determine how the ICF could be applied in clinical routine and to determine outcomes in 63 adult CI candidates before and 6 months after implantation.

Results
Data from this study will be presented in this conference. Besides looking at the data from the ICF perspective, it is also interesting to review the raw data from this study. Results of speech in quiet, speech in noise, localisation, a questionnaire on quality of life and a questionnaire on work status show that participants improved over time during the 6 months test period.

Conclusion
The ICF is a useful tool in measuring the holistic perspective of a patient, determining their disabilities, and using this in the rehabilitation process. The ICF is also a useful tool, creating a common language for multi-centre clinical research.

Keywords : ICF, Outcomes, Quality of Life

Audiological Examination

PP 020

Whether Auditory Steady-State Responses is useful tool in evaluation of CI Candidacy?

Sudhir Sakharam KADAM

Ent, Yashashri Ent Hospital & Cochlear Implant Centre, India

Dr. Sudhir S Kadam ; Yashashri ENT Hospital Cochlear Implant Centre, Miraj, India.

Aim : To evaluate role of Auditory Steady-State Responses (ASSR) in evaluation of pediatric cochlear implant candidates
Setting - Tertiary referral ENT Hospital
Study design - prospective study

Materials and methods : ASSR was done along with ABR & OAE to evaluate 35 children with suspected severe-to-profound hearing loss, aged from 6 to 72 months. ASSR were evoked using single frequency stimuli at 110 dB HL with a 10 dB down-seeking procedure. ASSR responses were compared with ABR responses on both sides. ASSR responses were used to detect residual hearing.

Results : Bilateral ASSR responses were recorded in 32 children. ASSR & ABR responses were non recordable bilaterally in 2 children and on right side in one child. 18 children showed correlation between ABR & ASSR responses. In 14 children ASSR responses were recorded in absence of ABR responses. 3 children showed evidence of residual hearing in speech frequencies on ASSR.

Conclusions : ABR to both click and tone burst stimuli does not appear to be able to distinguish severe-to-profound hearing losses in the range of 85 to 95 dB HL from those in the more profound ranges of 100 to 120 dB HL. ASSR can predict hearing loss within severe to profound deafness range up to 120dB.
Recordable ASSR thresholds in patients with absent ABR is beneficial in evaluation of CI Candidacy, particularly in 1)children with cochlear and cochlear nerve anomalies and 2) deciding worst side to be operated in Govt funded programmes.
Detection of residual hearing in speech frequencies can guide surgeon towards Hearing preservation techniques and planning of EAS device.

Keywords : ASSR, Paediatric, CI Candidacy evaluation

Audiological Examination

PP 021

Aided Auditory Evoked Potentials: Non-Invasive pre-CI assessment to determine auditory nerve functionality

Amit Kumar ANAND[1], Aninda Duti BANIK[2]

[1]*Department of Audiology and Research, Apple Speech & Speech, India*
[2]*Audiology, Advanced Bionics India Pvt Ltd, India*

Purpose
Quandary for cochlear implantation in inner ear malformations, hypoplastic auditory nerve(AN), conflicting observations quoting absent AN in radiological evaluation versus observation in awareness of sounds via hearing aids in pre-CI candidacy stages in these cases,
professionals to offer CI as a solution with restricted benefits. TT-EABR is invasive and tedious procedure, and hit rate has been on the lower side which has artefacts in the operating theatre leads to further uncertainty of a definite result. Aim of the study is to explore the efficacy of non-invasive pre-CI procedures using Aided-AEPs viz… aided ABR and aided LLR.
Methods
2 out of 3 cases with absent AN who showed optimal awareness with hearing aids underwent aided AEPs along with routine audiological procedures.
Results
Atleast on one ear, a very low amplitude & delayed wave-V or Aided-LLR having delayed P1 latency around >65-95 ms and subsequent delays in N1, P2 with variations in amplitude were observed. This corelated with awareness on test with pre-calibrated noise-makers and speech sounds over 3 months. One case showcased no waveforms. CI were done on 2 cases, where eSRT was present across 2 bands (4 electrode in each band) in one-case and scattered 1st NRI on few electrodes at high levels (450 – 560 CU) with lower amplitudes in both cases. This replicated at switch-on and recipients are undergoing habilitation program where they will be monitored over the next few years for progress in speech & language skills.
Conclusion
Such cases opt for CI as possible line of treatment under funding schemes where they would not be able to afford the expenses of other implantable options. The attempt is to explore possibilities of performing non-invasive cheaper pre-CI objective test procedures to determine candidacy of CI & prognosis.

Keywords : Aided AEPs; TT-EABR; Cortical AEP; inner ear malformation
Keywords : Aided LLR, TT-EABR, Inner ear malformation

Audiological Examination

PP 022

Electrically Evoked Auditory Brainstem Responses in Children Fitted with Hearing Aids Prior to Cochlear Implantation

Li CHEN[1], Xiaotao GUO[1], Jingwu SUN[1], **Jiaqiang SUN**[1]

[1]Department of Otolaryngology-head and Neck Surgery, The First Affiliated Hospital of University of Science and Technology of China, China

This study investigates the effect of hearing aid use on the peripheral auditory pathways in children with sensorineural hearing loss prior to cochlear implantation, as revealed by the electrically evoked auditory brainstem response (EABR). Forty children with hearing aids were recruited. Half of them had normal inner ear structures and the other half had inner ear malformations (IEMs). The EABR was evoked by electrically stimulating the round window niche (RWN) and round window membrane (RWM) during the cochlear implantation operation. The onset age of hearing aid use was significantly correlated with the peak latencies, but not amplitudes, of the wave Ⅲ (eⅢ) and wave Ⅴ (eⅤ). Higher EABR thresholds were found for RWN stimulation than for RWM stimulation and in the children with IEMs than in those without IEMs. Our study provides neurophysiological evidence that earlier use of hearing aids may ameliorate physiological functions of the peripheral auditory pathway in children with and without IEMs. The EABR evoked by the electrical stimulation at RWM is more sensitive compared with that at RWN for evaluating functions of the auditory conduction pathway.

Keywords : Cochlear implant, Electrically evoked auditory brainstem response, Hearing aid

Audiological Examination

PP 024

A novel ICF-based classification system for reporting localization outcomes

Artur LORENS[1], Griet MERTENS[2], Ellen ANDRIES[2], Anja KURZ[3], Dayse TAVORA-VIEIRA[4], Miryam CALVINO[5], Edda AMANN[6], Ilona ANDERSON[6]

[1]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[2]Department of Otorhinolaryngology, Head and Neck Surgery, Antwerp University Hospital, Belgium
[3]Department of Otorhinolaryngology, Plastic, Aesthetic and Reconstructive Head and Neck Surgery, University Hospital Würzburg, Germany
[4]Otolaryngology, Head & Neck Surgery, Medical School, Division of Surgery, The University of Western Australia, Australia
[5]Department of Otolaryngology, Hospital Universitario La Paz, Spain
[6]Department of Clinical Research, Med-el Medical Electronics, Austria

Objective
To use International Classification of Functioning, Disability and Health, known more commonly as ICF, as a clinical tool for evaluating localization outcomes.
Methods
The opinions of experts were gathered on their clinical experience about the procedural elements of localization testing. The wide variations in localization testing procedures were identified that can this can reduce the ability to directly compare results. Therefore a novel classification system was proposed to report localization errors according to the International Classification of Functioning, Disability and Health (ICF) framework. The five-point graded scale from the CF model was used to evaluate a degree of impairment in sound source localization.
Results
Improvement of comparability of localization results across institutes, localization testing setups, and listeners was demonstrated by applying the classification system retrospectively to data obtained from cochlear implant patients from Antwerp University Hospital (UZA), the World Hearing Center (WHC), the University Clinic of Würzburg (UKW), and the University of Western Australia (UWA). The majority of the SSD patients experiencing complete impairment of sound localization in the unaided condition and moderate impairment in the aided condition.
Conclusion
The developed classification system for localization test outcomes will facilitate multi-center studies and allow meta-analyses of data.

Keywords : Localization, Cochlear Implant, ICF

Audiological Examination

PP 025

Hybrid technology with Nucleus 8 processor for partial deafness treatment in a 3 yr old child -1st experience in South East Asia

Punam KUMARI[1], **Sumit MRIG**[1], Yashu GOSWAMI[1], Samriddhi NIJHAWAN[1]

[1]Dept of Ent, Audiology & Cochlear Implant Surgery, Max Smart Super Speciality Hospital & Sankalp Ent & Cochlear Implant Centre, India

One overlooked segment of the hearing impaired population is individuals with a steeply sloping high-frequency hearing loss which is a common pattern of adult sensorineural hearing loss and a rare and difficult to identify symptom in children.

The present study highlights the importance of detailed audiological evaluation in a 3 years old child whose parents were worried about her delayed speech and language development inspite of some hearing and limited response to speech stimuli. A detailed case history followed by Oto-acoustic emission, Brain Evoked Response Audiometry with click stimulus and Auditory Steady State Response was conducted. To correlate parent's information with our findings which showed severe to profound hearing loss, a 500 Hz toneburst Brain Evoked Response Audiometry was administered and a peak V response could be obtained at 80-90dB 500Hz tone burst stimuli. A conditioned play audiometry was further done to get estimated behavioural thresholds across the frequencies.

Based on our detailed tests and diagnosis, the child received Ci632 perimodiolar electrode array in the right ear through roundwindow approach and attempt was made to achieve hearing preservation at low frequencies to get benefit of electroacoustic stimulation post switch on. A compatible super power hearing aid was fitted in the left ear. A post operative unaided conditioned play audiometry was done to ensure the preservation of low frequency hearing at 250 Hz, 500Hz and 1 KHz

The use of hybrid technology was associated with better speech perception in noise and better music perception. Quality of life (QoL) scores were higher for these patients. Speech understanding in noise could be improved especially in the older children with electro-acoustical stimulation.

The method of atraumatic implantation and electro-acoustic stimulation extends the conventional indication for Cochlear Implantation and opens the perspective to future technologies, e.g. hair cell regeneration.

Keywords : Hybrid technology, Hearing preservation, Electroacoutic stimulation

Audiological Examination

PP 026

Sound4all: Re-engineered device and strategy for best results in UNHS

Pragya TYAGI[1], **Kapil SIKKA**[1], Amit Chirom SINGH[1], Dinesh KALYANASUNDARAM[2]

[1]Department of Otorhinolaryngology and Head & Neck Surgery, All India Institute of Medical Science, India
[2]Centre For Biomedical Engineering, Indian Institute of Technology, India

Purpose: The implementation of universal hearing screening program is a crucial step towards early identification and rehabilitation of congenital hearing impairment. In Indian scenario where diagnosis and intervention of hearing loss in children is often delayed and screening every neonate for hearing sensitivity is not a norm yet, a large-scale implementation study can give the insight into execution of most effective screening protocol and framework.

Method: The data was collected from August 2021- March 2023, wherein 4074 babies were screened. A two-step screening process was executed. The quality indicators such as coverage rate, refer rate and follow-up rates were analysed. The factors affecting the follow-up for re-screening and diagnostic evaluation were assessed. Also, the impact of change in probe design and device specifications were analysed with respect to effect of ambient noise and ease of probe placement.

Result: The coverage rate of the program was 95.74% with 13.17% refer rate at initial screening and 10.60% refer rate at re-screening. Several challenges such as high noise levels at screening sites, missed follow-up of failed screening and timely diagnosis along with intervention were handled through corrective measures. A novel re-engineered hearing screening device was tested in various environmental conditions and best testing environment was wielded. The initial and re-screening was done before the discharge and parents/caregiver were counselled regarding the implications of screening and its results. A comprehensive hearing screening card was given with the test results and the follow-up date if needed. These significantly improved the follow-up percentage for re-screening and diagnostic evaluation.

Conclusion: The program was successfully implemented adhering to the guidelines recommended by WHO. It efficiently executed the framework that in future with effective device, stringent follow-up and increased sensitization of parents can elevate to the goal of early diagnosis and intervention of every newborn with congenital hearing loss.

Keywords : Hearing screening, Implementation, Screening device

Audiological Examination

PP 027

Cochlear Implant Success in Auditory Neuropathy Disorder

Birgul GUMUS[1], Armagan Saziye İNCESULU[2]

[1]*Department of Audiology, Faculty of Health Sciences, Ondokuz Mayıs University, Samsun, Türkiye*
[2]*Department of Otorhinolaryngology Head and Neck Surgery, School of Medicine, Eskisehir Osmangazi University, Türkiye*

Objective: Auditory neuropathy spectrum disorder is an umbrella term used to describe a range of disorders affecting afferent neural activity in the peripheral and central auditory pathways. Management of children with Auditory neuropathy spectrum disorder has been a controversial issue. When there is inadequate progress in speech and language development, despite appropriate amplification, cochlear implantation becomes the optimal choice This study presents the audiological outcomes and the auditory perception of cochlear implant users with auditory neuropathy spectrum disorder.
Methods: Cochlear microphonics were used to determine auditory neuropathy spectrum disorder. The auditory perception was evaluation by categories of auditory performance scale and speech intelligibility rating scale. The hearing thresholds were measured in a free field both before the surgery with hearing aids and after the surgery with a cochlear implant.
Result: Out of the 12 patients, 5 had a bilateral pass response during the newborn hearing screening, but among those 5, bilateral refer response was obtained. The remaining patients did not undergo the newborn hearing screening. While there were variations in hearing aid thresholds among patients, the cochlear implant hearing thresholds were similar and within the expected range. Over time, the patients' auditory perception gradually improved with the use of the cochlear implant.
Conclusions: Cochlear implantation can provide improvements in both hearing thresholds and the ability to perceive sound in patients with auditory neuropathy spectrum disorder.

Keywords : Auditory neuropathy, Cochlear implant, Auditory perception performances

Audiological Examination

PP 028

Cochlear Implantation in Siblings with Usher Syndrome

Chu Man CHANG[1], Ting CHIU[1], Hong Ping CHIOU[1], Hung Pin WU[1]

[1]*Department of Otolaryngology, Taichung Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Taiwan*

Objective:
Usher syndrome type 1B (USH1B) is characterized by congenital profound hearing loss, early-onset retinitis pigmentosa, and vestibular areflexia. They always have poor hearing aids performance and undergo cochlear implantation eventually. This case report aims to compare the clinical outcomes of two individuals diagnosed with USH1B from the same family who underwent cochlear implantation at different ages.

Materials and methods:
Two siblings were diagnosed with USH1B through genetic testing, aged 16 (patient No.1) and 1 (patient No.2) years old are both male, suffered from severe to profound sensorineural hearing loss. They received cochlear implant on the same day, by the same surgeon, and adjusted the speech processor of the cochlear implant (CI) by the same audiologist after surgery. Audiological outcomes and speech perception data were collected.

Result:
Postoperative CI usage time was more than 8 hours per day, and attended auditory rehabilitation session once a week for more than one year. Five years after the CI surgery, the average CI-aided hearing level for two siblings were 30 dB HL (patient No.1) and 22.5 dB HL (patient No.2), and 3 vs. 8 for CAP (Categories of Auditory Perception) score, and 2 vs. 5 for SIR (Speech Intelligibility Rate), and 9 vs. 40 for MAIS (Meaningful Auditory Integration Scale) and IT-MAIS (Infant-Toddler Meaningful Auditory Integration Scale) respectively.

Conclusion:
The data indicated that earlier age of cochlear implantation was beneficial for patients with USH1B and leads to better speech perception compared to those who undergo the procedure at a later stage.

Keywords : Usher Syndrome Type 1B, Cochlear implantation, Age of Implantation

Audiological Examination

PP 029

Hearing differences according to the use of cochlear implants and hearing aids in South Korea

Eun Bit BAE[1,2]

[1]*Neurology, Seoul National University Hospital, Korea*
[2]*Korea University Research Institute For Medical Bigdata Science, Korea*

Introduction
Cochlear implants and hearing aids have often suggested a limitation that some hardly use the devices. This study was conducted to explore affecting clinical factors in the use of the devices and evaluate the hypothesis that there could be a relationship between hearing thresholds and hearing device use.

Methods
In this study, those who received cochlear implants or are having hearing aids are inclusion criteria. From the Korea National Health and Nutrition Examination Survey conducted on 44,085 individuals, 2009 through 2013, 237 participants' data was screened and used to evaluate hearing thresholds. To examine the differences in hearing characteristics between hearing aids and cochlear implants and those who do not use them, pure tone audiometry data of eight frequencies were retrospectively analyzed via an independent t-test.

Results
Two hundred thirty-seven participants (M: F = 134: 103, M = 69.7, SD = 10.8) showed no significant differences in gender, population, and age. Group comparison results show significant differences in 500Hz on both sides of the ears, the right $t(235) = 3.258$, $p = .001$, and the left $t(235) = 2.874$, $p = .004$. On the right ear, the hearing threshold in 1kH was significantly lower in those who hardly use the hearing devices, $t(235) = 2.141$, $p = .033$. Other pure tone frequencies over 1kHz showed no significance between those who use cochlear implants and hearing aids and those who hardly use the hearing devices.

Discussion
Although considering the limitation of unidentifiable who used cochlear implants/hearing aids, these results suggest that the hearing thresholds of the recipient of cochlear implants and hearing aids can affect the use of those devices.

Keywords : Cochlear implant, Hearing aid, Hearing threshold

Audiological Examination

PP 030

Preliminary study on the impact of auditory perception to cochlear implantation for residual hearing by evoking potential in the cortical auditory area

Chi Ching LIN[1], Mei Jui HUANG[1], Yen Jung PAN[1], Kuan Ju CHEN[1], Kuan Hua CHEN[1], Kuang Chao CHEN[1]

[1]*Holistic Hearing Healthcare Center, China Medical University Hospital, Taiwan*

Objective: In literatures, for children with residual hearing before cochlear implant, they would retain speech perception better than those without residual hearing (Robert D. Cullen,2004). However, from our clinical observation, not all hearing loss levels with cochlear implant would result in similar speech perception. Since speech perception relies on the central auditory processing that many literatures showed the difference in results of cochlear implant for residual hearing, this study intended to investigate if the cortical auditory evoked potential in terms of sound field thresholds in the cerebral cortex would vary among individuals due to different processing by the auditory center.
Method: 30 patients who received cochlear implant in our center from July 2021 to March 2023 were included in the study. 15 patients in the experimental group were diagnosed with severe sensorineural hearing loss with residual hearing before the implant, while the other 15 patients had complete hearing loss who received cochlear implant. Their age ranged from 2 to 32-year-old, with an average of 14.8 years in age. The residual hearing threshold before the surgery and the hearing preservation after operation were respectively recorded, as well as the post-operative CAEP and the sound field thresholds after three months of aural rehabilitation, which would be analyzed with descriptive statistics and M-ANOVA for significant difference.
Result: For both groups with and without residual hearing, there was no statistically significant difference in sound field thresholds. However, the CAEP of patients with residual hearing showed higher amplitude than CAEP P1 of those without residual hearing, and the latency was shorter.
Conclusion: Regardless of unilateral or bilateral cochlear implant, there was significantly higher cortical auditory evoked potential in patients with residual hearing than those without, but in terms of sound field thresholds, both groups showed no significant difference.

Keywords : Cortical auditory evoked potential, Residual hearing, Sound field thresholds

Radiology

PP 031

A Novel Methodology in the Identification of Inner Ear Malformation Types

Anandhan DHANASINGH[1,2]

[1]*R&d, Med-el, Austria*
[2]*Translational Neurosciences, University of Antwerp, Belgium*

Pre-operative computer-tomography (CT) scans of temporal bones of 112 ears with various IEM types were taken for analysis. Images were analyzed using DICOM viewers, 3D-slicer and OTOPLAN®. The inner-ear was captured in oblique-coronal plane for the measurement of length and width of cochlear basal turn which is also called as A-, and B-values respectively (Step- 1). In the same plane, the angular-turns of lateral-wall (LW) of cochlear basal turn were measured (Step-2). As step-3, mid-modiolar section of inner ear was captured in the axial plane by following A-value and perpendicular to cochlear view. From mid-modiolar section, the outer-contour of inner ear was captured manually by following contrasting grey area between fluid filled and bony promontory and was compared to known resembling objects to identify IEM types (Step-3).

Following reference values have emerged from our analysis: A-, and B-values (Step-1) on average are > 8mm and > 5.5mm respectively in normal cochleae (NA), enlarged vestibular aqueduct syndrome (EVAS), incomplete partition (IP) type-I and II, whereas it is < 8mm and < 5.5mm respectively in IP type-III and cochlear hypoplasia (CH). Angular-turn of LW consistently observed in cochlear basal turn (step 2), is 540° in NA and EVAS, 450° in IP II, and 360° in IP types I & III. In subjects with CH type, angular-turn of LW is either 360° or 450° or 540°. In true mid-modiolar section, outer-contour of inner-ear (step-3), other than in CH and cystic inner-ear malformations, resembles recognizable shapes of known objects. Absence of EVA is an additional characteristic that confirms diagnosis of CH when the A-, B- values, and angular-turn of LW can be similar to other anatomical types. Drawing a straight line along posterior edge of internal auditory canal (IAC) in axial view can differentiate a true common cavity (CC) from cochlear aplasia-vestibular cavity (VC).

Keywords : Inner ear malformation, Cochlear view, Mid-modiolar section

Radiology

PP 032

Analysis of cochlear morphology prior to cochlear implantation using three-dimensionally reconstructed computed tomography images

Beomcho JUN[1], **Sunwha SONG**[2]

[1]*Otolaryngology, Uijeongbu St. Mary Hospital, Catholic University, Korea*
[2]*Radiology, Uijeongbu St. Mary Hospital, Catholic University, Korea*

Objective: Preoperative evaluation of cochlear morphology is important for successful cochlear implantation. This study analysed the cochlear canal by three-dimensional reconstructions of temporal bones using computed tomography (CT).
Methods: Fifty temporal bones from 25 patients aged 42–74 years were evaluated. The inner spaces of the bony cochlea were reconstructed using a surface rendering technique on the CT images. Eight angular points (P0–P7) every 90° were selected from 0° to 630° from the center of the round window using the reconstructed cochlear canal images. The radius (R) and thickness (T) of the cochlear canal at each point were measured. The cochlear canal length (CoCL) was estimated using an equation based on the radius at each point. The cochlear width and height based on multiplanar CT images were also measured and compared with the length and volume of the cochlear canal.
Results: The mean CoCL from 0° to 630° was 31.5 mm, and the cochlear volume was 55.9 mm3. The CoCL to P7 was correlated with the cochlear volume (r = 0.77), coiling ratios (R4/R0, r = 0.47; R5/R1, r = 0.384), cochlear width (long) (r = 0.539), cochlear height (r = 0.385), and total thickness at each point (r = 0.475). The cochlear volume was correlated with CoCL (630°) (r = 0.77), coiling ratio (R4/R0, r = 0.367), cochlear width (long) (r = 0.616), cochlear height (r = 0.447), and total T (r = 0.566).
Conclusions: Preoperative evaluation using three-dimensional reconstruction can elucidate the size and shape of the cochlear canal before cochlear implantation. This will aid selection of optimal cochlear implants for individuals.

Keywords : Cochlear, Morphology, Tomography

Radiology

PP 033

Feasibility and Limitations of Head Magnetic Resonance Imaging in Patients with Cochlear Implants

Shu YOKOTA[1], **Hidekane YOSHIMURA[1]**,
Kyoko SHIRAI[2], Yutaka TAKUMI[1]

[1]Department of Otorhinolaryngology- Head and Neck Surgery, Shinshu University School of Medicine, Japan
[2]Department of Otorhinolaryngology, Head and Neck Surgery, Tokyo Medical University, Japan

Cochlear implants (CIs) were not fully compatible with magnetic resonance imaging (MRI) initially. Recently, implants that allow MRI without magnet removal or bandage fixation have become available. However, these magnetic resonance images are sometimes deteriorated by artifacts and are not clinically applicable. In this study, we analyzed head MRI in four cases after cochlear implantation at our department and discussed the differences in the size of artifacts with respect to imaging methods and sequences with their clinical validity. Without magnet removal, diffusion-weighted images and T2 star-weighted images had larger artifacts and less useful images. T1-weighted images, T2-weighted images (T2WIs), T2-weighted fluid-attenuated inversion recovery images, and heavy T2WIs could evaluate the unimplanted side and middle of the head but had limited applicability on the CI side. The characteristic features of images differ from one MRI method to another as well as with the sequence, suggesting that it is essential that the MRI is planned based on clinical feasibility and the requirement. We should keep in mind the characteristics of images obtained from each MRI method and sequence. According to the aim of MRI, we need to judge whether the images are clinically feasible in advance of image testing.

Keywords : Artifact, Imaging method, Sequence

Radiology

PP 034

Temporoparietal Scalp Thickness and Cochlear Implantation: A Radiological Study in an Asian Population

Elaine Hui Chen ANG[2], Daniel CH'NG[2], **David LOW[1]**,
Heng Wai YUEN[1]

[1]Otorhinolaryngology - Head and Neck Surgery, Changi General Hospital, Singapore
[2]Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore

Objective
Within the last decade, cochlear implant (CI) manufacturers have changed out the axial magnets in their receiver-stimulators to diametric ones. The latter has the benefit of greater MRI compatibility. However, the magnetic strength of diametric magnets are less than that of axial ones, causing issues with retention of the speech processor. Temporoparietal scalp thickness (TPST) is the main determinant of such retention. In our search of the literature, there has been no study on TPST in Asians. Besides, the multi-ethnicity of our local Asian population provides us with the unique opportunity to study the inter-ethnic variation of TPST.

Our primary aim was to determine the TPST in our local population via a retrospective chart and radiologic review. Our secondary aim was to analyse factors which correlated with TPST, including ethnicity.

Methods
200 consecutive patients who underwent fine-cut CT of the temporal bones and temporoparietal scalp in a tertiary centre were included. Those who previously underwent otologic and neurological surgeries, or had known dermatological conditions affecting the temporoparietal scalp were excluded. Measurements of TPST were performed by 2 independent observers as described in Adkins et al (2022). Statistical analysis was then performed.

Results
There was good intra and inter-observer reliability. The mean TPST in our subjects was 7.1 mm. On multivariate analysis, only age, gender and BMI correlated with TPST.

Conclusion
Our results suggest that CIs with diametric magnets are likely suitable for most of our local population without the need for flap thinning. However, Otologists need to be aware of factors which predict for an increased TPST. This will allow them to better select devices and counsel patients preoperatively, and plan for their surgeries optimally.

Keywords : Cochlear Implant, MRI Compatibility, Diametric Magnet

Radiology

PP 035

Preoperative Considerations for Patients with Vestibular Schwannomas before Cochlear Implantation

Sarah DRAUT[1], **Joachim MÜLLER[1]**

[1]Department of Otorhinolaryngology, Lmu Klinikum München, Lmu Klinikum Der Universität München, Germany

Introduction:
Severe to profound sensorineural hearing loss can be associated with benign tumour i.e. vestibular schwannomas (VS). The treatment modalities of VS offer surgical (translabyrinthine, middle fossa, retrosigmoid approache) and non-surgical interventions (wait and scan, stereotactic radiosurgery). Based on the results of Cochlear Implants for SSD, nowadays innovative possibility of simultaneous or sequential hearing rehabilitation with cochlear implants together with tumour removal puts preoperative considerations also for hearing restoration for those patients who do not want to undergo surgery in a new light.
Aim and methods:
MRI follow up is considered mandatory after VS treatment. This study evaluated proper placement of the implant ensuring further MRI-Follow-Up and imaging of the region of interest.
Using a dummy cochlear implant adopted to the patient's skull allows for an individually optimized positioning of the device in relation to the region of interest (tumour site). Thus preoperative placement was explored. A fluid filled blood collection tube over the pinna was used as a marker to determine the future implant position in relation to the pinna, ensuring later accurate intraoperative placement of the implant considering the preoperative MRI i.e. the region of interest (internal auditory canal).
Results:
Precise repeated placement and marking of a dummy cochlear implant enabled us to minimize artefacts and to optimize the position of the device in a preoperative MRI. MRI sequences allow for artefact reduction and visualisation of the internal auditory canal (IAC) and the tumour for follow up in relation to the tumour site assuring further MRI-Follow-Up.

The co-authors agree with the stated results and have consented to inclusion as authors.
Authors and co-authors declare no conflicts of interest.

Keywords : Vestibularschwannoma, MRI, Cochlea Implant

Radiology

PP 036

Clinical Applicability of 3D Segmentation in Diagnosis of Inner Ear Malformation and Prediction of Cochlear Implant Electrode Insertion Depth

Shujin XUE[1], Xingmei WEI[1], Biao CHEN[1], Danmo CUI[1], Ying SHI[1], Jingyuan CHEN[1], Lifang ZHANG[1], Mengya SHEN[1], Simeng LU[1], Xinyue ZOU[1], Xinyi ZHANG[1], Ying KONG[2], **Yongxin LI[1]**

[1]Department of Otorhinolaryngology Head and Neck Surgery, Beijing Tongren Hospital, Capital Medical University, Beijing, China
[2]Key Laboratory of Otolaryngology Head and Neck Surgery, Ministry of Education, Beijing Institute of Otolaryngology, Beijing Tongren Hospital, Capital Medical University, Beijing, China

Objective: To investigate the clinical applicability of 3D segmentation in diagnosis of inner ear malformation compare to multiple planar reconstruction (MPR), accomplish measure methods of size, shape, and the cochlear duct length (CDL) of malformed cochlear, simulate electrode implantation with 3D and 2D reconstructions to detect the value of 3D segmentation in prediction of cochlear implant electrode insertion depth.
Methods: Forty-four temporal bones CT datasets of patients with variety of inner ear malformations (including CH, IP-I, IP-II, IP-III) made available retrospectively. Cochlear dimensions including diameter, width, height, volume of cochlear, CDL and predicted angular insertion depth of 84 ears were measured twice in both MPR and 3D views. Inter-observation agreements of the measurements in the two reconstruct methods were analyzed.
Results: From 44 preoperative CT datasets, cochlear malformation types including IP Types I (14 ears), II (46 ears), and III (X-linked) (10 ears), and CH (14 ears) were diagnosed and reconstructed. Diameter, width, height, volume of cochlear and CDL of IP-I, IP-II, IP-III and CH were significantly different between different malformation types($p<0.05$). Measurements in 3D segmentation had good inter-observation agreements. The mean implantation angle prediction error was $|23.74|°$ in the 3D segmentation and $|34.17|°$ in the MPR, with a significant difference by paired samples t-test ($p=0.029<0.05$).
Conclusion: Three-dimensional segmentation from the temporal bone CT is a valuable tool for surgeons especially in cases with inner ear malformation, which will certainly help to understand the overall anatomical and dimensional variations and predict the electrode implantation situation, complete the preoperative imaging assessment process for cochlear implant for patients with inner ear malformation.

Keywords : Inner ear malformation, Cochlear implant, 3D segmentation

Radiology

PP 037

Application of fMRI in evaluation of auditory cortex in sensorineural hearing loss

Fang Zhong XIA

Ent, Wuhan Children Hospital, China

Functional magnetic resonance imaging (fMRI) is a new technology that is capable of showing brain functional status by testing magnetic field changes related to blood flowing into cerebral cells, providing accurate information regarding structural and functional relations. fMRI can be an important direct and objective imaging method for assessment of the central auditory cortex. This paper provides a review on the application of fMRI in evaluation of the auditory cortex in sensorineural hearing loss. Microscopic changes in the magnetic field gradient can be detected by enhancing the magnetic resonance signal, Some scholars through animal experimental studies, the results show that sensorineural hearing loss and normal temporal lobe of the volume of similar, found no atrophy of the temporal lobe, it is inferred that there is no loss of cells in the auditory cortex after sensorineural hearing loss, and there is functional remodeling and adaptation to noise in the auditory pathway and auditory cortex after sensorineural hearing loss, recombination occurs at the level of the auditory cortex. In patients with unilateral sensorineural hearing loss, fMRI showed that the activation intensity of medial geniculate body and inferior colliculus was greater on the contralateral side than on the ipsilateral side, while the auditory cortex was ipsilateral dominant and the auditory center had plasticity. The functional connectivity of resting fMRI in normal subjects and patients with unilateral sudden deafness is confined to the auditory system. The auditory pathway should be evaluated before cochlear implantation, and the direct and objective evaluation of the central auditory cortex depends on fMRI and electrophysiological techniques, fMRI is useful for screening patients with severe sensorineural hearing loss who are suspected to have potential auditory cortex problems before cochlear implantation, providing approach to preoperative assessment of auditory pathways.

Keywords : Functional magnetic resonance imaging fMRI, Sensorineural hearing loss, Auditory cortex

Radiology

PP 038

Cortical Volumetric Alterations Following Cochlear Implantation: MRI-based Correlational Study Using FreeSurfer in bilateral deaf adults

Yun Ji LEE[1], Hwon HEO[2], Hye Ah JOO[1], Yeonjoo CHOI[1], Woo Hyun SHIM[3], **Hong Ju PARK[1]**

[1]Otorhinolaryngology-head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea
[2]Convergence Medicine, Asan Medical Center, University of Ulsan College of Medicine, Korea
[3]Radiology and Research Institute of Radiology, Asan Medical Center, University of Ulsan College of Medicine, Korea

Objective: The objective of this study is to analyse the volumetric changes in brain MRI based on the word recognition scores (WRS) of patients before and after cochlear implantation (CI) in bilateral deaf adults.
Methods: From May 2020 to May 2022, patients who underwent CI and consented to participate in the study were included. For each subject, volumetric T1-weighted brain MRI (T1WI) were obtained before and one year after the surgery. We applied SynthSR, a public AI tool to turn heterogeneous clinical brain scans into high-resolution T1WIs for 3D morphometry. To run FreeSurfer, a full brain image without missing area is essential. To overcome the lost part due to the artifact caused by the internal device in post-CI image, image reconstruction was performed using the contralateral brain of the pre-CI MRI data.
Results : A total of 16 patients were included in the study, of which 13 had acquired hearing loss. We conducted within-subject template estimation for unbiased longitudinal image analysis by FreeSurfur, based on the linear mixed effect models, comparing before and after CI according to the WRS. The correlation analysis revealed a significant increase in cortical volume in the postcentral gyrus and superior temporal gyrus of contralateral hemisphere.
Conclusion: This technique provides a potential solution for detailed volumetric analysis of the CI recipients in contralateral hemisphere. Out study suggest that the contralateral postcentral gyrus and superior temporal gyrus is significantly increased associated with post WRS in patients who have undergone CI.

Keywords : Word recognition score, FreeSurfer, Superior temporal gyrus

Radiology

PP 039

Cochlear electrode angular insertion measurements using the post-operative x-ray.

Hessa Ali ALHAMMADI[1],
Ahmad Mohammad ALAMADI[1]

[1]Ent, Emirates Health Services, United Arab Emirates

Cochlear implant angular insertion of depth which is the angle of the last electrode; electrode 1 in relation to the round window is an important information for both surgeon and Audiologist. It will provide the anatomical position of the electrode inside the cochlea to know how deep we are and if the low frequency hearing level is covered and to improve the pitch match.
We explain a simple method to measure angle of insertion after cochlear implantation by using Routine plane x-ray taken postoperatively.
In order to avoid extra radiation to the patients from repeating CT scans and to reduce the cost and time for the patients and hospital services, we use the routine post-operative skull x-ray to measure the angular insertion of depth. Stenverse view is recommended to be used. Three reference lines are used.
• The first baseline is to define the position of the round window, it's a line from Superior Semicircular canal passing through the vestibule and the point where it will cross the electrode will be the round window position.

• A value from round window to lateral wall passing through modulus.
• B value: Line passing through modulus and making a 90 degree angle with A value line.
We measured retrospectively angle of insertion for our patients with different electrodes primarily performed by one surgeon.

Keywords : Angle of insertion, Cochlear implant, X-ray

Radiology

PP 040

Modified artifact reduction technique 3.0T MRI in cochlear Implantees receiving diametrically bipolar magnets

Kaitian CHEN[1], **Guanxia XIONG[1]**

[1]Otorhinolaryngology, The First Affiliated Hospital, Sun Yat-sen University, China

Background: The necessity of 3.0 Tesla MRI examination increases in cochlear implantees, particularly with the broad use of diametrically bipolar magnets implant. However, image artifacts remain challenge for many physicians, affecting the final diagnosis and efficiency of MRI.
Objectives: To explore the clinical results of 3.0 Tesla MRI using our modified artifact reduction technique (ART) in cochlear Implantees in this prospective study.
Methods: Five consecutive patients (two males and three females) implanted with diametrically bipolar magnets (Synchrony, Med-EL) received 3.0 Tesla MRI test due to necessary head disease re-examinations (e.g., pituitary adenoma). The duration of test after cochlear implant was one month to three months. Each patient wears a head bandage without magnet removal. We applied our modified ART practice to analysis the final MR images. Detailed technique included adjustment of scanning sequences and parameters for each study. Adverse events, including discomfort or pain and displacement of the internal magnet, were also recorded.
Results: All patients finished the MRI study. One patient (12 yrs. old) complained of pain (VAS score: 4) during the study, while the rests (aged 10 yrs. to 36 yrs.) felt no pain. Neither displacement nor tilt of the internal magnet was seen. Impedance test and neural response telemetry test were both similar before and after the test. Significantly, targeted diseases regions (e.g., pituitary area), as well as the auditory canal, were clearly revealed in MRI with our modified technique.
Conclusion: Minor MRI complications in cochlear implant with diametrically bipolar magnets (Synchrony, Med-EL) are acceptable. Our present modified ART greatly facilitates the clinical practice for cochlear implantees, who are candidates for 3.0 Telsa MRI study.

Keywords : Cochlear implant, MRI, Artifact reduction

Radiology

PP 041

Cochlear duct length and its relationship to audiological outcome after cochlear implantation surgery in prelingually deafened children

Vidhu SHARMA[1], Priyank AGRAWAL[1], Vishudh MOHAN[1], Sarbesh TIWARI[2], Pushpinder KHERA[2], Kapil SONI[1], Darwin KAUSHAL[3], Bikram CHOUDHURY[1], **Amit GOYAL[1]**

[1]Otorhinolaryngology, All India Institute of Medical Sciences, Jodhpur , Rajasthan, India
[2]Diagnostic and Interventional Radiology, All India Institute of Medical Sciences, Jodhpur , Rajasthan, India
[3]Otorhinolaryngology, All India Institute of Medical Sciences, Bilaspur, Himachal Pradesh, India

Introduction - With constant technological evolution of cochlear implants, a need for developing customized electrodes, which can be tailored according to the needs of each patient, is arising. With the advent of electrodes of variable sizes, it has become important to consider cochlear parameter measurement as part of routine preoperative evaluation. One such parameter is Cochlear Duct Length (CDL).
Objective - To assess the relation between cochlear duct length and audiological outcome after cochlear implant surgery in prelingually deafened children.
Methodology - In a prospective cohort study, 36 prelingually deaf children underwent cochlear implantation at AIIMS Jodhpur. Preoperative high-resolution computed tomography scans (HRCT) of temporal bones were used to calculate Cochlear duct length. Patients were followed 3 monthly postoperatively for audiological scoring using Infant Toddler Meaningful Auditory Integration Scale (IT-MAIS) & Revised Categories of Auditory Performance score (revised CAP score) up to one year.
Results – Thirty-six candidates were included in the study. Although malformed cochlea was not an exclusion criterion, all the candidates were found to have normal cochlear anatomy. All candidates received routine preoperative auditory-verbal therapy for at least 2-3 months. Mean age of candidates undergoing cochlear implantation was 50+/-13.335 months. The mean cochlear duct length was 32.185+/-1.725 mm. There was no statistically significant correlation between Cochlear Duct length as measured by HRCT and audiological scores (IT-MAIS & revised CAP score).
Conclusion - We found no statistically significant correlation between Cochlear Duct Length and audiological outcome after cochlear implantation in prelingually deaf children. If the surgeon has achieved full insertion of electrodes during cochlear implantation surgery, there is no effect of CDL on audiological outcomes.

Keywords : Cochlear implantation, Cochlear duct length, Audiological outcome

Radiology

PP 042

Comparison of depth of electrode insertion between Cochleostomy and Round Window approach: A Cadaveric Study

Anupriya JANGRA[1], Nidhin DAS K[1], Vidhu SHARMA[1], Pushpinder KHERA[2], Sarbesh TIWARI[2], Surajit GHATAK[3], Shilpi Gupta DIXIT[3], Ashish Kumar NAYYAR[3], **Amit GOYAL[1]**

[1]Otorhinolaryngology, All India Institute of Medical Sciences, Jodhpur, India
[2]Dignostic and Interventional Radiology, All India Institute of Medical Sciences, Jodhpur, India
[3]Anatomy, All India Institute of Medical Sciences, Jodhpur, India

Introduction - Round window approach and cochleostomy approach can have different depth of electrode insertion during cochlear implantation which can alter the audiological outcomes.
Objective - The objective of the current study was to determine the difference in the depth of electrode insertion via cochleostomy and round widow approach when done serially in the same temporal bone.
Methodology - A cross-sectional study was conducted in the Department of Otorhinolaryngology in conjunction with Department of Anatomy and Department of Diagnostic and Interventional Radiology over a period of one year. 12-Electrode array insertion was performed via each approach (cochleostomy and round window) in 12 cadaveric temporal bones. HRCT Temporal bone scan of the implanted temporal bone was done and depth of insertion and various cochlear parameters calculated.
Results - A total of 12 temporal bones were included for imaging analysis. The mean cochlear duct length was 32.892mm, the alpha and beta angles were 58.175 degrees and 8.350 degree, respectively. The mean angular depth of electrode insertion via round window was found to be 325.2 degree (SD= 150.5842) and via cochleostomy 327.350 (SD= 112.79) degree and the mean linear depth of electrode insertion via round window was 18.80 mm (SD= 4.4962), via cochleostomy 19.650 mm (SD=3.8087), calculated using OTOPLAN 1.5.0 software. There was statistically significant difference in linear depth of insertion via round window and cochleostomy. Although the angular depth of insertion was higher in CS group, there was no statistically significant difference.
Conclusion - Depth of electrode insertion is one of the parameters influencing the hearing outcome. Linear depth of electrode insertion was found to be more in case of cochleostomy as compared to round window approach (p=0.075), and difference in case of angular depth of electrode insertion existed but was not significant (p=0.529).

Keywords : Depth of insertion, Angular depth of insertion, Linear depth of insertion

Radiology

PP 302

Difficult round window access during cochlear implantation - a simple prediction method utilising preoperative CT imaging

Jun Wei SIA[1], Dhana Senthil KUMAR[1], Heng Wai YUEN[2], **Jia Hui NG[3]**

[1]Yong Loo Lin School of Medicine, National University of Singapore, Singapore
[2]Department of Otorhinolaryngology, Changi General Hospital, Singapore
[3]Department of Otorhinolaryngology, Singapore General Hospital, Singapore

INTRODUCTION: Difficulty with visualisation of the round window is an occasionally encountered issue during cochlear implant (CI) surgery. This paper presents a novel method for assessment of round window accessibility using preoperative computed tomography (CT) imaging.

METHODOLOGY: This is a retrospective review of all patients who underwent cochlear implantation in a tertiary hospital between 2018-2021. Patients with CT scans not available for review and patients with congenital anatomical anomalies such as aural atresia were excluded. Preoperative CT temporal bone scans were reviewed and 2 lines were drawn on axial cuts images. The first is a line intersecting the round window anterior margin and the anterior mastoid facial nerve; this is a surrogate marker of the position of the round window with respect to the facial nerve. The second is a line intersecting the round window posterior margin, tangent to the cochlear basal turn, representing the degree of cochlea rotation. Intraoperative notes were reviewed for all cases. Statistical analysis was performed using SPSS v29.0.0.

RESULTS: A total of 58 patients (60 ears) met inclusion criteria and were included in this study. Mean age of included patients was 40.8 years (range: 1.00-86.00). 57 cases (95.0%) were classified to have easy round window access whilst 3 cases (5.0%) were classified as difficult. All 3 difficult round window access cases were found to have lines which converged and intersected medial to the round window. All easy cases were found to have diverging lines which intersect lateral to the round window. This is statistically significant at $p<0.001$.

CONCLUSION: This study describes a simple and effective visual method to predict difficult round window access on axial CT temporal bone images, without the need for reconstructed images or to measure complex angles and distances, allowing for easy use by clinicians. Further analysis for interrater reliability is underway.

Keywords : Round Window Access, Cochlear Implant, Computed Tomography

Basic Research (Others) & Future Technology

PP 043

Possibilities for utilising electrocochleography after cochlear implant surgery

William Peter Rea GIBSON[1], Halit SANLI[1]

[1]Gladesville Cochlear Implant Centre, Nextsense, Australia

Electrocochleography can be performed utilising a cochlear implant electrode as the non-inverting (active) electrode. It has been used to monitor insertion of the array. There are three main potentials: action potentials, cochlear microphonics and summating potentials. The action potentials show residual audiometric levels. These can be obtained weeks or years after the surgery and indicate if useable hearing is present in recipients including in very young children. If there is sufficient remaining cochlear function, the summating potential can indicate if endolymphatic hydrops is present. The methodology and some early results will be shown.

Keywords : Electrocochleography, Residual hearing, Endolymphatic hydrops

Basic Research (Others) & Future Technology

PP 044

Speech Dereverberation Based on Integrated Deep and Ensemble Learning Algorithm for Cochlear Implant Coding Strategy

Chao-Min WU[1], Harisma Khoirun NISA[1,2]

[1]*Electrical Engineering, National Central University, Taiwan*
[2]*Data Science, Pt. Mitra Pinasthika Mulia, Indonesia*

Purpose

Human speech activity in the real world is still distorted by background noise and reverberant condition that affects the speech intelligibility, especially for cochlear implant (CI) users. Even in a noiseless environment, reverberation still makes people with hearing loss unable to hear clearly. The purpose of this study is to investigate the performance of Mandarin speech perception under various reverberant conditions using efficient machine learning algorithm with a small amount of training data and limited computational resource.

Method,

The neural network architectures were investigated in this experiment including two dereverberation algorithms, i.e., hierarchical extreme learning machine (HELM) and integrated deep and ensemble learning algorithm (IDEA). For our purpose, the HELM model provides training efficiency with a small amount of training data and limited computational resources. We further investigated the optimal network structure of the HELM model.

In this study, sentences from TMHINT (Taiwan mandarin hearing in noise test) previously recorded by our research team (NCU, one male and female) and Academia Sinica (AS, 4 male and 4 female speakers) were used as the speech material for experiments. These data were simulated as the reverberant speech under three different conditions for training and one condition for testing.

This experiment was evaluated with short-term objective intelligibility (STOI) to measure the speech intelligibility of speech enhancement.

Results

The results showed that the HELM framework performed better than those of the IDEA for speech dereverberation in a limited training dataset (10%, 25% and 50% of the training dataset) with window size 3 and neuron layers [2000 2000 4000]. This performance demonstrated its effectiveness in a limited training data.

Conclusion

With efficient learning under a small amount training data and fast training time, HELM model could be considered as an extension of a deep learning based CI sound coding strategy.

Keywords : HELM, CI Coding Strategy, Speech Dereverberation

Basic Research (Others) & Future Technology

PP 045

Quality of reporting of randomised controlled trials of artificial intelligence in healthcare: a systematic review

Bushra AYUB

Learning Research, Patel Hospital, Pakistan

Objectives: The aim of this study was to evaluate the quality of reporting of randomised controlled trials (RCTs) of artificial intelligence (AI) in healthcare against Consolidated Standards of Reporting Trials—AI (CONSORTAI) guidelines.

Material and Methods: Data sources We searched PubMed and EMBASE databases for studies reported from January 2015 to December 2021. Eligibility criteria We included RCTs reported in English that used AI as the intervention. Protocols, conference abstracts, studies on robotics, and studies related to medical education were excluded. Two independent graders graded the included studies using the CONSORT-AI checklist, comprising 43 items. The results were tabulated and descriptive statistics were reported.

Results: We screened 1501 potential abstracts, of which 112 full-text articles were reviewed for eligibility. A total of 42 studies were included. The number of participants ranged from 22 to 2352. Only two items of the CONSORTAI items were fully reported in all studies. Five items were not applicable in more than 85% of the studies. Nineteen percent (8/42) of the studies did not report more than 50% (21/43) of the CONSORT-AI checklist items.

Conclusions: The quality of reporting of RCTs in AI is suboptimal. As reporting is variable in existing RCTs, caution should be exercised in interpreting the findings of some studies

Keywords : Artificial intelligence, Healthcare, Consolidated Standards of Reporting Trials(CONSORT)

Basic Research (Others) & Future Technology

PP 046

Research is an important skill for Otolarygology residents. How should it be developed?

Bushra AYUB

Learning Research Centre, Patel Hospital, Pakistan

The time has changed. You could be an exemplary clinician or surgeon, but only a few people will know who you are. Having high-caliber publications increases your recognition on a global scale. No one will be aware that you handled a novel situation or used a newly developed strategy unless you publish it. Research always gives you an upper hand on those who not done it.

The objective of research is considerably broader than merely writing a synopsis and desertion. In addition to advancing your knowledge, researches and publications can broaden your expertise and help you to obtain grants for scholarships, conferences and academic trips. It assists you in strengthening your resume and increasing recognition, which helps to boost your chances of receiving fellowships and necessary job positions.

However, a lot of the trainees hold a variety of preconceptions, which causes them to become frustrated with their academic or research coursework. To make every effort through research, you require better mentoring and supervision. Remember that you need knowledge, skills, and research to succeed as a great doctor.

Keywords : Awareness, Research skills, Otolayngology

Basic Research (Others) & Future Technology

PP 047

A feasibility study of sound localization training using virtual reality in single-sided deafness

Haewon RHI[3], Leeseul SHIM[1,2], Ja Hee KIM[1,3], Gibbeum KIM[1], **Hyo-Jeong LEE[1,2,3]**

[1]Laboratory of Brain & Cognitive Sciences For Convergence Medicine, Hallym University College of Medicine, Korea
[2]Ear and Interaction Center, Doheun Institute For Digital Innovation in Medicine (d.i.d.i.m.), Hallym University Medical Center, Korea
[3]Department of Otorhinolaryngology-head and Neck Surgery, Hallym University College of Medicine, Kore

Appropriate auditory stimuli that contain accurate spatial cues are essential to train participants to localize sound using virtual reality (VR) technology. The generic head-related transfer function (HRTF) grounds the programmed spatial audio in VR does not reflect individual variation in monaural spatial cues, which is critical for auditory spatial perception in patients with single-sided deafness (SSD). As binaural difference cues are unavailable, auditory spatial perception is a typical problem in the SSD population that warrants intervention. This study assessed the applicability of binaurally recorded auditory stimuli in VR-based training for sound localization in SSD patients.

Sixteen subjects with SSD and thirty-eight normal-hearing controls (NHs) underwent VR-based training for sound localization and were assessed three weeks after completing training. The VR program incorporated pre-recorded auditory stimuli created individually in the SSD group and over an anthropometric model in the NH group.

Sound localization performance revealed significant improvement in both groups after training, with retained benefits lasting for an additional three weeks. Subjective improvements in spatial hearing were confirmed in the SSD group.

By examining individuals with SSD and NH, VR-based training for sound localization that used binaurally recorded stimuli, measured individually, was presented as effective and beneficial. Furthermore, VR-based training does not require sophisticated instruments or setups. These results suggest that this technique represents a new therapeutic treatment for impaired sound localization.

Keywords : Sound localization, Virtual reality, Single-sided deafness

Basic Research (Others) & Future Technology

PP 048

Preoperative Neuroanatomical Differences Predict Speech Development in Children with Cochlear Implants: Cross-Validation and Preliminary External Validation

Di YUAN[1,2], Patrick C. M. WONG[1,3], **Nancy M. YOUNG[4,5]**

[1]Brain and Mind Institute, The Chinese University of Hong Kong, China
[2]Department of Psychology, The Chinese University of Hong Kong, China
[3]Department of Linguistics and Modern Language, The Chinese University of Hong Kong, China
[4]Department of Otolaryngology - Head & Neck Surgery, Northwestern University, USA
[5]Division of Otolaryngology - Head & Neck Surgery, Ann & Robert H. Lurie Children's Hospital of Chicago, USA

Cochlear implant (CI) is one of the most successful neural prostheses that enables children with sensorineural hearing loss (SNHL) to perceive sounds and develop their speech and language abilities. However, individual differences in post-CI outcomes pose a significant challenge for interventions in both educational and clinical settings. This study aims to predict the post-CI outcomes using preoperative brain structural data obtained from MRI scans of pediatric CI candidates. The primary sample consists of 118 children with congenital SNHL from the Lurie Children's Hospital in Chicago (55 girls, age at CI activation = 28.8 ± 20.6 months). Their whole brain gray matter (GM) density was calculated by voxel-based morphometry and used to predict the speech and language abilities up to 24 months after CI. Machine learning was conducted using a nested k-fold cross-validation procedure and a support vector regression (SVR) classifier. Additionally, the predictive model was externally validated by an independent sample of thirteen children with SNHL from the Prince of Wales Hospital in Hong Kong (8 girls, age at CI activation = 36.4 ± 17.8 months). The predictability was measured by Spearman rank correlation between the predicted values and the actual observations. The higher the correlation, the more accurate the predictive performance of the model. Post-CI outcomes can be predicted using preoperative neural features from the primary sample (predictability: $r = 0.47$, $p < 0.001$, two-tailed), which was externally validated with data from the independent sample (predictability: $r = 0.49$, $p = 0.046$, one-tailed). These results provide evidence that preoperative brain structure can serve as an objective feature to predict long-term post-CI speech and language development in children with SNHL. Our model may help identify children who may receive limited benefit from CI to offer necessary interventions beforehand.

Keywords : Children with sensorineural hearing loss, Post-CI outcomes, Preoperative brain structure

Basic Research (Others) & Future Technology

PP 049

EFFECT OF ARGININE METHYLTRANSFERASE INHIBITOR-1 ON CISPLATIN OTOTOXICITY IN COCHLEAR CELLS: A Preliminary Study

Yüksel OLGUN[1], Selen Kum ÖZSENGEZER[2], Hongling YUAN[2], Kerem ALTUN[3], Zekiye ALTUN[2]

[1]Otorhinolarygology, Dokuz Eylül University School of Medicine, Türkiye
[2]Basic Oncology, Dokuz Eylül University Institute of Oncology, Türkiye
[3]School of Medicine, Dokuz Eylül University, Türkiye

Cisplatin is a chemotherapeutic drug widely used in oncology clinics. Its long-term administration may cause ototoxicity and subsequent hearing loss. Protein arginine methyltransferase 5 (PRMT5) is involved in several processes, including gene transcription regulation, DNA repair damage and other biological processes. Arginine methyltransferase inhibitor 1 (AMI-1) is a small molecule inhibitor of PRMTs. The effect of AMI, a selective PRMT5 inhibitor, on cisplatin ototoxicity has not been determined. In this study, we aimed to determine whether AMI-1 has a protective effect against cisplatin-induced (CDDP) ototoxicity in the House Ear Institute-Organ of Corti 1 (HEI-OC1) cell line through apoptotic (Bax, Bcl2) and PRMT5 gene expressions.

HEI-OC1 cells were grown with using high glucose DMEM and 10% FBS at 33ºC. HEI-OC1 cells were treated with AMI-1, CDDP and AMI-1-CDDP combinations for 24, 48 and 72 hours. Cell viability was measured by MTT. After 24 hours AMI-1 (50µM), CDDP (40 µM) and AMI-1-CDDP (50µM-40µM) treatment of cells, PRMT5, BAX and BCL2 gene expressions were determined by RT-PCR. Compared to the control group, no decrease in cell viability was detected in the AMI-1 group, while a 50% decrease was detected in the CDDP group. A significant increase in viability was found in the AMI-1-CDDP group compared to the CDDP.

When the PRMT5 gene expression was examined, there was no change in AMI-1 compared to the control group, while a 1-fold decrease was found in CDDP and AMI-1-CDDP groups. There was no significant change in BAX and BCL-2 gene expressions compared to control. According to the preliminary data of the study, AMI-1 has a protective effect against CDDP ototoxicity by affecting cell viability. However, further experiments are needed to reveal the mechanism of action. (This study was financially supported by Health Institutes of Turkey (TUSEB -20161)).

Keywords : Hair Cells, Arginine Methyltransferase Inhibitor-1, Cisplatin

Basic Research (Others) & Future Technology

PP 050

How dependent are recent image guided individualization techniques for cochlear implantation on observer and imaging type?

Daniel SIEBER[1], Max TIMM[2], Tobias WELLER[2], Marie SUHLING[2], Thomas LENARZ[2], Daniel SCHURZIG[2,3]

[1]Medical & Health Technologies, Mci | The Entrepreneurial School, Austria
[2]Dept. of Otolaryngology, Hannover Medical School, Germany
[3]Med-el Research Center, Med-el, Germany

Background

Image guided individualization for selection of cochlear implants and programming of stimulation parameters has been increasingly popular. However, manual tracings and estimation algorithms utilized in assessment of the cochlear spatial lateral wall are associated with observer related variabilities, which may negatively impact derived clinical recommendations for electrode individualization. The aim of our study was to investigate such deviations across different image types and qualities as well as three different state-of-the art assessment methods.

Methods

The study used five publicly available digitized human temporal bones including micro-slicing, as well as CBCT data at two quality levels. The lateral wall was manually traced and parametrized in regards of diameter, width and height for all modalities by four observers resulting in 60 delineations of the bony lateral wall and 180 cochlear parametrizations in total. State-of-the-art elliptic-circular approximation and regression scaling models were used to estimate cochlear geometry. Radial and height deviations were computed along the cochlear spiral as well as deviations in total length, total angular length and tonotopic frequencies.

Results

Significant observer related radial and height deviations were found across imaging modalities. Differences in tonotopic frequency were found in the range of four semitones at 540° in high-resolution CT. Long electrode arrays were found to be anatomically indicated in four out of the five anatomies consistently across imaging modalities and assessment methods. Observers consistently identified the remaining anatomy as requiring a shorter electrode array.

Conclusions

Manual tracing as well as state-of-the-art estimation methods for the bony lateral wall yield observer and image modality related deviations. Automation of the anatomical characterization may offer potential in minimizing such inaccuracies. Nonetheless, observers were consistently able to detect a smaller inner ear demonstrating the ability of current methods to contributing to an optimized choice of electrode based on individual patient anatomy.

Keywords : Individualization, Image-Guided Surgery, Cochlear Implantation

Basic Research (Others) & Future Technology

PP 052

Clinical application of the 4K-3D exoscope system in cochlear implantation

Honglei ZHANG[1,2], Guojian WANG[2], Xin ZHANG[3], Wei LIU[3], Jun XIAO[1], Han XIA[3], Yongyi YUAN[2], Bo GAO[2], Dongyang KANG[2], Hang SHAO[3], Qionghai DAI[3], **Pu DAI[2]**

[1]Ent Department, Air Force Medical Center, Pla, China
[2]College of Otolaryngology Head and Neck Surgery, Chinese Pla General Hospital, China
[3]Zhejiang Future Technology Institute, Zhejiang Future Technology Institute, China

Purpose: To evaluate a system for otomicrosurgery that is based on 4K three-dimensional (3D) exoscope technology and apply it to cochlear implantation.
Methods: An open stereoscopic vision-based surgical system, which differs from traditional surgical microscopes, was created by utilizing 4K stereo imaging technology and combining it with low-latency 4K ultra-high-definition 3D display. The system underwent evaluation based on 57 cochlear implantation surgeries, three designed microscopic manipulations, and a questionnaire survey.
Results: The surgical images displayed by the 4K-3D exoscope system (4K-3D-ES) are stereoscopic, clear, and smooth. The use of 4K-3D-ES in cochlear implantation is not inferior to traditional microscopes in terms of intraoperative bleeding and surgical complications, and the surgical duration is not slower or may even be faster than when using traditional microscopes. On this basis, 4K-3D-ES offers several advantages, including clearer identification of fine structures, a more relaxed visual experience when enlarging the surgical field, reduced fatigue in the neck, shoulders, waist and back of users, better assistant cooperation and synchronous teaching with multiple people sharing a stereoscopic view. In addition, it facilitates the convenient storage of high-definition stereoscopic surgical image data for later sharing experiences and publishing images in books.
Conclusion: The 4K-3D-ES enables low-latency head-up stereoscopic observation of microscopic tissue structures, demonstrating its safety and feasibility for cochlear implantation through clinical testing.

Keywords : 4K-3D, Exoscope technology, Cochlear implantation

Basic Research (Others) & Future Technology

PP 053

Machine learning and cluster analysis in predicting prognosis of idiopathic sudden sensorineural hearing loss

Ryouhei AKANABE[1], **Harukazu HIRAUMI[1]**

[1]Department of Otorhinolaryngology-head and Neck Surgery, Iwate Medical University, Japan

Logistic regression analysis (LRA) has been used to predict the prognosis of idiopathic sudden sensorineural hearing loss (ISSNHL), but it has problems. One is the non-linearity of the explanatory variables and the other is that the audiogram type (AT) is decided visually. Recently, non-linear analysis using machine learning has been examined, and the AT have been revised using cluster analysis (CA). However, no analyses were conducted about the combination of these two procedures and the results were not compared to LRA. In this study, we compared the machine learning with LRA, with and without CA.
The data were extracted from 2442 patients registered in a Japanese multicenter database. We used the average hearing on the affected side, the averaged hearing on the healthy side, days from the onset of illness to the start of treatment, the presence of vertigo, and the type of the hearing loss (5 factors). Analysis with more factors was also conducted including smoking, hyperlipidemia, tinnitus, heart disease, renal disease, diabetes, stroke, age, and sex (14 factors). The type of the hearing loss is decided according to the conventional AT or from the CA. In CA, the type of the hearing loss was classified into five groups. The analysis algorithms were LRA, deep belief network, random forest, support vector machine (SVM), multilayer perceptron (MLP), Lasso regression, and gradient boosting.
Machine learning improved the predictivity of ISSNHL compared to LRA. SVM and MLP showed good results with 5 factors. With 14 factors, random forest showed same result to these 2 procedures. CA improved the prediction in LRA and Lasso regression. In the other analysis, the AT showed better results. This may suggest that the conventional AT are valid and the problem concerning the non-linearity is overcome by the machine learning.

Keywords : Machine learning, Cluster analysis, Sudden sensorineural hearing loss

Basic Research (Others) & Future Technology

PP 054

Speech perception and subjective questionnaire outcomes by the new Cochlear™ Nucleus® 7 Sound Processor compared to previous processors in experienced cochlear implant users for more than 10 years

Jee Yeon LEE[1], **Hong Ju PARK[1]**

[1]Department of Otorhinolaryngology Head & Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea

To assess objective speech recognition performance,aided hearing thresholds, and dynamic ranges following a one-year usage with the new Cochlear™ Nucleus® 7 Sound Processor (SP), in experienced cochlear implant(CI) users with previous SPs for more than 10 years who are believed to have a stable performance. 77 experienced CI users who were newly fitted with and used the Nucleus 7 SP for more than one year were enrolled. Baseline open-set monosyllabic word recognition score (WRS) using each participant's previous SP was assessed before the upgrade to the Nucleus 7 SP and were compared to the WRS which was assessed 1 year after the upgrade of SP using the new SP. To adjust the variables according to the timing of the examination, the baseline WRSs using previous SPs were compared to those assessed 1 year before the upgrade, using previous SPs. Changes of aided hearing thresholds and C- and T-levels were analyzed in the same manner. Subjective evaluation of comfort and listening performance with Nucleus are reported for CI users questionnaires after four weeks of device use . Previous SPs were 3G in 5, Freedom in 40, N5 in 24, and N6 in 6. The baseline WRSs (76±19%) using previous SPs were equivalent to those (74±19%) obtained using the same previous SP 1 year before the upgrade. However, WRS (80±17%) with the Nucleus 7 SP at 1 year after the upgrade was significantly better when compared to performance with the previous SP. The Nucleus 7 SP showed similar currents in C-levels, but significantly higher T-levels at high frequencies compared to the previous SP. Long-term CI users showed improved speech perception ability and better hearing thresholds after upgrade to the Nucleus 7 speech processor, though there were subjectively better satisfaction in ease of use, connectivity, talking on the telephone, and quality of sound.

Keywords : Growing up with CI, Subjective questionnaire outcomes, Speech processor

Basic Research (Others) & Future Technology

PP 055

A Study on the Development of Middle-Ear Microphone for Fully Implantable Hearing devices using piezoresistive sensor

Woonhoe GOO[1,6], Jongwoo LIM[2], Keedong YANG[3], Namkeun KIM[4], Jaehoon SIM[5], **Seung-Ha OH[1]**, Juyong CHUNG[6]

[1]Department of Otorhinolaryngology, Seoul National University Hospital, Korea
[2]Department of Mechanical Engineering, Korea Advanced Institute of Science and Technology (kaist), Korea
[3]Advanced Medical Device Research Center, Korea Electrotechnology Research Institute (keri), Korea
[4]Department of Mechanical Engineering, Sogang University, Korea
[5]Department of Otorhinolaryngology, Head & Neck Surgery, University Hospital Zurich, University of Zurich, Switzerland
[6]Department of Otolaryngology, Wonkwang University School of Medicine, Korea

Most conventional cochlear implants and hearing devices use the external microphones to capture the sound field. However, the external devices cause some challenges, such discomfort, social stigma, and restrictions on physical activity such as swimming. In order to overcome these limitations, the development of implantable microphone is one of the main challenges. A bio middle-ear (ME) microphone that obtains acoustic energy from vibrations of the eardrum or ossicles has the advantage of being able to use the physiological amplifier effects and acquiring the directionality of sound. Using a high-sensitive MEMS piezoresistive sensor, a bio middle-ear microphone inserted between the umbo to promontory was designed. Umbo movements was measured and analyzed using laser-doppler-vibrometer (LDV) from fresh-frozen temporal bones (TBs). After mastoidectomy and posterior tympanotomy, the sensor package was inserted between the umbo and promontory, and the remaining space was filled with biocompatible silicone. An sound pressure was stimulated with 0.5Hz ~ 8 kHz pure tone and 100Hz ~ 10 kHz sweep sound. Finite element method (FEM) 3D model simulation was performed to compare the effect of insertion of the sensor package. We developed a novel implantable ME microphone package (Juyong Chung et al., Korea Patent 10-2022-0125929). The effect of sensor package insertion resulted an average 5dB decrease in displacement transfer function (DTF; normalized umbo movement by SPL). which is a similar result compared to the FEM simulation result. The SNR for pure tone sound achieved a maximum of 55dB. The EIN is 50 dB or higher, it was thought that a 10 times improvement would be necessary for commercialization.The high EIN value and the low SNR value are still insufficient to be used as a bio middle-ear microphone. In order to develop an ideal implantable ME microphone, the sensor needs to require 10 times improvement in SNR, EIN, and sensitivity.

Keywords : Cochlear implant, Hearing device, Microphone

Basic Research (Others) & Future Technology

PP 056

Mini-pigs are the better animal model for Cochlear Implantation

Chao JIANG[1,2,3,4,5], **Wei CHEN[1,2,3,4,5]**

[1]College of Otolaryngology Head and Neck Surgery, Chinese Pla General Hospital, Chinese Pla Medical School, China
[2]National Key Labortary of Hearing and Balance Science, Chinese Pla General Hospital, China
[3]National Clinical Research Center For Otolaryngologic Diseases, Chinese Pla General Hospital, China
[4]State Key Lab of Hearing Science, Ministry of Education, China
[5]Beijing Key Lab of Hearing Impairment Prevention and Treatment, Beijing, China

Purpose: There are about one billion people suffering hearing loss in the world. The most effective treatment for severe sensorineural hearing loss is cochlear implants (CI), which can replace the function of hair cell to stimulate spiral ganglion neurons. Small animal models are the most commonly used for CI studies, but the cochlear structures in small animal models are significantly different from those in human. Therefore, it is necessary to explore large animal models which cochlear structures more closely resemble the structure of the human cochlea.
Method: We inserted CI electrode array designed for human into the miniature pigs through the round window membrane rather than designing a special cochlear electrode arrays for small animal models. The surgical process in pigs is similar to that in human. We selected two-month-old miniature pigs, anesthetized them using intramuscular anesthesia and ventilator-assisted respiration with isofluorane which is similar to that in human surgery, shaved the surgical area and performed the cortical mastoidectomy, exposed the round window membrane, and inserted the CI electrode array slowly. Then we checked the electrode impedance of all channels to confirmed the CI integrity and performed the evoked compound action potential (ECAP) test to evaluate the function of the auditory nerve, and confirmed the location of the arrays by CT scanning.
Result: The artificial cochlear electrode arrays designed for human could be suitable for implanting in mini-pigs.
Discussion: Although CI are a mature method for treating sensorineural hearing loss, many physiological and pathological mechanisms are unknown, which need large animal models similar to human. The inner ear anatomy of mini-pigs is similar to that of human and the price of mini-pigs is cheap. In addition, the mini-pigs are easy to obtain. So the miniature pigs are the better animal model for CI.

Keywords : CI, Animal model, Mini-pigs

Basic Research (Others) & Future Technology

PP 057

Age-Stratified Gender Differences in Verbal Fluency Tasks

Hyojeong KOH[1], Eun Jin PAEK[2], **Jee Eun SUNG[1]**

[1]Department of Communication Disorders, Ewha Womans University, Korea
[2]Department of Audiology and Speech Pathology, University of Tennessee Health Science Center, USA

Verbal fluency (VF) is a measure of cognitive ability associated with frontal lobe functions (Woods et al., 2005). VF abilities are often measured using phonemic fluency (PF), semantic fluency (SF), and action fluency (AF) tasks(Troyer & Moscovitch, 2006). Previous studies reported gender differences favoring females in PF tasks(Weiss et al., 2006), while findings from SF tasks were inconclusive (Capitani et al., 1998). This study aims to systematically investigate gender effects on VF by administering two tasks (SF and AF) across different age groups.

A total of 120 Korean-speaking individuals participated with three age groups: 1) 40 young (M=26.88; SD=3.851; Range=20-39), 2) 40 middle-aged (M=48.60; SD=5.495; Range=40-59), and 3) 40 older (M=64.80; SD=5.019; Range=60-75). Across all age groups, the gender ratio was matched by 20 per each with 16 years of education. They completed SF (animals) and AF (action-related words) tasks for one minute per each.

Three-way mixed ANOVA revealed significant main effects for task type [$F(1, 114) = 33.968$, $p < .0001$] (SF > AF), age group [$F(2, 114) = 38.20$, $p < .0001$] (Younger > Middle-aged > Older), and gender [$F(1, 114) = 13.278$, $p < .0001$] (Female > Male). The task x gender interaction was significant [$F(1, 57) = 3.957$, $p = .049$] with females generating more words in SF than AF tasks across the age groups.

This finding is consistent with previous studies that report female advantage in PF (Weiss et al., 2006), but contradicts with the results of male superiority in SF (Capitani et al., 1998). These results shed light on the potential influence of gender on different types of VF tasks and emphasize the need for further investigations into the underlying gender effects in VF measures.

Keywords : Gender differences, Semantic fluency, Action fluency

Basic Research (Others) & Future Technology

PP 058

Sentence comprehension abilities in age-related hearing loss on auditory and visual modalities

Jee Eun SUNG[1], Jimin PARK[1]

[1]*Department of Communication Disorders, Ewha Womans University, Korea*

Recent studies suggest that older adults with hearing loss(HL) struggle with processing sentences. They devote more cognitive resources to auditory processing, leaving fewer resources available for linguistic information processing compared to individuals with typical hearing(TH) (Wingfield et al., 2005; DeCaro et al., 2016). We investigated sentence comprehension abilities in HL and TH by varying the modality of presentation(auditory, visual).

Forty-four Korean-native speakers(22HL, 22TH) were age- and education-adjusted normal range on the following tasks: the Korean version of Mini-Mental State Examination (Kang et al., 2006), a short version of the Geriatric Depression Scale and an immediate recall of Seoul Verbal Learning Test in the Seoul Neuropsychological Screening Battery-II (Kang et al., 2012). Two groups did not significantly differ on these tasks, and TH had hearing threshold below 25dBHL on pure tone screening.

A sentence comprehension task was administered using auditory and visual paradigms. We manipulated the sentence-type(active, passive) and question-type(agent, theme). Accuracy and response time(RT) served as dependent measures.

In both auditory and visual paradigms, there were more errors($p=.002$ for auditory; $p<.001$ for visual) and longer RTs in passive- than active-sentences($p=.029$ for auditory; $p=.007$ for visual). HL demonstrated longer RT than TH($p=.006$ for auditory; $p=.018$ for visual). Theme-questions elicited longer RT than agent-questions only in the auditory paradigm($p=.007$).

The sentence- and question-type interaction was significant on both paradigms, showing longer RT on agent- than theme-questions on active-sentences, whereas the opposite pattern was observed in passive-sentences($p<.001$ for both). The group and sentence-type interaction was only significant on the visual paradigm; TH showed longer RT on theme- than agent-questions, while HL showed the opposite pattern($p=.042$).

HL exhibited challenges in comprehending sentences compared to TH, especially when sentences were presented visually. These findings imply that HL shows difficulties not only in hearing abilities but also in higher-level cognitive functions involved in processing linguistic information.

Keywords : Sentence comprehension, Age-related hearing loss, Auditory and visual modality

Basic Research (Others) & Future Technology

PP 059

A Comparative Analysis of Clustering and Switching in Semantic and Phonemic Verbal Fluency by Korean-speaking Older Adults with and without Hearing Loss

Junyoung SHIN[1], Eunji HWANG[1], Jisu SONG[1], Shinhee NOH[1], Hyeonju KIM[1], **Jee Eun SUNG**[1]

[1]*Department of Communication Disorders, Ewha Womans University, Korea*

The present study investigated semantic and phonemic verbal fluency in Korean-speaking older adults with hearing loss (HL) compared to those with typical hearing (TH). A total of 34 participants with 17 individuals in each group (HL and TH) were included. All participants exhibited normal performance (adjusted for age and education) on the Korean Mini-Mental State Examination (Kang, 2006), the Seoul Verbal Learning Test, the Digit Span Test from the Seoul Neuropsychological Screening Battery-II (Kang et al., 2012), and the Short version of Korean Geriatric Depression Scale. Semantic and phonemic verbal fluency tasks were administered, focusing on the total number of words produced, clusters, mean cluster size, and switches.

Results demonstrated no significant group differences in semantic verbal fluency performance. In phonemic verbal fluency, however, the HL group generated significantly fewer words and switches compared to the TH group. No significant differences were found in the number of clusters and mean cluster size between the two groups. Discriminant analyses were conducted to identify the most effective factor for differentiating the HL group from the TH group. The factors that best discriminated the two groups were the total number of words produced (sensitivity: 76.5%, specificity: 76.5%) and number of switches (sensitivity: 46.7%, specificity: 73.3%) in phonemic verbal fluency tasks.

Our findings indicate that older adults with hearing loss demonstrate lower production in phonemic verbal fluency compared to those with typical hearing. These results imply that impaired phonological search operations may contribute to poorer phonemic fluency performance in the aging population with hearing loss, indicating a greater impact on phonological representations in individuals with acquired hearing loss. Moreover, the utilization of phonemic verbal fluency tasks is valuable for assessing differences in verbal fluency between the two groups, with higher switching strategies being linked to increased productivity in phonemic verbal fluency.

Keywords : Semantic Verbal Fluency, Phonemic Verbal Fluency, Switching

Basic Research (Others) & Future Technology

PP 060

What is an ideal number of Cochlear implant channels? Results of analysis with AI based computational model and electrodogram study.

Prahlada NAYAKA BASAVANTHAPPA[1], Gopika RAJ[1], Shailashri NAYAKA PRAHLADA[1]

[1]*Ent - Head and Neck Surgery, Basaveshwara Medical College & Hospital, India*

During the last decade major developments in the cochlear implants involves design and manufacturing of electrode arrays. Now a wide variety of electrode arrays are available. There are several studies describing the pros and cons of these electrodes and there is no consensus about an ideal electrode and number of channels. Even though manufacturing high-density multi-channel electrode arrays is technically challenging, it may be a possibility in the future with the technical advancements. Multiple factors determine the outcome of a cochlear implant. We developed a physical and virtual model to assess the utility and outcomes of varying number of multi-channels to determine the ideal number of cochlear implant channels.

Methods: The physical model, the electrodogram and the virtual computational model based on an artificial neural network were used to assess the cochlear implant outcomes. Different electrical stimulation properties such as amplitude and pulse widths, at different inter-electrode distances, and two commonly used speech coding strategies were applied, on different number of CI channels and results were analyzed on MATLAB, a multi-paradigm programming language and numeric computing environment.

Results: A good speech perception was obtained at 8 channels. There was an incremental increase in the speech perception with an increasing number of channels, reaching a peak at 16 channels. Further increase in the number of channels did not offer additional advantage and was associated with electrical interference, which reduced the speech perception.

Conclusion: An ideal cochlear implant testing model is a working cochlear implant and a live subject. However, electrodogram and virtual models, artificial neural networks and computational algorithms can provide useful data which can help in future developments in cochlear implants. Increasing the number of channels may be technically feasible in the future, however high-density multi-channels may not offer much advantage due to multiple factors.

Keywords : Cochlear Implant, Muti-channel, Electrode array

Basic Research (Others) & Future Technology

PP 061

Comparison of cochlear implantation and inner ear gene delivery in miniature pigs

Wei CHEN[1], Xiaojun JI[1]

[1]*College of Otolaryngology Head and Neck Surgery, Chinese Pla General Hospital, China*

Cochlear implants (CI) are the most effective method to treat people with severe-to-profound sensorineural hearing loss. A large animal model with cochlea characteristics similar to those of humans may provide a research and evaluation platform for advanced and modified arrays before their use in humans. Inner gene therapy offers great promises as a potential treatment for hearing loss. One of the critical determinants of the success of inner ear gene therapy is to find a delivery method which results in consistent transduction efficiency of targeted cell types while minimizing hearing loss. We compared and established standard CI and inner ear gene delivery methods with Bama mini-pigs, whose inner ear anatomy is highly similar to that of humans. There is no difference between anesthesia and surgical preparation. The surgery routes include postauricular incision, cortical mastoidectomy and exposure of the round window membrane. The procedure of CI includes fix the receiver package and insert the electrode array. Whereas the micro-tube was introduced into the scala tympani through the round window membrane by a micro-injection pump. The surgical approach of trans-window membrane is an attractive option for inner ear gene delivery in big animal model. The procedure could be applied to research into new types of arrays and into biotherapy and gene therapy combined with CI. As a topic of future research, we aim to establish a series of methods to combine the CI and inner ear gene therapy to solve the problem of apoptosis of hair cells.

Keywords : Cochlear implant, Gene delivery, Comparsion

Basic Research (Others) & Future Technology

PP 062

Automated Pure-Tone Audiometry: A Narrative Review and its Potential Impact on Community Hearing Health Services

Nor Hidayah MOHAMMED HATTA[1,2],
Wan Najibah WAN MOHAMAD[1],
Mohd Normani ZAKARIA[1], **Mohd Fadzil Nor RASHID[1]**

[1]Audiology Programme, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia
[2]Otorhinolaryngology Department, Hospital Tuanku Ja'afar Seremban, Jalan Rasah 70300 Seremban, Negeri Sembilan, Malaysia

Automated pure-tone audiometry has emerged as a promising tool to revolutionize hearing health services, particularly in response to the escalating demand for accessible hearing testing in crowded urban clinics and underserved remote regions. In this narrative review, we comprehensively delve into automated audiometry, focusing on its validation, reliability, and potential advantages over traditional manual audiometry methods. While manual audiometry has long been considered the gold standard for hearing testing, automated audiometry demonstrates comparable outcomes, yielding clinically acceptable audiograms and presenting potential cost-saving benefits. The ability of automated audiometry to provide accurate results raises the prospect of optimizing the efficiency of audiologists, allowing them to allocate more time to other crucial aspects of hearing health care. This could lead to improved patient access to hearing services, particularly in areas facing a shortage of audiologists and hearing healthcare professionals. However, despite the promising features of automated audiometry, certain challenges require further exploration. Environmental noise can potentially impact the accuracy of test results, necessitating robust noise monitoring measures to ensure reliable outcomes. Moreover, translating automated audiometry instructions and reports into different languages and cultural contexts demands careful validation, where variations in language proficiency can influence test accuracy. The validation studies are vital across various languages and diverse cultural settings to assess the widespread applicability of automated audiometry. Such endeavors will provide valuable insights into the adaptability and accuracy of automated audiometry systems, allowing healthcare providers to implement these technologies in diverse populations confidently. Ultimately, this review underscores the transformative potential of automated audiometry in enhancing hearing health services globally and addressing the needs of underserved populations. By efficiently conducting hearing tests and improving accessibility, automated audiometry promises to contribute to a more equitable distribution of community hearing care services, thereby advancing the overall well-being and quality of life for individuals with hearing impairments.

Keywords : Pure Tone Audiometry, Self Hearing Test, Community Hearing Healthcare

Basic Research (Others) & Future Technology

PP 063

Stimulation crosstalk between cochlear and vestibular spaces during cochlear electrical stimulation.

Joyce TANG[1], Ángel RAMOS DE MIGUEL[2],
Isaura RODRIGUEZ MONTESDEOCA[1],
Juan Carlos FALCÓN GONZÁLEZ[1],
Silvia BORKOSKI BARREIRO[1], Andrzej ZAROWSKI[3],
Morgana SLUYDTS[3], Nadia FALCÓN BENITEZ[2],
Angel RAMOS MACIAS[1]

[1]Department of Otolaryngology, and Head and Neck Surgery, Complejo Hospitalario Universitario Insular Materno Infantil De Gran Canaria, Las Palmas, Spain, Spain
[2]Hearing and Balance Laboratory, University of Las Palmas De Gran Canaria, Las Palmas, Spain, Spain
[3]European Institute For Otorhinolaryngology, Gza Hospitals Antwerp, Wilrijk, Belgium, Belgium

Objectives: Possible beneficial "crosstalk" during cochlear implant stimulation on otolith end organs has been hypothesized. The aim of this case-control study is to analyze the effect of electrical cochlear stimulation on the vestibule (otolith end-organ), when using a cochleo-vestibular implant , comparing vestibular stimulation (VI) and cochlear stimulation (CI)
Methods: Four patients with bilateral vestibulopathy were included. A double electrode array research implant was implanted in all cases. Dynamic Gait Index, VOR gain measured by using vestibular head impulse test (vHIT), acoustic cervical myogenic responses (cVEMP) recordings, and electrical cVEMP were used in all cases. Transimpedance Matrix analysis was used to evaluate the current flow from the cochlea to the vestibule .
Results: While patients did not have any clinical vestibular improvement with the CI stimulation alone, gait metrics of the patients revealed improvement when the vestibular electrode was stimulated. The average improvement in the Dynamic Gait Index was 38% when the vestibular implant was activated, returning to normal range in all cases. Our findings suggest that any current flow from the cochlear space to the otolith organs was insufficient for effective cross-stimulation. The functional results correlated with the data obtained in Transimpedance Matrix analysis, confirming that there is no current flow from the cochlea to the vestibule .
Conclusion: The only way to produce effective electrical otolith end-organ stimulation, demonstrated with this research implant, is by direct electrical stimulation of the otolith end organs. No effective cross-stimulation was found from cochlear electrode stimulation.

Keywords : Vestibular implant, Cochlear implant, Balance

Basic Research (Others) & Future Technology

PP 064

Protective Effect of Resveratrol in an Experimental Model of Salicylate-Induced Tinnitus

Chul Ho JANG[1], Gwang-Won CHO[2], Changjong MOON[3], Ilyong PARK[4]

[1]*Otolaryngology, Gwangju Veterans Hospital, Korea*
[2]*Biology, Chosun University, Korea*
[3]*Veterinary Anatomy, Chonnam National University, Korea*
[4]*Biomedical Engineering, Dankook University, Korea*

To date, the effect of resveratrol on tinnitus has not been reported. The attenuative effects of resveratrol (RSV) on a salicylate-induced tinnitus model were evaluated by in vitro and in vivo experiments. The gene expression of the activity-regulated cytoskeleton-associated protein (ARC), tumor necrosis factor-alpha (TNFα), and NMDA receptor subunit 2B (NR2B) in SH-SY5Y cells was examined using qPCR. Phosphorylated cAMP response element-binding protein (p-CREB), apoptosis markers, and reactive oxygen species (ROS) were evaluated by in vitro experiments. The in vivo experiment evaluated the gap-prepulse inhibition of the acoustic startle reflex (GPIAS) and auditory brainstem response (ABR) level. The NR2B expression in the auditory cortex (AC) was determined by immunohistochemistry. RSV significantly reduced the salicylate-induced expression of NR2B, ARC, and TNFα in neuronal cells; the GPIAS and ABR thresholds altered by salicylate in rats were recovered close to their normal range. RSV also reduced the salicylate-induced NR2B overexpression of the AC. These results confirmed that resveratrol exerted an attenuative effect on salicylate-induced tinnitus and may have a therapeutic potential.

Keywords : Salicylate-induced tinnitus, Resveratrol, Protection

Basic Research (Others) & Future Technology

PP 065

Punjabi Articulation Errors in Cochlear Implant Children

Dharam VIR[1], Ritika DUTTA[1], Jyoti MAKKAR[1], Jaimanti BAKSHI[1], Naresh K PANDA[1], L. KAUR[2], P. KUMAR[2], Shailendra SINGH[3]

[1]*Department of Ent,, Post Graduate Institute of Medical Education and Research, Chandigarh, India*
[2]*Department of Education, Rayat Bahra University, Mohali, Punjab, India*
[3]*Department of Computer Science & Engineering, Punjab Engineering College, Deemed To Be University, Chandigarh, India*

Purpose: Around 15.8% children in India suffer from sensori neural hearing loss and require hearing aids or cochlear implant surgeries for developing listening and speaking skills. Cochlear implants although improves speech and language skills significantly but still few phonemic errors are common even after years of implantation. The main purpose of this study is to assess these common articulatory errors in children aged 3 - 18 years (36 months to 216 months) using Punjabi articulation test.
Methods: In this study total number of children was 18 in numbers which equally divided into male and female i.e. 9 male and 9 females. They were divided into three sub groups based on their hearing age (minimum hearing age of 12 months and maximum hearing age of 96 months). Inclusion Criteria: 1. Congenital Hearing Loss 2. Child predominantly exposed to Punjabi Language at home.
Results and Discussion: Medial level word error is common in all age group as compared to initials word errors. Almost all participants showed less difficulty in nasals and bilabials, proving that these sounds develop before other articulatory sounds. Participants make more errors in posterior sounds in comparison to the anterior, which highlights the importance of visual interpretations during speech. Our study showed that intelligibility increases as hearing age increases and most improvement occurs after 3-4 years (36 months to 48 months) of implantation.
Conclusion : These results concluded that articulatory errors varies with age of hearing and just like typically developing aged matched children anterior speech sound production is easy in comparison to posterior speech sounds.

Keywords : Punjabi Articulation Test (PAT), Congenital Hearing Loss, Cochlear Implant

Surgical Issues and Complications

PP 066

Various Approaches to the Round Window for Cochlear Implantation: A Systematic Review

Isra ALJAZEERI

Otology, King Abdullah Ear Specialist Center, Saudi Arabia

This can be presented as a keynote.

Round window (RW) approaches are used to insert the cochlear implant electrode array into the scala tympani. We aimed to review the literature to find the reported RW approaches.
Methods: This review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Articles that described their surgical approach to the RW were included. The PubMed, Scopus, Web of Science, and Cochrane Library electronic databases were searched through June 2021. The study protocol was registered on PROSPERO (CRD42021226940).
Results: A total of 42 reports were included. The following approaches were documented: the standard facial recess, keyhole, retrofacial, modified supra-meatal, trans-aditus, combined posterior tympanotomy, and endomeatal, modified Veria, canal wall down approaches, and endoscopically assisted technique.
Conclusion: This review suggests that there are numerous distinct RW approaches, providing alternatives when the RW is inaccessible through the standard facial recess.

Keywords : Cochlear implant, Round window, Surgery

Surgical Issues and Complications

PP 067

Panel discussion: Labrynthitis Ossificans

Isra ALJAZEERI

Otology, Ministry of Health, Saudi Arabia

A panel discussion with experts in the field discussing the controversial issues of the treatment options in patients with cochlear ossification.
Including a treatment algorithm.

Keywords : Cochlear implantation, Surgery, Labrynthitis ossificans

Surgical Issues and Complications

PP 068

Head Trauma in Children after Cochlear Implant and Its Effect on the Implants

Huidong CHEN[1], **Qingquan HUA[1]**, Jie REN[1]

[1]Otorhinolaryngology-head and Neck Surgery, Renmin Hospital of Wuhan University, China

Objective: To investigate types of head trauma and its influence on cochlear implant in pediatric cases for prevention and therapy.

Methods: A retrospective analysis was made for 327 cases (201 Males,126 Females) accepted CIs in Renmin Hospital of Wuhan University from January 2013 to March 2018 to investigate the types of head trauma,influence on cochlear implant and management.

Results: Of 327 cases in this study, there were 19 head trauma cases (5.81%, 19/327) , including 9 males and 10 females. 4 cases(21.05%) aged from 0~3 years old, 8 cases(42.11%) aged from 4~6 years old, and 7 cases(36.84%) aged from 7~13 years old. Types of head trauma included 3 cases of scalp contusion, 2 cases of scalp abrasion, 1 case of scalp laceration and 13 cases of scalp hematoma. There were 3 cases with skin flap infection and 2 cases with temporal bone fracture. Influence on CI included 2 cases of cochlear implant magnet displacement, 1 case of broken cochlear implant, and 1 case of surgical removal of cochlear implant due to infection. The scalp contusion and scalp abrasion were cured by debridement. The scalp hematoma were cured by puncture and drainage, pressure dressing and antibiotics to prevent infection. For the case of scalp hematoma with skin flap infection, surgery was performed to take out cochlear implant and reoperation was performed 6 months later. The case of scalp hematoma with magnet displacement and broken cochlear implant was cured by surgery.

Conclusions: Head trauma in CIs can cause scalp contusion, abrasion, laceration and hematoma. Influence on CI included cochlear implant magnet displacement and broken cochlear implant. Head trauma cases with skin flap infection and temporal bone fracture have greater impact on cochlear implants. Thus, it is important to prevent trauma and treat it in time. Surgical treatment is necessary when conservative treatment is ineffective.

Keywords : Cochlear Implantation, Head trauma, Complications

Surgical Issues and Complications

PP 069

Management of Exposed Cochlear Implant : Two cases of Salvaging Implants Using Rotational Scalp Flap

Young Jun SEO[1], Ji Hyung LIM[1], Jae Sang HAN[1], Jae Hyun SEO[1], **Shi Nae PARK[1]**

[1]Department of Otorhinolaryngology-head and Neck Surgery, Seoul St. Mary's Hospital, The Catholic University of Korea, College of Medicine, Seoul, Korea, Korea

Cochlear implant(CI) is an effective surgical option for managing severe sensorineural hearing loss. Among the postoperative complications, implant exposure has been considered as one of the most threatening and serious complications. Conventionally, replacing a new device after a removal of the exposed one has been performed. Salvaging the original implant can be challenging and recently has been reported as a successful management option using a rotational scalp flap reconstruction combined with implant coverage using a galeal flap. Here, we present our experience salvaging two cases of exposed cochlear implants. A 68-year-old female patient who underwent CI 4 years ago visit our clinic with an itching sensation near the implant device. Thin and erythematous scalp was observed, so we prescribed antibiotics and low-dose steroids and decreased the power of the magnetic device. Unfortunately, after 2 weeks, a slot-like dehiscence was observed, and the implant was extruded through the wound site. No signs of infection were observed. Intraoperatively, necrotic and unhealthy skin and tissue were removed, and the implant was mobilized, irrigated with 3 liters of saline, soaked in betadine and gentamicin solution, and replaced the internal device antero-superior to the original position. A rotational scalp flap was designed, and tension-free skin approximation was done after covering the implant device with a galeal flap.
A 72-year-old female patient who underwent CI 1 year ago complained of crust formation around the skin above the internal device. Despite the conservative care with medication, a small coin-like dehiscence over the device was formed within two weeks. Surgery was performed as a similar manner to the first case and successful outcome was observed. In conclusion, based on our experience, rotational scalp flaps reconstruction combined with implant coverage using a galeal flap seems to be a viable and good option for managing extruded implant.

Keywords : Salvage, Cochlear implant, Rotational scalp flap

Surgical Issues and Complications

PP 070

Revision Cochlear Implant (RCI) Surgery: Indications, Outcomes and Clinical Predictors

Mohamed ALSHEHABI[1], Laura VIANI[2], Peter WALSHE[2]

[1]Ent, Royal Medical Services, Bahrain
[2]Cochlear Implant and Hearing, Beaumont Hospital, Ireland

Objectives

- Categorisation of RCI
- Outcomes of RCI

Methodology

RCI Surgery Patients Demographic data
Gender, Age, Mean Age
CAtegorisation of Indication, In pediatrics and adults
CI Model
Integrity testing
Categories of auditory performance (CAP)& speech intelligibility rating (SIR)

Results

To be announced

Conclusion

Single center, 20yr experience
1 in 20 implantation requires revision
1 in 35 device fails
Commonest cause for RCI: device failure
Need to incorporate these evidences into counseling on potential need for revision
RCI results in improved or similar outcome as compared to pre-RCI performance

Keywords : Revision, Outcome, Categorization

Surgical Issues and Complications

PP 071

The Surgify Safety Burr: Cochlear implant surgery with a novel device

Aarno DIETZ[1,2,3], Laura IHALAINEN[1,3], Matti ISO-MUSTAJÄRVI[1,2]

[1]Dept. of Otorhinolaryngology, Kuopio University Hospital, Finland
[2]Microsurgical Center of Eastern Finland, Kuopio University Hospital, Finland
[3]Institute of Clinical Medicine, University of Eastern Finland, Finland

Objective: Cochlear implantation (CI) requires mastoidectomy and drilling of an implant well. It therefore carries potential risks of facial nerve, sinus sigmoideus, and dura damage. Cutting burrs are highly effective at cutting bone but may easily cause soft tissue damage. Here we present our first experiences with the novel Surgify Safety Burr (SSB). The SSB is a 5.4 mm burr with a moving, self-centering ring placed around the cutting tip that requires to be pressed against bone to initiate cutting, thus preventing soft tissue injuries.

Methods: The SSB was compared to conventional 5.0 mm cutting burrs in 9 cadaveric fresh-frozen temporal bones. We collected data on the efficiency (i.e., duration to perform mastoidectomy) and on the drilling characteristics as assessed by the surgeons on a Likert scale (1 = poor to 5 = superior) Furthermore, we assessed the characteristics of the SSBTM in 17 patients undergoing CI.

Results: In temporal bones, we observed no differences in the mean drilling times between the SSB (10 min 57s) and conventional burrs (10 min 40s). The SSB scored higher than conventional burrs with respect to drilling characteristics: soft tissue protection (4,40 vs. 1,25), absence of jumping (5,00 vs. 2,00), predictability of cutting (5,00 vs. 2,75) and precision (4,80 vs. 2,25). For CI, the SSB was found slightly less efficient for mastoidectomy, however, for implant bed drilling it was more efficient. No soft tissue damage was observed in any of the patients.

Conclusion: The SSB found to be feasible for CI with superior handling and controllability compared to conventional burrs. It excelled for drilling the implant bed due to its soft tissue protection mechanism. With adequate training, the SSB may facilitate bone drilling during CI, ultimately resulting in shorter operation times. Further studies are needed to evaluate the role of the SSB in CI.

Keywords : Safety Burr, Complications, Mastoidectomy

Surgical Issues and Complications

PP 072

Cochlear Implantation in A Case With Down Syndrome, Neonatal Meningitis With Cochlear Malformation And Anomalous Facial Nerve – A Case Study

Rohit UDAYA PRASAD[1], Sailaja TIMMARAJU[2], Mathew DOMINIC[3], Nikhil BEN VETTATH[2]

[1]Ent & Hearing Implantology, Aster Rv Hospital, India
[2]Education and Training, Med El India, India
[3]Ent & Head Neck Surgery and Cochlear Implants, Medical Trust Hospital, India

INTRODUCTION: Down syndrome is the most prevalent neurodevelopmental disorder which causes hearing loss in children, predominantly conductive in nature, with a small portion of this population also affected with sensorineural hearing loss (SNHL). Neonatal meningitis, another common cause for hearing loss is a serious infection of the central nervous system. Meningitis also affects hearing due to fibrotic changes in the cochlear fluid, perilymph, which is originated from cerebrospinal fluid. In this retrospective case study, we aim to present about cochlear implantation (CI) as a treatment option in a case with Down syndrome with congenital SNHL with cochlear hypoplasia and a history of meningitis and other anatomical challenges.
METHOD: A three year old male presented with Down syndrome with a history of congenital severe to profound hearing loss with bilateral cochlear hypoplasia and delayed developmental milestones with neonatal meningitis. Radiological evaluation revealed cochlear malformation along with posteriorly rotated cochlea and enlarged diameter in vertical segment of facial nerve, anteriorly placed sigmoid, contracted mastoid and low-lying dura on both sides. 3D reconstruction using Slicer software showed cochlear hypoplasia bilaterally. CI was recommended in the left ear due to persistent serous otitis media in the right ear. Endaural transcanal approach was chosen to insert the electrode array through a tunnel drilled in the mastoid bone to avoid injury to the enlarged facial nerve and overcome the challenges of a contracted mastoid with a narrow facial recess.
RESULTS: A MEDIUM MED-EL electrode with 24 mm length was inserted. Intraoperative test results show presence of ECAP and normal impedance levels and with an uneventful post operative period.
CONCLUSION: Thorough pre-operative surgical investigation and family counselling have provided valuable information for surgical planning in this case. Choice of surgical technique and surgical route depended on the anatomy which provided a successful surgical outcome.

Keywords : Cochlear hypoplasia, Anomalous facial nerve, Down syndrome

Surgical Issues and Complications

PP 073

Patient and surgeon perspectives on hearing performance and satisfaction with the slim modiolar electrode (CI632): translating clinical evidence into real-world experience in China

Yongxin LI[2], Jingwei CUI[1], Daogui ZHU[1], Keli CAO[3], Yiqing ZHENG[4], Yu ZHAO[5], **Xiguang TIAN[1]**

[1]Department of Otolaryngology and Head and Neck Surgery, Boao Super Hospital, China
[2]Department of Otolaryngology and Head and Neck Surgery, Beijing Tongren Hospital, Cmu, China
[3]Department of Otolaryngology and Head and Neck Surgery, Beijing Chao-yang Hospital, Capital Medical University, China
[4]Department of Otolaryngology and Head and Neck Surgery, Sun Yat-sen Memorial Hospital, Sun Yat-sen University, China
[5]Department of Otolaryngology and Head and Neck Surgery, West China Hospital, Sichuan University, China

Purpose:
While previous clinical studies have demonstrated hearing benefits and safety and hearing of the CI632 implant system (Nucleus® CI600 Profile™ Plus Series implant with a Slim Modiolar electrode), there is currently limited experience of its use in China. The aim of this study was to gain insights from Chinese cochlear implant (CI) recipients with CI632 and surgeons implanting this device in a real-world setting.

Methods:
A prospective, single centre open-label observational study with 25 recipients of the CI632 cochlear implant. All subjects had bilateral moderate sloping to profound sensorineural hearing loss. Surgeries were performed by four experienced cochlear implant surgeons at the Bo'ao Super Hospital.
Pre and post operative hearing performance was evaluated using aided 4-frequency pure tone thresholds (PTA4 at 500, 1000, 2000 and 4000 Hz) and age-appropriate functional listening questionnaires.
At the time of surgery, the CI surgeon completed a survey that assessed ease of implantation and satisfaction with the CI632.

Results:
Participants (n=25) were 18 males and 7 females aged between 2 to 62 years (mean age 22.56)
The ease and satisfaction of the surgical procedure with the CI632 implant was rated high by all surgeons indicated they would use this as a device in future surgeries.
At one-month post-device activation, improvements in hearing thresholds were evident with all recipients tested were able to access the speech spectrum for PTA4 (500, 1000, 2000 and 4000Hz).
Functional listening questionnaire data collection was collected at three- and six-months post CI.

Conclusion:
This implant was considered an effective and safe surgical option for a wide age range of CI recipients in China. This real-world study demonstrates positive experiences of surgeons using the CI632 CI system. Hearing performance across age groups demonstrated significant improvements in audiometric outcomes.

Keywords : Cochlear implant, Slim modiolar electrode, Hearing loss

Surgical Issues and Complications

PP 074

Revision Cochlear implant our surgical technique – Case report

Hessa Ali ALHAMMADI[1],
Ahmad Mohamed ALAMADI[1]

[1]Otorhinolaryngeology, Emirates Health Services, United Arab Emirates

A female in her early 20's present with recurrent history of ear discharge right ear since 5 years , associated with hearing loss bilaterally , she had a history of right ear cochlear implant in 2007 around 15 years ago. On microscopic ear examination there was erosion of posterior canal , attic retraction with squamous debris in the right ear and intact tympanic membrane on the left ear
CT scan was unremarkable and Left cochlear implant noted however after surgical exploration it was found that a transcanal techniques was used for cochlear implantation , there was a tunnel in superior ear canal and tympanic line in mastoid for implant electrode covered with pieces of cartilage till the attic with a posterior cochleostomy for electrode insertions.
Granulation tissue in the attic and the adhesions was cleared and a new cochlear implant inserted from antrum to the same posterior cochleostomy and covered with soft tissue, reconstructions of attic and superior ear canal using conchal cartilage.

We discuss different cochlear implant surgical techniques with possible complications and management.

Keywords : Revision, Cochlear implant, Complication

Surgical Issues and Complications

PP 075

Cochlear implantation after radiotherapy for nasopharyngeal carcinoma – a literature review

Genevieve LEE[1], Jiahui NG[1], Leonard SOH[2], Vanessa TAN[1]

[1]Department of Otorhinolaryngology, Singapore General Hospital, Singapore
[2]Department of Otorhinolaryngology, Khoo Teck Puat Hospital, Singapore

Nasopharyngeal carcinoma (NPC) is a common cancer in Southeast Asia. Treatment with chemoradiotherapy confers good survival rates but often leaves patients vulnerable to hearing loss. Should hearing become non-serviceable, cochlear implantation (CI) may be considered. However, the irradiated temporal bone poses unique perioperative challenges for CI surgery. Radiation induced otitis media and osteoradionecrosis of the temporal bone preclude standard cochlear implantation techniques due to risk of implant complications. Patients may also be at higher risk of intraoperative injury to the facial nerve and carotid artery due to altered temporal bone texture and bony dehiscence. Wound healing may be compromised in the irradiated soft tissue, an important post operative consideration as well.

A review of literature was performed to evaluate the challenges of surgery in this unique group of patients, along with their surgical and audiological outcomes. 9 studies were identified, encompassing 63 patients with history of NPC treated with radiotherapy and 103 patients without history of radiation to the temporal bone, all undergoing CI surgery. CI surgery was done as a staged procedure in 10 patients. Common intraoperative findings reported included: cholesterol granulomas (n=11), altered temporal bone texture during drilling (n = 6), otitis media with effusion (n = 2), dehiscent facial nerve (n = 2), middle ear granulation and adhesions (n = 3). No major complications were reported in this series. Audiometric outcomes between both groups were comparable, with 1 study concluding no statistical difference between both groups.

CI in patients with previous radiotherapy is feasible with good audiometric outcomes. Care must be taken intraoperatively due to radiation induced changes of the temporal bone. Surgical approach may be personalised accordingly to the status of the ear.

Keywords : Cochlear implant, Radiotherapy, Nasopharyngeal carcinoma

Surgical Issues and Complications

PP 076

Salvaging Cochlear Implant in Deep Incisional Surgical Site Infection: Our Experience

Sunil GOYAL[1], Himanshu SWAMI[2], Rajeev CHUGH[2], Ravi ROY[2], Devendra Kumar GUPTA[2], Sneha YADAV[2]

[1]Otorhinolaryngology, Command Hospital, Kolkata, India
[2]Otorhinolaryngology, Army Hospital, Delhi Cantt, India

Background: Deep incisional surgical site infection (DI-SSI)in cochlear implantees is a challenging situation. Spectrum of management included conservative medical management, surgical intervention and explantation of cochlear implant.
Aim of the presentation is to determine the ideal clinical practice to salvage cochlear implant post DI-SSI in paediatric population. The objectives included:- a) to determine the prevalence of (DI-SSI) at our institute; b) to determine the likely perioperative factors that contributed to DI-SSI; c) to propose a primary treatment option in such cases based on our experience.
Methods: 5 Cochlear implantees who presented to us with surgical site infections and exposure of implant between 2018-2020 were included in the study. All of them were surgically treated with temporoparietal fascial flap reconstruction and cochlear implant was salvaged in all cases except in one case where explantation was done.
Results: Salvaging of Cochlear implant with deep incisional SSI with 2 layered (Skin & temporoparietal fascial flap) rotational flap as primary treatment option resulted in successful outcomes in 4 out of 5 cases.
Conclusions: Salvaging of Cochlear Implant with deep incisional SSI should involve resection of infected tissue, drilling of bone over implant bed, rotational pedicled flap and intensive targeted antibiotic therapy as primary treatment option.

Keywords : Tea tree oil, Biofilm, Temporoparietal fascial flap

Surgical Issues and Complications

PP 077

CLINICAL AUDIT OF SURGICAL OUTCOMES IN COCHLEAR IMPLANTATION: OUR EXPERIENCE

Sunil GOYAL[1], Himanshu SWAMI[2], Sneha YADAV[2], Deepika TANWAR[2]

[1]Otorhinolaryngology, Command Hospital, Kolkata, India
[2]Otorhinolaryngology, Army Hospital, Delhi Cantt, India

Background: Unlike clinical research which determines the safety and effectiveness of a treatment, clinical audit is an actual recordingof factual truth and its effecct for further improvement of clinical practice in future. In this article we aim to present a systematic critical analysis of quality of surgical care at our centre.
Methodology: The clinical audit will include retrospective data of cochlear implantation (CI) performed at our centre between 2018 and 2022. The various aspects analysed would include: 1) Duration of surgery (DOS); 2) Length of Hospital Stay (LOHS); 3) Unplanned return to theatre; 4) Unplanned readmission and 5) Surgery specific complication
Results: A total of 114 ears (111 patients with 3 bilateral CI) who underwent CI were analysed. Normal inner ear (IE) anatomy was present in 103 patients (including 5 patients with cochlear ossificans). Remaining 11 patients had abnormal bony IE anatomy. Posterior tympanotomy (PT) with round window insertion (RW) of electrode (n=91) was the most common route followed by cochleostomy (n=20). Subtotal petrosecctomy (STP) with RW insertion of elecctrode was done in remainder 3 ears. The mean DOS in PT & STP group was approximately 77 minutes and 140 minutes respectively. 2 cases had unplanned return to operation theatre immediately after primary surgery. 5 patient underwent readmission and revision surgery because of various reasons. Intraoperative complication were experienced in 12 patients and post operative complication in 15 patients.
Progress or Changes: Improved surgical sterility protocols and antibiotic protocol. Changes in surgical tecchnique especially with respect to Advance Bionic 1J electrode. Use of intraoperative C-arm X-ray for all patient with abnormal inner ear anatomy and revision cases. It was proposed for provision of OT table which allows intraoperative X-ray or Hybrid OT.
Coclusion: Surgical audit is an Unbiased systemic & Critical analysis with culture of no blame.

Keywords : Length of hospital stay, Revision cochlear implantation, Surgical site infection

Surgical Issues and Complications

PP 078

Cochlear Implant Surgical Complications in Cipto Mangunkusumo General Hospital-Indonesia: Single Institutional Review of 300 Cochlear Implantation

Ayu Astria SRIYANA[1], Harim PRIYONO[1], Rangga Rayendra SALEH[1], Ratna Dwi RESTUTI[1]

[1]Ear, Nose, Throat, Head and Neck Surgery, Faculty of Medicine University of Indonesia- Cipto Mangunkusumo General Hospital, Indonesia

Objectives: The purpose of this study was to evaluate patients characteristics and complications due to cochlear implant surgery in our institution. Study design: Descriptive study using medical record and secondary data from Cipto Mangunkusumo General Hospital between 2015-2022. Material and methods: All cochlear implantation performed by four otologist in our institution between 2015-2022 were reviewed. All postoperative complications, minor or major including complication which need revision surgery were included. Results: There were 216 patients with bilateral and unilateral cochlear implantation with total 300 ears undergone cochlear implant surgery in 2015-2022 in Cipto Mangunkusumo General Hospital. There were 0/300 (0%) facial nerve paralysis, 3/300 (1%) hematoma/seroma, 1/300 (0.3%) intraoperative gusher, 1/300 (0.3%) cochleovestibular complication, 1/300 (0.3%) facial nerve stimulation, 4/300 (1.3%) device migration, 0/300 (0%) electrode migration, 1/300 (0.3%) device failure, 0/300 (0%) surgical site infection, 0/300 (0%) flap necrosis. Local aspiration was done in 3 patient and revision was done in 4 patient without any further complication. Conclusion: Cochlear implant surgery is safe and have low risk of complication in our institution. Comprehensive understanding in surgical anatomy, pre-operative imaging evaluation, and step-wise surgical technique may decrease risk of complication.

Keywords : Cochlear implant, Surgical complication, Surgery

Surgical Issues and Complications

PP 080

Facial Nerve Stimulation from Cochlear Facial Nerve Dehiscence

Sher-Lyn THAM[1], Huey Ting DIONG[1], Shermaine PNG[1], **Raymond NGO[1]**

[1]Otolaryngology Head & Neck Surgery, Ng Teng Fong General Hospital, Singapore

Facial nerve stimulation is one of the known complications for patients post cochlear implantation. The pre-disposing factors to facial nerve stimulation include otospongiosis from otosclerosis, cochlear ossification (post-meningitis), temporal bone fracture and osteoporosis. We present a single-sided deafness patient with persistent facial nerve stimulation that was detected from the onset of the cochlear implant surgery during intraoperative Neural Response Telemetry (NRT) testing. Despite multiple programming strategies and electrode deactivation, we were unable to strike a compromise between audition and facial twitching. This resulted in patient becoming a non-user of the cochlear implant. On review of her pre-operative Computed Tomography (CT) temporal bone scans with multi-planar reconstruction, we noted that the labyrinthine portion of her facial nerve was situated right next to the upper basal turn of the cochlear, possibly dehiscent. We postulate that cochlear-facial nerve dehiscence (CFD) could be a reason for the severe facial nerve stimulation with cochlear implant. Despite the low prevalence of CFD, the consequence of missed diagnosis can be severe. This abnormality should be taken into consideration by the surgeons during the preoperative cochlear implant evaluation as this may influence the decision for the side of implantation for patients with bilateral severe to profound hearing loss and candidacy for single-sided deafness.

Keywords : Cochlear Facial Nerve Dehiscence, Facial Nerve Stimulation, Imaging

Surgical Issues and Complications

PP 081

Special Cochlear Implantation – A Case Report of Congenital Petrous Bone Bholesteatoma Complicated with Congenital Cochlear Nerve and Facial Nerve Malformations

Jun LIU[1], Pu DAI[1], Dongyi HAN[1], **Shiming YANG[1]**

[1]Otolaryngology, Head and Neck Surgery, Chinese Pla General Hospital, China

A retrospective analysis was performed on the diagnosis and treatment of a unique auditory ear with petrous bone cholesteatoma. Presented with long-term right-sided deafness, incomplete eyelid closure, and facial asymmetry since childhood, and had repeated abscesses in the left ear, accompanied by hearing loss for 3 years, incomplete eye closure, and facial asymmetry for 4 months. The external auditory canal was filled with pus and epithelium, and the tympanic membrane structures were unrecognizable. The right ear was completely deaf and the left ear was moderate-severe mixed deafness. HRCT showed that the inner auditory canal was narrow, the facial nerve bone canal was slim, and the left outer ear, middle ear, and petrous bone filled with cholesteatoma occupied the inner auditory canal, cochlea, and vestibule. MRI showed a narrow inner auditory canal in the right and a fine cochlear nerve. The patient was diagnosed with temporal bone cholesteatoma (left), mixed deafness (left), congenital sensorineural deafness (right, severe), congenital facial palsy (right), peripheral facial palsy (left), and left cholesteatoma resection and cochlear implantation (CI). After resection of the cholesteatoma, the cochlea and vestibule were destroyed, resulting in the inability to preserve hearing. The CI, decompression of the facial nerve, occlusion of the external auditory canal, and placement of fat in the surgical cavity were all calculated simultaneously. After half a year, the CI was effective, facial paralysis was significantly improved, and there was no recurrence of cholesteatoma.The patient with a unique auditory ear, complicated by petrous bone cholesteatoma, could not maintain hearing due to the involvement of the cochlea and vestibule. Given the possibility of cochlear fibrosis and contralateral congenital deafness, CI was performed simultaneously, and follow-up should be strengthened to detect a recurrence of cholesteatoma. Surgical exploration should be carried out if necessary.

Keywords : Cochlear Implantation, Petrous Bone Bholesteatoma, Malformations

Surgical Issues and Complications

PP 082

Lessons learnt in a delayed identification of a misplaced electrode array in the vestibule

Huey Ting DIONG[1], **Raymond NGO[2]**, Shermaine PNG[1], Yuhan WONG[3]

[1]Audiology, Ng Teng Fong General Hospital, Singapore
[2]Otolaryngology Head & Neck Surgery, Ng Teng Fong General Hospital, Singapore
[3]Manchester Centre For Audiology and Deafness, University of Manchester, UK

Misplacement of the electrode array in the absence of inner ear malformations is a rare complication of cochlear implant. We report about a case of cochlear implantation with misplaced array in the vestibule without any vestibular symptoms displayed post-operatively. A patient with left single-sided deafness underwent cochlear implantation. Intra-operative assessment did not reveal any major red flags of electrode array misplacement. He did not display any vestibular symptoms but showed poor speech performance post-operatively despite having good aided thresholds. High resolution computed tomography showed that the entire perimodiolar electrode array was situated within the vestibule and a revision surgery was conducted. Retrospective analysis of the neural response telemetry (NRT) responses performed prior to the revision surgery revealed possible artefacts instead of true neural responses. On review of the pre-operative vestibular assessment, the team noted patient has absent cervical vestibular myogenic potential (cVEMP) response in the left ear. Unlike other previously reported cases, the patient did not display vestibular symptoms despite the misplacement of electrode in the vestibule due to possible otolith dysfunction. Further investigation is warranted when a motivated patient with normal inner ear anatomy does not show benefit with the cochlear implant post-operatively.

Keywords : Complication, Vestibule, Electrode

Surgical Issues and Complications

PP 083

Plain film interpretation of the electrode array after cochlear implant surgery

Neelam VAID[1], Jaxin JOY[1], Ajay KOTHADIYA[1], **Nikhil GOKHALE[1]**

[1]E.n.t., K.e.m. Hospital, India

Introduction
Electrode positioning issues represent a significant proportion of perioperative CI complications which can effect the outcomes of the implantees. To ensure that the electrode assumes a typical coil location within the cochlea, many cochlear implant center's take a postinsertion plain skull radiograph (modified Stenvers view). This enables evaluation of electrode array kinks or tip rollover, which are challenging to detect with conventional telemetry.
For the last 16 years, cochlear implantation is routinely done in our department. All our patients undergo a post implantation plain X ray to evaluate the electrode position and insertion depth.
Aim
1. To estimate the incidence of complications associated with the surgical placement of cochlear implant (CI) electrode arrays and to discuss the implications and management of these complications.
2. To compare the incidence of these complications in the different electrode arrays
Methods and material Study design Retrospective study Study duration 16 years Method Post-operative day one modified X-ray Stenver's view images were retrospectively investigated by a third party for the presence of any electrode positioning complications from 600 cases in a single tertiary care hospital in India.
Post operative films of all patients implanted from 2006 onwards were evaluated for electrode related issues.
Results

Electrode related complication were seen in 30 patients (5%). Electrode kinking was observed in 67%, followed by basal fold 16.7%,tip fold over 3.4% and misplacement (6.67%). The CI24 RST electrode had the maximum issues.
Conclusion
Postoperative radiographic evaluation of the stimulating electrode is essential for all implanted patients to document correct placement of the intracochlear electrode.
Prompt detection by imaging and correction of any such complication will increase the hearing benefit to these patients.
Key words – electrode, kinking, basal fold, tip fold over, plain radiography.

Keywords : Electrode array, Kinking, Plain radiography

Surgical Issues and Complications

PP 084

Hybrid surgical technique in cochlear implant surgery

Sudhir Sakharam KADAM

Ent, Yashashri Ent Hospital & Cochlear Implant Centre, India

Dr. Sudhir S Kadam ; Yashashri ENT Hospital Cochlear Implant Centre, Miraj, India.

Aim - To report our surgical technique for anatomical variations with limited access & cochlear malformations
Setting - Tertiary referral ENT Hospital
Study design - Retrospective case series

Materials & Methods - 30 paediatric cochlear implant surgeries performed at Yashashri ENT Hospital, Miraj from June 2018 to June 2022. Case selection was done according to radiological findings with possibility of limited access in performing posterior tympanotomy and implantation in cochlear malformations.
Endaural approach with simple mastoidectomy and drilling of tunnel in facial recess area was done for transit of electrode. Wide posterior tympanotomy was not done as there was limited anatomical access. Tympanomeatal flap was raised for access to mesotympanum, round window and insertion of electrode.
Cases were followed on 10, 20th day and every month thereafter upto 12 months. Follow up data in terms of wound healing and postoperative complications was compared with standard mastoidectomy with posterior tympanotomy and Veria technique.

Results - 30 prelingual children with mean age of 3.5 years were operated for cochlear implant surgery. All devices namely medel, cochlear, and Advanced Bionics were used with complete insertion in all. Mean duration of surgery was 2 hours. One child had external auditory canal granulations on 20th day & one had recurrence of CSF Leak on 3rd postoperative day. Both cases managed with medical management without any surgical interventions.

Conclusion - We describe our hybrid technique of cochlear implant surgery in children with limited access for posterior tympanotomy and cochlear malformations. It is possible to manage all anatomical variations of ear & cochlear malformation efficiently. Also devices from all manufacturers can be used without any limitations.

Keywords : Hybrid technique, Cochlear implant, Facial recess tunnel

Surgical Issues and Complications

PP 086

Challenges faced by candidates requiring cochlear implant in Karachi, what's the solution?

Talha Ahmed QURESHI

Ent and Head and Neck Surgery, Qureshi Ent and Medical Centre, Pakistan

In Pakistan, 1.6 per 1000 persons have bilateral hearing loss. Karachi, with a population of 14.9 million has suffer from hearing loss and only few centers operating cochlear implants, with few surgeons, preoperative diagnostic center and abundant financial challenges.
In early 2000s 1st cochlear implant was operated in Karachi. In Patel hospital, a tertiary Care hospital we have so far operated 80, cochlear implants patients. The number could have been much higher if challenges faced were less.
One of the main challenge is delayed diagnosis which is due to less availability of diagnostic services and awareness. The importance of hearing screening diagnosis is less understood by health care institutes by local health awareness and application departments.
The number of cochlear implant surgeon are very few with less hospitals managing them, putting a burden on the management of cochlear implant candidates resulting in delay of surgery. Time as you know is critical in management of patients is highly effected.
Pakistan, is a developing country with a large population living below poverty line making it very difficult for patient's family to handle the cost and postoperative rehab of patients requiring cochlear implants. Few NGOs have come forward for its management but financial support required compared to overall burden is less.

Keywords : Cochlear implant, Awareness, Financial cost

Surgical Issues and Complications

PP 087

'Making the Cut' - Evolving incisions in Cochlear Implantation: Our Experience

Amit GOYAL[1], Kranti BHAVANA[2], Pawan SINGHAL[3], Vidhu SHARMA[1]

[1]Otorhinolaryngology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
[2]Otorhinolaryngology, All India Institute of Medical Sciences, Patna, Bihar, India
[3]Otorhinolaryngology, Sms Medical College, Jaipur, Rajasthan, India

Introduction – Like any surgery, cochlear implantation (CI) has undergone various modifications and refinements in the surgical technique. The incisions too have been evolving as per surgeon preference, need for exposure and aesthetic results. We present our experience with three types of incisions for cochlear implantation while describing a novel incision.

Methodology – A retrospective analysis of patient data was done for all cochlear implantations performed at our institute during 2017 to 2023. The initial surgeries were performed using endaural incision and later the surgeon explored post-aural incision and a novel modified endaural incision. The experience of the surgeon with regards to adequacy of exposure, need for soft tissue dissection and wound healing is presented here.

Results – A total of 150 ears underwent cochlear implantation by Veria technique during the said period. The minimum age of implantation was 9 months while the maximum age was 8 years among the pediatric patients. Two adults (aged 32 and 39 years respectively) with post-lingual deafness underwent CI. The male: female ratio was 1.09:1. A total of 108 implantations were performed using post-aural incision, 21 using endaural incision and a modified endaural incision was later used in 21 cases. Electrode insertion was done via cochleostomy in 90 and round window in 60 cases. All surgeries were performed by a single senior CI surgeon. The modified endaural incision is a novel incision incorporating Lempert II incision with posterosuperior extension and gives great exposure and requires minimum dissection. It gives good results in terms of post-operative cosmesis and healing too.

Conclusion – The novel modified endaural incision has the advantages of giving the desired exposure and good cosmesis while minimizing extent of soft tissue dissection, thereby combining the benefits of both the postaural and endaural incisions and overcoming their limitations.

Keywords : Cochlear implantation, Endaural incision, Modified endaural incision

Surgical Issues and Complications

PP 088

Dizziness After Cochlear Implantation

Ji Won LEE[1], Soo Bin BAE[1], Jun Wan PARK[1], **Sung Il NAM[1]**

[1]Department of Otorhinolaryngology, Dongsan Hospital, Keimyung University, Korea

Dizziness after cochlear implant (CI) was studied in 115 adult patients receiving a cochlear implant in a single tertiary referral center for 10 years (2013-2022), 43(37.4%) of whom experienced dizziness post-operatively. Cochlear implant recipients' medical records were retrospectively reviewed to identify the clinical features and the etiology of post-implantation dizziness.

Patients with subjective symptoms and nystagmus on videonystagmography(VNG) were defined as who manifest significant dizziness. Nystagmus confirmed on VNG was present in 20(46.5%) of 43 patients who complained of dizziness. 22 patients (51.2%) developed dizziness within a week after surgery, and 14 patients had nystagmus. In 7(50%) patients, vestibular hypofunction was described and in other 7(50%) patients, benign paroxysmal positional vertigo(BPPV) was diagnosed. All the patients developed BPPV on the CI side. Out of 10 patients (23.3%), who developed symptoms within 2 to 4 weeks postoperatively, 6 patient showed nystagmus. 2 patients had vestibular hypofunction on implanted side, and 4 patients developed BPPV, which was on the CI side in 2, and on the other side in 2. 11(25.6%) patients complained of dizziness after 4 weeks postoperatively, but no patient was confirmed to have nystagmus on VNG. In all patients presented with significant dizziness, the nystagmus disappeared at the last follow up VNG. A subject dizziness persisted for more than a month in only 4(9.3%) of 43 patients who complained of symptoms.

In patients with CI, dizziness may appear after surgery due to transient vestibular dysfunction such as BPPV, secondary endolymphatic hydrops, labyrinthitis, etc. It seems to be a common and predictable symptom that needs to be fully informed and consulted with patient in advance. Also thorough preoperative and postoperative evaluation with vestibular function tests are required to determine tailored management for each patient.

Keywords : Cochlear implantation, Vestibular dysfunction, Dizziness

Surgical Issues and Complications

PP 089

HURDLES OF COCHLEAR IMPLANTATION SURGERY IN ABNORMAL ANATOMY OF THE TEMPORAL BONE.

Rajika RAMAKRISHNAN[1], Shilpa NAIR[1], Sreenivas KAMMATH[1], Kiran NATARAJAN[1], Raghunandhan SAMPATH[1], Mohan KAMESWARAN[1]

[1]Otorhinolaryngology, Madras Ent Research Foundation, India

Introduction: The indications of cochlear implantation (CI) have widened in the past few decades to include patients with abnormal anatomy, cochlear ossification, syndromic causes, etc. The CI surgeon has to therefore anticipate challenges during surgery and post-operative period to deal with them accordingly. Pre-operative evaluation is crucial to planning and achieving a successful outcome.

Aim: To highlight the challenges encountered during CI surgery in temporal bone anomalies for the past 10 years at our institution and to outline the management.

Methods and objectives: A retrospective study done in Tertiary hospital over a period of 10 years. A thorough pre-operative assessment for CI surgery included audiology, electro physiology, CT/MRI, evaluation by paediatrician, ophthalmologist, cardiologist, anaesthetic assessment in all implantees. Based on the pre-operative evaluation, a management protocol was formulated for each scenario and managed accordingly.

Results: Total of 107 patients between 2 to 6 years were included in the study. Incomplete partition II was found to pose the most common challenge during CI. Incomplete Partition I, common cavity deformity, hypoplastic cochlea, enlarged vestibular aqueduct, narrow internal auditory canal etc were some of the other situations encountered.

Conclusion: Cochlear implantation is a safe and uneventful procedure in most patients with abnormal anatomy with good hearing outcomes. A thorough pre-operative evaluation including imaging is mandatory. Pre-operative counselling is extremely important. Overall, the outcomes were gratifying, despite the challenges faced.

Keywords : Cochlear implantation, Abnormal anatomy, Temporal bone

Surgical Issues and Complications

PP 090

Subtotal Petrosectomy and cochlear implantation

Manoj Manikoth PUTHIYAPARAMBIL

Otoneurology, Mesiarc Ent Hospital, India

cochlear implants are hazardous in certain conditions are there is significant middle ear disease, cerebrospinal fluid leak, trauma and severe anomaly. Subtotal Petrosectomy aims to clear all of the mucosa and epithelium of the middle ear cleft, closing the external canal as a blind sac, plugging the Eustachian tube orifice and obliterating the cavity. This provides a safe and dry ear with the least chance of electrode migration or failure. This busy cochlear implant centre has a lot of experience in such cases and a variety of cases as already described have been performed successfully. the most common reason to perform subtotal Petrosectomy has been extensive middle ear disease, particularly following cochlear implantation earlier. post-traumatic CSF leaks, post-meningitic cases and anomalies have been seen less frequently. An analysis of the presentations, surgical methods used to prevent complications and outcomes are described here.

Keywords : Subtotal petrosectomy, Cochlear implantation, Safety

Surgical Issues and Complications

PP 091

A case of revision cochlear implantation via the transmeatal approach in child with lack of mastoid pneumatization

Donggu HUR

Otorhinolaryngology Head and Neck Surgery, Gyeongsang National University, Korea

Most cochlear implantation has been performed via posterior tympanotomy with canal wall up mastoidectomy. However, there are several alternatives technique for the insertion of electrodes such as the endomeatal approach, middle cranial fossa approach, mastoid tunnel technique, pericanal insertion technique, and the suprameatal approach. A 3-year-old boy presented at the outpatient department with bilateral hearing loss since birth. He had been diagnosed with prematurity, intrauterine growth retardation, bronchopulmonary dysplasia, and mitral valve regurgitation. He also had skull deformity with a lack of mastoid pneumatization. He received his first cochlear implantation via a transmeatal approach. Unfortunately, the device didn't work some months after implantation and it turned out as device failure. We recommended revision surgery but the surgery was delayed by non-medical reasons. At age 10, he received revision surgery. We report not only the status of the surgical field and electrodes during the revision surgery but also the performance after the revision surgery.

Keywords : Transmeatal, Revision, Cochlear implantation

Surgical Issues and Complications

PP 092

Cochlear Implant Explantation as a Sequela of Severe Infection - Case Report

Wei-Chieh LIN[1], Yao-Wen CHANG[1], Chuan-Jen HSU[1], **Hung-Pin WU[1]**

[1]Department of Otolaryngology, Head and Neck Surgery, Taichung Tzu Chi Hospital, Taiwan

Wound infection is a rare but serious problem after cochlear implant (CI) surgery. To date, no consensus has been reached on the decision to remove a CI in the setting of severe infection. This report documents a long-term CI wound infection that causes mastoiditis in a pediatric patient. After conservative management by intravenous antibiotics, surgical debridement, and a redesigned flap, the decision was made to explant the device. If CI wound infection recurs for >6 weeks or if purulence is in direct contact with the device, then explantation becomes necessary for wound recovery.

Keywords : Cochlear implant, Explantation, infection

Surgical Issues and Complications

PP 093

Cochlear implant in patient with bilateral sudden sensorineural hearing loss as presenting symptoms of chronic myeloid leukemia

Ching-Hui HSU[1,2]

[1]Institute of Medicine, Chung Shan Medical University, Taiwan
[2]Department of Otorhinolaryngology, Head and Neck Surgery, Changhua Christian Hospital, Taiwan

Cochlear implant in patient with bilateral sudden sensorineural hearing loss as presenting symptoms of chronic myeloid leukemia

Bilateral sudden sensorineural hearing loss as presenting symptoms is rare in patient with chronic myeloid leukemia (CML). A 40-year-old man presented with tinnitus, dizziness and sequential bilateral sudden sensorineural hearing loss(SNHL) within 5 days. Followed laboratory examination revealed severe leukocytosis that white blood cell (WBC) count more than 650 x 109/L; and quantitative reverse transcription polymerase chain reaction specific for the BCR-ABL fusion transcript confirmed the diagnosis of CML. Treatment with oral hydroxyurea and Dasatinib for 2 weeks was arranged, and he was discharged with normal level of WBC count. 4 months later, bilateral profound sensorineural hearing loss persisted that left cochlear implant surgery was arranged. However, mucin like fluid accumulation in mastoid cavity and small granulomas in middle ear were noted during the procedure, subclinical inflammation due to CML was noted. We made sufficient normal saline irrigation for secretion and removed all small lesions around the cochlear. There was no apparent cochlear ossification found and full insertion was achieved smoothly. On day 3 after the operation, sound field test revealed 30dB level that he could talk with us fluently.
In patients with bilateral sudden SNHL, we suggested obtaining a complete blood count to rule out leukemias, including CML. Otologic symptoms related to leukostasis may be treated with leukapheresis, hydroxyurea, chemotherapy or immunotherapy but return of function is unpredictable. Cochlear implant is a good solution for them; however, subclinical infection or cochlear ossification should be aware to achieve expectable result.

Keywords : Bilateral sudden sensorineural hearing loss, Chronic myeloid leukemia (CML), Cochlear implant

Surgical Issues and Complications

PP 094

It is not over after the insertion – intra-cochlear electrode movement during lead positioning

Rolf Benedikt SALCHER[1], Eralp ARTUKARSLAN[1], Suheda YILMAZ-BAYRAKTAR[2], Martina NULLMEIER[2], Nick PAWSEY[3], Thomas LENARZ[1]

[1]Ent, Medical School Hannover, Germany
[2]Surgery & Electrodes, Cochlear Deutschland Gmbh & Co. Kg, Germany
[3]Surgery & Electrodes, Cochlear Limited, Australia

Objectives: Electrode position in the cochlea is one of the factors that affects CI hearing outcomes. The objective of this study is to investigate the influence of lead positioning technique on post-insertion movement of the electrode.
Material & Methods: Electrode insertion and lead positioning tests were conducted in a plastic temporal bone model including mastoidectomy. Two different lead positioning techniques were compared, the first being lead stowing in the mastoid cavity using a conventional method, the second with the additional step of fixing the lead caudal to the facial recess prior to positioning the lead, according to the 'bone groove fixation' technique, which is the clinical routine in patients implanted with slim straight electrodes at MHH. Electrode-to-modiolus distances before and after lead positioning were measured from video recordings of the electrode in the cochlea model, for both slim straight and slim perimodiolar electrodes. The tests were performed by a senior and junior surgeon to assess the effect of surgical experience on the final electrode position.
Results & Conclusions: Preliminary results have shown that electrode-to-modiolus distances are varying dependent on the positioning technique and the electrode design. For the slim straight electrode, there was not a significant difference between the two lead positioning techniques in this study. For the slim perimodiolar electrode, the act of fixing the lead in the bone groove served as a "pull back" manoeuvre, reducing the electrode to modiolus distance, while also reducing change in intracochlear electrode position during lead positioning and resulting in better final electrode position.

Keywords : Electrode nerv interface, Surgical technique, Artifical cochlear model

Surgical Issues and Complications

PP 095

A case of cochlear implantation for nedaplatin-induced hearing loss

Yasuhiro ARAI[1], Kiyoshi SAKASAI[1], Takashi WADA[2], Kentaro TAKADA[3], Nobuhiko ORIDATE[1]

[1]Otorhinolaryngology and Head and Neck Surgery, Yokohama City University School of Medicine, Japan
[2]Otorhinolaryngology, Yokohama Sakae Kyosai Hosapital, Japan
[3]Otorhinolaryngology, Kanagawa Chileren's Medical Center, Japan

Introduction:
Nedaplatin, a second generation platinum drug, is used to treat many of the same types of cancers as cisplatin. There have been many reports of hearing impairment with cisplatin, fewer with hearing loss due to nedaplatin and no reports of cochlear implantation.
Case report:
We present the case of a 73-year-old man, who was diagnosed with esophageal cancer at the age of 63 years. After two courses of chemotherapy with cisplatin and 5-FU, the patient underwent a subtotal esophagectomy. Grade 4 (NCI-CTCAE v5.0) hearing impairment at age 70 years followed by one course chemotherapy with 5-FU and nedaplatin for cervical lymph node recurrence. Pure tone audiometry showed a steep high-frequency sensorineural hearing loss of 93.8 dB on the right and 83.8 dB on the left. Chemotherapy was switched to nivolumab and 12 courses were administered, resulting in CR. Therefore, he was referred to our department for cochlear implantation. The free field understanding of words in quiet were 35% (65dB SPL) with the bilateral hearing aid using Japanese monosyllable speech perception test. He underwent left cochlear implantatation (CI) at the age of 73. After 4 month of implantation, free field understanding of words in quiet were 85% (65dB SPL) with the left implant.
Discussion:
The incidences in the randomized comparative study were 17.6% for the nedaplatin/vindesine group and 20.0% for the cisplatin/vindesine group (M Horiuchi, 1992) . From these results, the ototoxicity of nedaplatin was thought to be similar to that of cisplatin. CI was effective in the case of nedaplatin-induced hearing loss as well as CI for hearing impairment due to pediatric nueroblastoma treated with cisplatin or carboplatin (Ryu NG, 2015) .
Conclusion:
An adult case was reported in which a single dose of nedaplatin caused severe hearing loss, but a cochlear implantation achieved a good hearing outcome.

Keywords : Nedaplatin, Cochlear implantation, Cisplatin

Surgical Issues and Complications

PP 096

REIMPLANTATION OF COCHLEAR IMPLANT AS A RESULT OF WOUND SITE INFECTION: FIRST EXPERIENCE IN WEST JAVA, INDONESIA

Lina LASMININGRUM

Otorhinolaryngology Head and Neck Surgery, Dr. Hasan Sadikin Hospital/universitas Padjadjaran, Indonesia

Background: The management of profound hearing loss has been entirely transformed by cochlear implantation. Despite being a safe and successful procedure, complications can be severe, and infection significantly increases morbidity. There have been 6-63% reports of surgical complications of cochlear implantation. In West Java cochlear implant program has started in 2012 and 123 ears has been implanted up to now. The complication rate is 6.5% with majority minor complications and only one that should underwent reimplantation.
Case Presentation: A 6-year-old girl with bilateral profound sensorineural hearing loss was performed Cochlear Implantation on the left side. Two weeks after surgery, there was a surgical wound with granulation tissue, pus, and extrusion of a small part of the electrode. Pus culture showed MRSA positive. The infection remained even though the patient was under antibiotics. Explantation, exploration, and necrotomy debridement were then performed at the surgical site. Granulation was found at multiple sites including the skin, cable ground, planum, and antrum mastoid. Reimplantation was performed into the contralateral ear.
Discussion: Complications can be divided into minor and major complications. Infections are one of the most frequent complications and can be classified into the nature and onset of infections. There were several considerations in managing the complications of this patient, and a series of examinations were performed. The surgical site infection and poor wound healing contributed to the complications. The implant itself might serve as the source of infection.
Conclusion: Implantation shall be performed suitably and appropriately, which includes preparation, selection of surgical approaches, and post-operative care to achieve optimal results. Patients require continual follow-up to prevent and treat if complications arise.

Keywords : Cochlear Implantation, Surgical Site Infection, Reimplantation

Hearing Preservation & Bimodal Hearing

PP 097

ELECRODE SELECTION FOR COCLEAR IMPLANTATION; EXPERIENCE WITH FULL COCHLEAR COVERAGE ELECTRODES.

Alejo LINARES CASAS

Ent, Hospital Provincial Del Centenario, Argentina

Objective: Show the electrode selection methodology according to the individual cochlear anatomy and the auditive thereholds of each patient.
The different lateral-wall electrode options are shown, and their advantages in the scalar position.
The published literature is compared between perimodiolar and lateral wall electrodes.
Anatomic dissection is shown to verify complete cochlear coverage as well as correct scalar position in lateral wall electrodes.
Surgical tips are mentioned in a surgical video.

Purpose: To discuss the electrode selection in cochlear implantation.

Keywords : Cochlear implants, Scalar preservation, Lateral wall

Hearing Preservation & Bimodal Hearing

PP 098

Temporal adjustment of interaural stimulation timing leads to improved sound localization in bimodal listeners

Stefan ZIRN[1], Julian ANGERMEIER[1], Werner HEMMERT[2]

[1]Peter Osypka Institute of Medical Engineering, University of Applied Sciences Offenburg, Germany
[2]Bio-inspired Signal Processing, Technical University of Munich, Germany

In bimodal cochlear implant (CI) / hearing aid (HA) users a constant interaural time delay in the order of several milliseconds occurs due to differences in signal processing of the devices and stimulation sites which superimposes angle-dependent interaural time differences. For MED-EL CI systems in combination with different HA types, we have quantified the respective device delay mismatch (Zirn et al. 2015).
In the current study, we investigate the effect of the device delay mismatch in actual bimodal listeners on sound localization accuracy. To deal with the device delay mismatch we delayed the CI stimulation according to the measured HA processing delay.
We observed highly significant improvements of the rms error compared to the test without the CI delay (14.7° improvement in average) in 11 bimodal listeners. Also the signed bias of sound localization improved significantly from 25.2° to 10.5° averaged across listeners (Angermeier et al. 2021).
The results reveal that sound localization in bimodal listeners benefits from a reduction of the device delay mismatch between CI and HA. With this form of temporal adjustment of modalities, spatial re-centering seems possible.

Keywords : Bimodal hearing, Interaural stimulation timing, Sound localization

Hearing Preservation & Bimodal Hearing

PP 099

The Clinical Effect of Steroids for Hearing Preservation in Cochlear Implantation: Conclusions Based on Three Cochlear Implant Systems and Two Administration Regimes

Magdalena Beata SKARZYNSA[3], Aleksandra KOŁODZIEJAK[1], Elzbieta GOS[1], Henryk SKARZYNSKI[1], **Piotr Henryk SKARZYNSKI**[1,2,3,4]

[1]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[2]Heart Failure and Cardiac Rehabilitation, Faculty of Dental Medicine, Faculty of Dental Medicine, Medical University of Warsaw, Poland
[3]Institute of Sensory Organs, Institute of Sensory Organs, Poland
[4]University of Maria Curie Sklodowska, University of Maria Curie Sklodowska, Poland

The aim of the paper is to assess a clinical effect of steroids (dexamethasone and prednisone) on hearing preservation in patients who were implanted with different cochlear implant systems (Oticon®, Advanced Bionics®, Med-El®). 147 adult patients were enrolled to the study and divided into three groups depending on the brand of cochlear implant they received and participated in all follow-up visits regularly. They were also randomly divided into three subgroups depending on the steroid administration regime: intravenous dexamethasone (0.1 mg/kg body weight twice a day for three days); combined intravenous and oral steroids (dexamethasone 0.1 mg/kg body weight twice a day plus prednisone 1 mg/kg weight once a day); and no steroids (control group).
Results were measured by PTA at three time points: before implantation, at processor activation, and 12 months after activation. A hearing preservation (HP) figure was calculated by comparing preoperative results and results after 12 months. Further measures collected were electrode impedance and hearing threshold in the non-operated ear.
Highest HP measures (partial and complete) were obtained in the subgroups who were given steroids. Of 102 patients given steroids, HP was partial or complete in 63 of them (62%). In comparison, partial or complete HP was achieved in only 15 patients out of 45 (33%) who were not given steroids. There were differences between three cochlear implant groups, with the Med-El and Advanced Bionics groups performing better than the Oticon group (45% and 43% of the former two groups achieved partial or complete HP compared to 20% in the latter). Hearing thresholds in the non-operated ear were stable over 12 months. Impedance was slightly lower in the 12 month follow-up in comparison with the activation period, with the exception of the Oticon group.
Pharmacological treatment with steroids in patients undergoing cochlear implantation helps to preserve residual hearing.

Keywords : Steroids, Hearing preservation, Cochlear implants

Hearing Preservation & Bimodal Hearing

PP 100

Utility of electrocochleography for cochlear implant recipients and its potential to predict post-operative hearing thresholds objectively

Lei XU[1], Ruijie WANG[1], Jianfen LUO[1], Xiuhua CHAO[1], Haibo WANG[1]

[1]*Department of Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital, China*

Background and purpose
Intracochlear recorded cochlear microphonics (CM) have been used to monitor the function of outer hair cells during cochlear implantation, where the CM amplitude can be used to predict hearing levels after surgery. The relationship between postoperative hearing threshold and CM measured using AIM system developed by Advanced Bionics was investigated in this study.
Methods
Seven participants (eight ears) with hearing thresholds better than 85dB HL at 500Hz were enrolled so far. All were unilaterally or bilaterally implanted with Advanced Bionics HiFocus Mid-Scala or SlimJ electrode arrays. Electrocochleography (ECochG) amplitudes were recorded both intraoperatively and postoperatively at different follow-up sessions. Objective hearing thresholds predicted by the AIM system were compared to the participants' behavioural hearing thresholds. Postoperative CBCT scans were further investigated to confirm the scalar positions of the electrode arrays.
Results
Six out of eight ears showed intraoperative ECochG responses above noise floor during electrode insertion. The trace of CM amplitude showed patterns of either rising or steady responses, except decrease in one case (response amplitude dropped for 12μV). For the eight participants, the mean difference between the objective hearing levels (ECochG thresholds) measured immediately post-operatively and the preoperative behavioural threshold across 125Hz, 250Hz, 500Hz and 1000Hz is 4.90dB , while its difference to postoperative behavioural threshold is 3dB. No scalar translocations were found in the current eight ears based on CBCT results.
Conclusion
AIM can assist the surgeon to optimize electrode array insertion and thus reduce the possibility of insertion trauma or translocation. Objective hearing thresholds predicted via AIM by calculating from the CM amplitude could be a reliable and time-saving method to evaluate patients' residual hearing after cochlear implantation. This could be potentially beneficial for electro-acoustic stimulation (EAS) fittings in the future.

Keywords : Cochlear implant, Hearing preservation, Electrocochleography monitoring

Hearing Preservation & Bimodal Hearing

PP 101

Benefits of wireless link technology between cochlear implant and hearing aid in patients with bimodal hearing

Ji Hyuk HAN[1], **Jae Young CHOI[1]**

[1]*Otorhinolaryngology, Yonsei University College of Medicine, Korea*

Introduction: Many unilateral cochlear implant (CI) users have a hearing aid (HA) on the opposite side, but the CI and HA are not usually linked. However, Binaural Voice Steam Technology (BVST) has been introduced to be able to connect the CI sound processor and HA. The effect of such wireless link technology was investigated in this study.
Methods: Unilateral CI users fitted with Naída CI Q sound processor and Naída link were enrolled. Speech test was performed to evaluate sentence scores. Speech perception level was measured using Korean version of hearing-in-noise test. To evaluate StereoZoom (SZ), speech signal was presented from the front and noise was from the back (S0N180). For the ZoomControl (ZC), speech was presented from the CI side and noise from the other (setup 1, SCINHA), or vice versa (setup 2, SHANCI). Patients' satisfaction on speech understanding, sound quality, and listening effort were evaluated with questionnaires and numerical rating scales.
Results: The sentence scores with bimodal hearing were higher than CI only (bimodal, 93.6 ± 9.0 %; CI only, 66.8 ± 13.6 %). In the setting of bimodal hearing in noise condition, activated SZ showed decrease of dB signal-to-noise ratios (SNR) (SZ off, 9.5 ± 7.0 dB; SZ on, 6.9 ± 7.0 dB). Activated ZC showed decreased dB SNR in setup 1 (ZC off, 8.8 ± 8.7 dB; ZC on, 5.6 ± 4.0 dB), whereas increased SNR in setup 2 (ZC off, 5.9 ± 5.7 dB; ZC on, 9.4 ± 7.4 dB). Participants' satisfaction with speech understanding, sound quality, and listening effort were higher in activated SZ and ZC conditions.
Conclusion: The bimodal hearing showed better speech scores than the CI only. Activation of BVST showed further benefits in noisy environments. Technological development and assistance will give more convenience to patients with bimodal hearing.

Keywords : Cochlear implant, Bimodal hearing, Wireless link technology

Hearing Preservation & Bimodal Hearing

PP 102

Effect of interaural beamforming in a diffuse noise field on speech intelligibility in bimodal cochlear implant users

Nienke C. LANGERAK[1,2], H. Christiaan STRONKS[1,2], Raphael KONING[3], Jeroen J. BRIAIRE[1], Johan H.m. FRIJNS[1,2]

[1]*Department of Otorhinolaryngology and Head & Neck Surgery, Leiden University Medical Center, The Netherlands*
[2]*Leiden Institute For Brain and Cognition, Leiden University, The Netherlands*
[3]*European Research Center, Advanced Bionics, Germany*

Bimodal listeners that use a cochlear implant (CI) and a contralateral hearing aid benefit from the acoustic hearing in terms of speech intelligibility (SI) in particular in adverse listening conditions. However, localization performance is poor because of the reduced frequency overlap in aidable hearing between both ears. Side beamformers were developed to convert interaural time differences at low frequency to level cues to provide cues for localization. The influence of those algorithms on SI is only partially known.
SI tests with the Dutch/Flemish Matrix test in a diffuse eight-talker babble field were performed in 18 bimodal listeners. Processing conditions were an omnidirectional microphone setting, and two side beamformers, i.e., a binaural side beamformer and a monoaural side beamformer. Furthermore, the effect of synchronizing the automatic gain controls on both devices to provide salient level cues was studied. Speech was presented at the front (0°), CI side (90°) or HA side (-90°). To assess the bimodal benefit, an additional listening test for speech from the front with only CI or only HA was administered.
In terms of SI with the side beamformers, no statistically significant of the side beamformers with and without synced automatic gain control was obtained. SI in noise was significantly better for speech from the front or from the CI side than from the HA side ($P<0.005$). A mean bimodal benefit of 2.4 dB speech reception threshold was obtained
In summary, there was no effect of interaural beamforming on SI in any condition. Other studies have shown a benefit when the target and noise sources were spatially distributed This study indicates that even in a very challenging situation for the algorithms, there is at least no harm by the interaural beamforming. The obtained bimodal benefit was in-line with previous studies and the literature.

Keywords : Interaural beamforming, Bimodal benefit, Bimodal hearing

Hearing Preservation & Bimodal Hearing

PP 103

Technical and perceptual assessment of the device delay mismatch in bimodal cochlear implant users

Raphael KONING[1], Joachim THIEMANN[1], Josef CHALUPPER[1]

[1]*European Research Center, Advanced Bionics, Germany*

To achieve fusion of the electric and acoustic sound percept in bimodal users (cochlear implant (CI) users with a contralateral hearing aid (HA)), the latencies of the auditory pathway of both ears should not differ significantly. Commercial devices differ in latency and it is still unknown how much difference in latency is tolerable. In this study, we will present new technical measurements using the method proposed by Zirn et al. (2015) and summarize the findings on perceptual consequences of technical latency mismatch between CI and HA.
To determine the latency of Advanced Bioncs' speech processor Marvel CI, technical measurements of the group delay was done. Furthermore, to determine the latency of the entire electric stimulation path, the EABR wave V latencies evoked on different intracochlear sites was summed (Zirn et al., 2015). To determine the latency mismatch for bimodal listeners, the wave V latency of the electric path with CI and acoustic path with HAs were compared.
In a range between 500 Hz and 4 khZ, the ABR latencies of the Marvel CI are in the range of 16 ms to 11.7 ms. Hence, the latency mismatch is in the range of 0 ms to 2 ms when a comparison with a state-of-the-art FFT based HA is done. Due to the fact that the just noticeable difference in latency for bimodal recipients is in the range of 8 ms to 10 ms, it should not be perceivable.
The method proposed by Zirn et al. (2015) can be used to reliably measure latencies in the clinic. The latency mismatch for AB's Marvel CI is within tolerable limits for bimodal users with most modern HAs.

Keywords : Bimodal fusion, EABR latency mismatch, Device delay

Hearing Preservation & Bimodal Hearing

PP 104

Long-term Hearing Preservation with the SlimJ Electrode Array

Andreas BUECHNER[1], Michael BARDT[1], Rolf SALCHER[1], Thomas LENARZ[1]

[1]*Department of Otorhinolaryngology, Medical Universlty of Hannover, Germany*

Introduction
With expanding indications, a growing number of today's cochlear implant (CI) candidates present to the clinic with significant amounts of residual hearing in the low frequencies. Preservation of residual hearing leads to better post-operative outcomes and safeguards against future revision surgeries and treatment options. This challenges CI manufacturers to develop atraumatic electrode arrays and surgeons to insert them in ways that minimize the loss of hearing.
Material and Methods
220 patients were included in this retrospective data analysis, who have been implanted with the HiFocus SlimJ lateral wall electrode array from Advanced Bionics since the end of 2017. The majority of insertions were supported by ECochG monitoring through a research system or the AIM tablet, where inner ear responses to acoustic stimulation are recorded with the most apical electrode contact in order to provide real-time insights on cochlear health during surgery. The electrode insertion was modified based on the amplitude if necessary. Audiometric thresholds and speech intelligibility test results were collected pre-operatively and on routine appointments post-operatively. Additionally, the electrode position was reconstructed based on pre-operative MRI and post-operative CT data, with a view to investigate which parameters influence hearing preservation significantly (e.g. ECochG monitoring, age, insertion depth).
Results
For 171 patients, a pre-operative audiogram was available (median LF PTA 75 dB). The average post-operative hearing loss was 9 dB after three months, 17 dB after one year and 28 dB after two years. The analysis of influential parameters is ongoing and will be presented at the conference.
Conclusion
To drive the future development of atraumatic electrode arrays and structure preserving insertion techniques, a good understanding of the important factors influencing hearing preservation is essential. The results of this analysis will bring valuable insights and provide a good foundation for future improvements in insertion planning and quality control analyses.

Keywords : Hearing preservation, ECochG, EAS

Hearing Preservation & Bimodal Hearing

PP 105

Speech perception and sound localization ability in CI subjects with electric-acoustic stimulation and contralateral normal hearing

Tobias WEISSGERBER[1], Monika KOERTJE[1], Timo STÖVER[2], Uwe BAUMANN[1]

[1]*Audiological Acoustics, Ent Department, University Hospital Frankfurt, Germany*
[2]*Ent Department, University Hospital Frankfurt, Germany*

The use of electric-acoustic stimulation (EAS) is an established treatment in patients with partial deafness and residual hearing in the low frequencies. Several studies have demonstrated better speech perception in noise and better sound quality compared to cochlear implant (CI) users with electrical stimulation only. In unilateral deafness or unilateral partial deafness with contralateral normal hearing, the lack of ability to localize sound and decreased speech perception in noise could lead to the desire for cochlear implantation. The aim of the present study was to assess hearing abilities in subjects with single-sided partial deafness using EAS stimulation.
15 EAS users with contralateral normal hearing participated in this study. Speech reception thresholds (SRTs) in noise and subjective listening effort were assessed in different spatial noise conditions and for different noise characteristics with and without reverberation. SRTs were assessed with EAS stimulation and compared with acoustic stimulation of the contralateral ear alone. Mean error in sound localization was measured with an LED pointer method.
Improved SRTs with EAS stimulation in simultaneous and spatially separated masker conditions were observed. In contrast to previous studies, EAS users showed no adverse effect of EAS/CI stimulation on glimpsing in modulated noise conditions. In more diffuse noise conditions and in the presence of reverberation, no beneficial effect of EAS stimulation on SRT was found. However, subjective listening effort with EAS was lower compared to unilateral acoustic hearing even for positive SNRs. Mean localization error using EAS was improved by 28.5° into the range of normal hearing listeners.
Even for patients with contralateral normal hearing, EAS can improve speech perception in noise, restore sound localization and reduce listening effort in everyday life. While sound localization abilities in the horizontal plane were comparable to normal hearing, SRTs were still worse than in normal hearing participants.

Keywords : EAS, Sound localization, Speech perception and listening effort

Hearing Preservation & Bimodal Hearing

PP 106

The use of ECochG monitoring in cochlear implant surgery

Patrick AXON[1], James TYSOME[1], Neil DONNELLY[1], Manohar BANCE[1]

[1]Ent Department, Cambridge University Hospitals, UK

Background
The AIM tablet is a medical grade Windows tablet designed for intra- and post-operative use. It can measure Electrocochleography (ECochG), via the cochlear implant during insertion of the electrode array. Real time feedback is provided to the surgeon, so that he or she can adjust the insertion, with the intention of reducing the amount of trauma imposed onto the cochlea.

Method

In a series of 22 implantations ECochG was recorded while the electrode array was being slowly introduced. A 500 Hz acoustic stimulus at 110 dB SPL, introduced via an insert earphone, was used to stimulate the cochlea. The resulting cochlear potentials were recorded, had the cochlear microphonic (CM) extracted and its amplitude displayed in real time. In roughly half of the cases the CM amplitude was simply recorded and ignored, while in the rest attention was paid to any drop in amplitude

Results

CM could be recorded in around 75% of cases. In 25% of cases drops in the CM amplitude were responded to by pausing, withdrawing, or rotating the electrode array to maintain the CM amplitude. In 25% of cases insertions CM amplitude did not drop significantly during insertion. The hearing preservation rate for 250 Hz to 1,000 Hz, was between 50% and 60% and was stable from first-fitting, to beyond 12 months post-surgery. For a sub-group of 8 participants, for whom hearing levels at 125 Hz were measured, the median rate was over 75%.

Conclusion

Recording of ECochG tends to lead to a natural slowing of insertion speed. The CM level could be maintained in some cases by adjusting the electrode array insertion when a drop in amplitude occurred. However, our goal is still to achieve a full insertion of the electrode array, even if this cannot be achieved without a drop in CM amplitude.

Keywords : Electrocochleography, Hearing preservation, AIM

Hearing Preservation & Bimodal Hearing

PP 107

The effect of speed and experience on hearing preservation outcomes in In-Vitro Models

William CROHAN[1], Dayse TAVORA-VIEIRA[1], Gunesh RAJAN[2]

[1]Otorhinolaryngology, University of Western Australia, Australia
[2]Otorhinolaryngology, Lucerne, Switzerland

Aim To investigate factors significant for intracochlear pressure changes in In-Vitro cochlear implantation
Background: Preservation of residual hearing is an important goal of modern cochlear implant surgery. Many factors are thought to be significant in the preservation of residual hearing through the reduction in intraoperative trauma to the cochlea.
Methodology: Participants at a cochlear implantation hearing preservation workshop open to surgeons and audiologists were invited to participate in a challenge to insert a cochlear implant electrode into an In-Vitro model of a cochlea. Intracochlear pressure variation was measured as a surrogate marker for intracochlear trauma against insertion speed, method of insertion, moisturization of the electrode, and participant experience.
Results: The study demonstrated that the relative experience of a surgeon and the speed of insertion were significant for maximal intracochlear pressure variation. The more experienced participants likely to demonstrate lower pressure variation, and a slower insertion on average (0.124kPa) produced significantly smaller pressure changes than a fast insertion (0.177kPa). No other variables were deemed significant for maximal pressure variation.
Conclusion: Surgeon experience and speed of implant insertions were significant factor in the reduction of intracochlear pressure variation during cochlear implantation simulations

Keywords : Hearing Preservation, Intracochlear Pressure Variation, Robotic surgery

Hearing Preservation & Bimodal Hearing

PP 108

The role of the Paediatric Implanted Recipient Observational Study (P-IROS) to inform factors impacting cochlear implant outcomes in China

Lei XU[1,2], Chongxian YU[3], Ruijie WANG[1,2], **Jianxin QIU[3]**

[1]Department of Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital, Shandong University, China
[2]Department of Auditory Implantation, Shandong Provincial Ent Hospital, China
[3]Department of Otolaryngology and Head and Neck Surgery, The First Affiliated Hospital of Anhui Medical University, China

Purpose:
Understanding factors that impact outcomes of hearing habilitation in young children with severe to profound hearing loss can inform families, professionals and health authorities regarding hearing devices and educational supports. This study, aimed to identify factors that impacted cochlear implant (CI) outcomes of two sites in mainland China.

Method:
Analysis of data collected from two sites involved in a prospective, longitudinal observational study (the Paediatric Implanted Recipient Observation Study – P-IROS). Participants were aged <10 years at time of implantation. Standardised self-assessment scales included the Categories of Auditory Perception II (CAPII). A non-standard questionnaire for the clinician and implant user/s parent/ caregiver evaluated Quality of life and parental expectations. Data was collected prior to device activation, and then at 6 monthly intervals up to 2 years post implantation, with additional data extending up to 4 years.

Results:
Baseline data was collected for 288 children from two clinics in mainland China. Compliance at 1 year was 59% and by 3 years had reduced to 29%.
Data analysis identified significant benefits of hearing aid use preimplantation (p=0.026); younger age at implantation (p<001) and higher maternal education levels (p<0.001). Bilateral device users achieved significantly better auditory performance on the CAPII (p<0.001). Lower parental expectations of their child's outcomes correlated with significantly poorer than those with higher expectations (p<0.001). Quality of life scores followed a different trajectory for both sites, however no significant difference between sites was identified by 3 years post CI (p=0.054).

Conclusion:
Between site comparisons identified factors contributing to a steeper trajectory for improved audition and quality of life outcomes in children following CI. Increasing access to enable a younger age of cochlear implantation, bilateral device fitting and counselling to improve parental expectations were associated with achieving superior outcomes at a younger age and inclusion in mainstream educational settings.

Keywords : Longitudinal study, Impact factor, Younger age

Hearing Preservation & Bimodal Hearing

PP 109

Evaluation of Cochlear Implant Outcomes with Patient-specific Electrode Selection Utilizing Pre-operative Cochlear Duct Length Measurements

John Jw LEE[1], Matthew G CROWSON[2], Kari SMILSKY[1], Joseph M CHEN[1], Vincent Y LIN[1], Trung N LE[1]

[1]Department of Otolaryngology-head and Neck Surgery, Sunnybrook Health Sciences Centre, University of Toronto, Canada
[2]Department of Otolaryngology-head and Neck Surgery, Massachusetts Eye and Ear, Harvard University, USA

Objectives
1. To utilize a pre-operative planning software (Otoplan) to select patient-specific cochlear implants (CI) based on cochlear duct lengths (CDL).
2. To evaluate the benefit of electrode selection based on CDL on speech outcomes.

Methods
50 individuals receiving Med-El Flex 28 or 31 electrodes based on pre-operative Otoplan CDL measurements were compared with a control group of 50 CI patients matched by age, gender, height and pre-operative audiograms. Intra-operative electrode insertion, number of deactivated electrodes, angular insertion depth (AIDs), post-operative speech scores (HINT, CNC, AzBIO) and hearing preservation rates were compared.

Results
CDL-based electrode selection resulted in 40(80%) vs 17(34%) Flex-28, and 10(20%) vs 33(66%) Flex Soft-31 implants between the Otoplan and control group respectively(p=6x10-6). CDL of patients receiving Flex-28 and Flex Soft-31 implants were 29.8 and 33.6mm respectively (p=2.9x10-5). Total post-operative inactivate electrodes was significantly lower in the Otoplan (n=22, 3.7%) vs the control group (n=8, 1.8%) (p=0.0096). No difference was seen in the rate of incomplete insertions. Calculated AIDs were significantly higher in the Otoplan group for both Flex-28 and Flex-31 implants between two groups (Flex 28, p=0.005, Flex 31, p=0.01). Post-operative HINT, AzBIO, CNC and hearing preservation scores at 1 year were not significantly different between the two groups.

Conclusions
Using a pre-operative planning software to guide electrode selection is feasible and practical. A Fewer deactivated electrodes with increased insertion depths were observed in the Otoplan group. No differences were observed in 1-year post-operative speech and hearing preservation outcomes.

Keywords : Hearing preservation, Cochlear Duct Length, Pre-operative Planning

Hearing Preservation & Bimodal Hearing

PP 110

Near Infrared light pre-treatment reduces hearing loss associated with cochlear implantation in both guinea pigs and humans

Dan JIANG[1], Dietmar BASTA[2], Susanne SCHWITZER[2], Moritz GROESCHEL[2], Philipp MITTMANN[2], Lenneker KIEFER[2], Arne ERNST[2], **Patrick BOYLE[3]**

[1]Ent Department, Guys and St Thomas' Nhs Foundation Trust, UK
[2]Ent Department, Unfallkrankenhaus Berlin, Germany
[3]European Research Center, Advanced Bionics Gmbh, Germany

Background

Electrode array insertion into the cochlea can initiate the loss of hair cells and spiral ganglion neurons through direct mechanical injury, along with the expression of intracochlear inflammatory cascades. Near infrared light (NIL) can significantly decrease the auditory threshold shift if ap¬plied as a single pre-treatment, immediately before insults to the cochlea such as a noise exposure or electrode array insertion. This study investigated NIL efficacy in guinea pigs and humans.

Method

Normal hearing adult guinea pigs had one cochlea pre-treated with NIL for 15 minutes. Immediately afterwards a specifically designed guinea pig electrode array, was inserted into both cochleae through a cochleostomy. Human patients were similarly NIL exposed then implanted unilaterally with a HiRes 90k cochlea implant Controls were the contra-lateral guinea pig ear, or non-NIL exposed humans. Four weeks after implantation, frequency specific auditory brainstem response thresholds or pure tone audiometry was performed in animals and humans respectively. Electrode contact impedance was also measured.

Results

The data demonstrated that a 15 min NIR pre-treatment can protect the residual hearing in both guinea pigs and in humans. The amount of protection amounted of approximately 20 dB. Furthermore, electrode impedances were decreased in NIL pre-treated patients. The protection of hair cells and spiral ganglion cells possibly contributes to the observed hearing preservation, since both were significantly less reduced in NIL pre-treated guinea pig cochleae.

Conclusion

Our results suggest that a very effective protection of cochlear structure and function is possible during cochlear implantation by a single NIL pre-treatment. Decreased electrode impedances suggest an inhibition of fibrotic tissue growth through the actions of NIL. Future studies should investigate these effects in more detail.

Keywords : Cochlear implant, Near infrared light, Hearing preservation

Hearing Preservation & Bimodal Hearing

PP 111

Hearing Preservation in Cochlear Implant Surgery

Rohit MEHROTRA

otorhinolaryngology, Mehrotra Ent Hospital, Kanpur, India

The loss of low-frequency hearing during cochlear implantation is the result of the technique used to create the cochleostomy and its size combined with the characteristics of the electrode design (diameter, stiffness, and length) since it may induce substantial damage to the basilar membrane and cochlear hair cells as it advances into the scala tympani. Advancements in cochlear implant surgical approaches and electrode designs have enabled preservation of residual acoustic hearing. Preservation of low-frequency hearing allows cochlear implant users to benefit from electroacoustic stimulation, which improves performance in complex listening situations, such as music appreciation and speech understanding in noise. The idea of acoustic plus electric hearing means a cochlear implant aided by an ipsilateral hearing aid, to benefit from the residual low-frequency hearing of an individual. Principle of preserving low-frequency hearing by a "soft surgery" cochlear implantation could also be useful to the population of children who might profit from regenerative hair cell therapy in the future. Thin, flexible, lateral wall arrays are preferred for hearing preservation. Both shortened and thin, lateral wall arrays have shown success with hearing preservation and the optimal implant choice is an issue of ongoing investigation. Electrocochleography can monitor cochlear function during and after insertion of the electrode array.

Keywords : Cochleostomy, Electrocochleography, Residual acoustic hearing

Hearing Preservation & Bimodal Hearing

PP 112

CONTRALATERAL HEARING AID USE IN ADULT COCHLEAR IMPLANT RECIPIENTS: Retrospective analysis of auditory outcomes

Griet MERTENS[1,2], **Ellen ANDRIES**[1,2], Charis CLEMENT[1], Ellen COCHET[1], Anouk HOFKENS – VAN DEN BRANDT[1,2], Laure JACQUEMIN[1,2], Iris JOOSSEN[1], Hanne VERMEERSCH[1], Marc Jan-Willem LAMMERS[1,2], Vincent VAN ROMPAEY[1,2], Olivier VANDERVEKEN[1,2]

[1]Dept. of Otorhinolaryngology, Head and Neck Surgery, Antwerp University Hospital, Belgium
[2]Experimental Laboratory of Translational Neurosciences and Dento-otolaryngology, University of Antwerp, Belgium

The study aims to investigate retrospectively the frequency of usage of bimodal stimulation among cochlear implant (CI) users, as well its clinical benefit relative to unilateral CI use. 103 adults with bilateral postlingual profound sensorineural hearing loss and unilateral CI use were extracted from the local database. These were divided into two groups: those who only used a CI and those who used bimodal stimulation. All subjects had been monitored with the clinical Minimal Outcome Measurements (MOM) test battery. The preoperative contralateral residual hearing in the bimodal group was significantly better than that of the CI-only group. In both groups, speech perception in quiet and in noise improved after cochlear implantation, with no significant difference between their postoperative unimodal conditions. For the bimodal group, an additional significant improvement was found for the bimodal condition compared to the unimodal. Given the observed auditory benefit of bimodal stimulation in comparison to unimodal stimulation and given the finding that degree of residual hearing is not correlated with bimodal benefits, it is recommended to encourage CI recipients to continue contralateral HA use after cochlear implantation. As a result of expanding CI criteria worldwide, the population of bimodal users is expected to grow in the near future.

Keywords : Bimodal Stimulation, Cochlear Implantation, Binaural hearing

Hearing Preservation & Bimodal Hearing

PP 113

Effects of Contralateral Hearing Aids on Mandarin Voice Emotion Recognition in Adults with Bimodal Hearing

Yuqi XIA[1,2], **Yuhe LIU[1,2]**

[1]Department of Otolaryngology, Head and Neck Surgery, Peking University First Hospital, China
[2]Department of Otolaryngology, Head and Neck Surgery, Beijing Friendship Hospital, Capital Medical University, China

Purpose: Cochlear implant (CI) listeners have deficits in voice emotion perception due to limited spectro-temporal fine structure. Additional acoustic cues from contralateral hearing aids (HAs) may improve CI users' prosody perception, especially meaningful in Mandarin. This study aimed to investigate the effects of HAs on voice emotion recognition for Mandarin-speaking bimodal adults to provide better rehabilitation for CI users.
Method: Twenty-two Mandarin-speaking bimodal adults and control groups (twenty-two unilateral CI adults and twenty normal hearing adults) completed voice emotion recognition and speech recognition tasks. Bimodal listeners completed with bimodal listening and CI-alone listening. The Chinese version of the Nijmegen Cochlear Implant Questionnaire (NCIQ) was used for the evaluation of health-related quality of life for bimodal listeners.
Results: Participants with normal hearing had the best performances. Unilateral CI users took significantly longer time than bimodal users in voice emotion recognition, suggesting decreased listening effort via HAs. Bimodal listeners had similar voice emotion perception patterns to people with normal hearing. Bimodal listeners perceived voice emotions more accurately and faster with bimodal devices than with CI only. The accuracies of neutral and angry were higher than those of happy, sad and fear in bimodal listeners. Voice emotion recognition ability was associated with residual hearing in the nonimplanted ear and speech recognition ability among bimodal listeners. The NCIQ scores significantly correlated with the accuracy scores of speech recognition rather than with the accuracy scores of voice emotion recognition for bimodal listeners.
Conclusions: A contralateral HA improves the ability of voice emotion perception for Mandarin-speaking bimodal listeners, even though they continue to experience more challenges than normal hearing peers. The residual hearing in the nonimplanted ear and speech recognition ability play an important role in Mandarin-speaking bimodal adults' voice emotion perception.

Keywords : Bimodal listening, Voice emotion recognition, Contralateral Hearing Aid

Hearing Preservation & Bimodal Hearing

PP 114

Evaluation of Electrode Insertion Trauma Induced Loss of Residual Hearing in Cochlear Implant Recipients.

Nidhin DAS K[1], Vidhu SHARMA[1], Sarbesh TIWARI[2], Pushpinder KHERA[2], **Amit GOYAL[1]**

[1]Otorhinolaryngology, All India Institute of Medical Sciences, Jodhpur, India
[2]Diagnostic and Interventional Radiology, All India Institute of Medical Scienecs, Jodhpur, India

Objective: This study investigated electrode insertion-induced residual hearing loss in cochlear implant (CI) recipients. A comparison of preoperative and postoperative auditory steady-state response (ASSR) thresholds at 3 and 6 months was conducted among 16 patients, with 8 patients undergoing cochleostomy and 8 patients using the round window approach. The study also assessed the statistical significance of changes in ASSR thresholds postoperatively.

Methods: Sixteen patients with severe-to-profound sensorineural hearing loss underwent CI surgery via cochleostomy or round window approach. Preoperative bone conduction ASSR thresholds were measured, and the average at 500Hz, 1KHz, 2KHz, and 4 KHz was compared to postoperative values. Postoperative ASSR thresholds were evaluated at 3 and 6 months. An increase in ASSR threshold > 5dB from baseline was considered significant. Statistical analysis compared preoperative and postoperative ASSR thresholds, focusing on identifying significant changes.

Results: Out of 16 patients, 10 were male and 6 were female children. Ten children received bilateral CI, and 6 received unilateral CI, totaling 26 implanted ears. Median age was 4 years (range 2-5). Mean preoperative ASSR threshold was 98.32+/-2.1 dB. Mean postoperative ASSR thresholds at 3 months were 100.21+/-1.8 dB (cochleostomy) and 99.9+/-1.1 dB (round window). At 6 months, cochleostomy and round window values were 102.1+/-1.7 dB and 100.1+/-1.1 dB, respectively. Postoperative ASSR thresholds increased in cochlear implant recipients, suggesting electrode insertion-induced residual hearing loss. However, these changes were not statistically significant ($p > 0.05$) at 3 and 6 months. Comparisons between cochleostomy and round window groups did not reveal significant differences in observed ASSR threshold changes.

Conclusion: This study suggests that electrode insertion during CI may cause a slight increase in ASSR thresholds, indicating possible residual hearing loss. However, these changes were not statistically significant at the 3-month and 6-month follow-up.

Keywords : Electrode insertion induced hearing loss, Residual hearing, Intra cochlear fibrosis

Hearing Preservation & Bimodal Hearing

PP 115

Multicentric Bimodal Outcomes for the Oticon Medical Neuro 2 Cochlear Implant System and Optimised Contralateral Hearing Aid.

Stephanie CARRICK[1], Catherine SUCHER[2,3], Ronel CHESTER-BROWNE[2], Nina SWIDERSKI[4], Caren SAWERS[4], Melissa ROSENZWEIG[4], Billy KOPSAFTIS[4], Christopher LIND[4], Dakota BYSOUTH-YOUNG[5]

[1]Oticon Medical, Oticon Medical, Australia
[2]Ear Science Implant Clinic, Ear Science Institute Australia, Australia
[3]Ear Sciences Centre, Medical School, The University of Western Australia, Australia
[4]The South Australian Cochlear Implant Centre, The South Australian Cochlear Implant Centre, Australia
[5]Hearing Implants Australia, Hearing Implants Australia, Australia

Background: Bimodal hearing involves listening through a cochlear implant (CI) in one ear and a hearing aid (HA) in the other. Optimal bimodal fittings achieve bilateral hearing benefits and the best possible speech recognition and quality of life outcomes. However, the devices are often managed by different care teams, which brings challenges in optimising the bimodal solution.

Objectives: The present study introduces a method for optimised contralateral HA fitting and demonstrates the benefit of bimodal fittings when this method is used together with the Oticon Medical Neuro CI system.

Methods: This longitudinal multicentric study included 80 adults (35-90yr), with bilateral hearing loss who received a unilateral CI. They all had aidable contralateral hearing, but with different hearing loss configurations. They were fitted with their new contralateral HA prior to surgery using verification such as real-ear measures. Bimodal HA fittings and follow up were completed with optimization of i) loudness balancing and ii) frequency allocation. Following CI surgery and switch on, patient progress was assessed under conditions CI alone and bimodal using words and CUNY sentences in quiet and noise at 1, 3, 6, and 12 months post op.

Results: Regardless of hearing loss configuration in the contralateral ear, all patients performed better ~20% improvement, in the bimodal condition than in the CI or HA alone condition.

Conclusion: The Neuro CI system yields greater benefit bimodally than when using only one CI or one HA . This study demonstrates the importance of optimally aiding cochlear implant users with bimodal hearing solutions. These results support that all CI users should have their contralateral hearing and HA reviewed prior and after surgery to ensure that the HA is optimised as part of a bimodal solution. Future studies could further investigate bimodal fitting procedures and best clinical practice.

Keywords : Bimodal, Outcome measures, Standard of care

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The Impact of Bimodal Hearing on Voice Emotion Recognition and Categorical Perception of Lexical Tones in Mandarin Cochlear Implant Listeners

Yuqi XIA[1,2], **Yuhe LIU**[1,2]

[1]Department of Otolaryngology, Head and Neck Surgery, Beijing Friendship Hospital, Capital Medical University, China
[2]Department of Otolaryngology, Head and Neck Surgery, Peking University First Hospital, China

Purpose: As a tonal language, Mandarin Chinese depends on fundamental frequency cues more strongly than non-tonal language. The impacts of bimodal hearing on suprasegmental speech features in Mandarin cochlear implant (CI) listeners are still unclear. This study investigated the perception of suprasegmental speech features in Mandarin bimodal listeners through voice emotion recognition and categorical perception of lexical tones.
Methods: Thirty-two Mandarin-speaking bimodal listeners (aged 9-53 years) were recruited. Tasks were completed with bimodal listening and CI-alone listening. In voice emotion recognition, sentences were spoken by a male/female talker with different emotions (happy, angry, sad, fear and neutral). Categorical perception of lexical tones included two classical tasks: identification task and discrimination task.
Results: In voice emotion recognition, bimodal listeners had significantly higher accuracy scores and shorter reaction time with bimodal devices than with CI only, indicating better recognition ability and less listening effort. The scores of neutral and angry were higher than those of happy, sad and fear. Voice emotion recognition scores were associated with residual hearing thresholds in the nonimplanted ear and speech recognition scores. In categorical perception of lexical tones, identification task showed typical S shapes curves and discrimination task showed peakness, indicating the capacity of categorical perception in bimodal listeners. Significant bimodal benefits were observed in the slope of identification curves and between-category accuracy of discrimination task. The slope of identification curves was significantly associated with residual hearing thresholds in the nonimplanted ear and chronological age. There was a positive correlation between voice emotion recognition scores and the slope of identification curves.
Conclusions: Bimodal listeners obtain significant bimodal benefits for perception of suprasegmental features via contralateral hearing aids. The correlation between the two tests shows that suprasegmental tasks used are providing a measure of pitch ability. Better low-frequency acoustic hearing in the nonimplanted ear provides greater bimodal advantages.

Keywords : Bimodal hearing, voice emotion recognition, Categorical perception of lexical tones

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Electrode impact on residual hearing

Manoj Manikoth PUTHIYAPARAMBIL[1],
Sasidharan PULIBALATHINGAL[1], Shabeena BACKER[1]

[1]*Otology, Mesiarc Ent, India*

Changing selection criteria for cochlear implants have included patients with significant residual hearing. However, much caution should be exercised in operating on such patients as any loss of residual hearing will negate any advantage the procedure will bring. Many techniques have been described in hearing preservation approaches. The use of steroids, slow insertion, thinner and more flexible approaches and atraumatic techniques have been proposed. Though all these techniques are important, the most important variable appears to be the electrode used in many studies. Our centre, primarily a pediatric cochlear implant centre, now has many crossover candidates who are opting for cochlear implants as the benefits are becoming increasingly apparent. The use of masks during the post covid pandemic era has cut out lip reading as a communication aid to the partially deaf. We studied a few patients with significant residual hearing and evaluated the amount of hearing preservation seen in them. Our technique to achieve this result is also described in this study.

Keywords : Residual hearing, Partial deafness, Cochlear implants

Hearing Preservation & Bimodal Hearing

PP 118

Large group monaural and binaural speech perception outcomes for adult cochlear implant recipients

Rod HOLLOW[1], Richard DOWELL[1], Jaime LEIGH[1],
Rebecca FARRELL[1], Raoul WILLS[1]

[1]*Cochlear Implant Clinic, Royal Victorian Eye and Ear Hospital, Australia*

Aim: The Royal Victorian Eye and Ear Hospital Cochlear Implant Clinic uses large group speech perception data to counsel cochlear implant candidates about expected outcomes and to establish criteria for recommending cochlear implantation. In particular, the 1st quartile scores for monosyllable words and phonemes are used as the clinic's speech perception criteria. This study describes the results of speech perception tests presented to adults implanted with Nucleus CI500 and CI600 series cochlear implants.

Materials and Methods: A test battery involving a monosyllable word test (Consonant Vowel Consonant Word test) and an adaptive speech-in-noise test (Australian Sentence Test in Noise) was administered pre-implantation and at 3 and 12 months post-implantation to all adult recipients who were able to participate in the tests. The test battery was presented monaurally and binaurally.

Results: An analysis of speech perception data from 798 adults established the mean, median and 1st quartile scores for post-lingually deafened adults in monaural and binaural listening conditions. In the monaural listening condition, the median scores for the monosyllable word test and the adaptive noise test at 12 months post-implantation were 46% (words), 72% (phonemes) and 8.8dB respectively. The 1st quartile were 26% (words), 56% (phonemes) and 13.6dB. In the bimodal listening condition, the median scores for the same tests were 64% (words), 84% (phonemes) and 6.0dB respectively.

Conclusions: Results from a large group of adults who received Nucleus CI500 and CI600 series cochlear implants showed that 75% of the group obtained a phoneme score of 55% or greater on a monosyllable word test. Our clinic has adopted this score as our speech perception criteria when assessing cochlear implant candidates. The results also show the benefits of using bimodal hearing devices and therefore, the importance of supporting cochlear implant candidates and recipients to optimize their hearing in both ears.

Keywords : CI outcomes, Selection criteria, Bimodal

Hearing Preservation & Bimodal Hearing

PP 119

Comparing hearing preservation outcomes: extended versus single-dose steroid therapy in cochlear implantation

Hung-Pin WU

Department of Otolaryngology Head and Neck Surgery, Taichung Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Taichung, Taiwan, Taiwan

Objectives: The purpose of this study was to compare the hearing preservation outcomes of patients who received extended versus single-dose steroid therapy in cochlear implant surgery.

Design: Case-control.

Setting: Tertiary referral centers in Taiwan from April 2017 to 2019.

Participants: A total of 70 patients aged 1 to 78 years old (mean = 18.04, standard deviation [SD] = 21.51) who received cochlear implantation via the round window approach were included in the study. Prospectively, 35 cases were enrolled for cochlear implantation with single-dose therapy. Thirty-five controls who underwent cochlear implantation with extended therapy were retrospectively enrolled after frequency matching.

Outcome measures: The main outcome measure was the rate of hearing preservation. This was calculated based on the HEARRING Network formula and results were categorized as complete, partial, and minimal. Impedances served as secondary outcomes.

Results: There was no significant difference in the complete hearing preservation rates between the extended and single-dose groups at 6 months postoperatively. Impedances were significantly lower in the extended group after 1 month and 6 months of follow up. When the complete and partial hearing preservation groups were compared, the size of round window opening and speed of insertion were found to be statistically significant.

Conclusions: Both extended and single-dose therapies result in good hearing preservation in patients who undergo cochlear implantation. However, better impedances can be expected from patients who received extended therapy. A slower speed of insertion and a widely opened round window play a role in hearing preservation.

Keywords : Cochlear implantation, Steroid therapy, Hearing preservation

Hearing Preservation & Bimodal Hearing

PP 120

Monitoring of hearing preservation with electrocochleography in cochlear implant recipient during intraoperative & post-operative measurements : A longitudinal clinical experience & case study

Dr. Aninda Duti BANIK[1], Dr. Milind KIRTANE[2], Amit ANAND[3]

[1]Clinical & Research - Audiology, Advanced Bionics India Pvt Ltd, India
[2]Ent & Cochlear Implant, Dr Kirtane Clinic, India
[3]Audiology, Apple Speech and Hearing Clinic, India

Purpose
Intracochlear real-time electrocochleography via AIM system may provide crucial information about the health of cochlea during electrode insertion which can potentially help in structural preservation and thus preserving the low-frequency acoustic hearing.
Methods
9 year-old child with bilateral moderate to profound steeply-sloping high-frequency sensorineural hearing-loss was implanted with HiRes Ultra3D HiFocus Mid-Scala electrode & Naida CI M90-EAS unilaterally. Modified slow round-window insertion was achieved with favorable angular insertion. Intracochlear ECochG was performed with 500 Hz toneburst acoustic stimuli at 115 dBSPL. Acute ECochG based automated-sweep objective audiometry was obtained along with impedance & NRI measurements. Comparison was made at switch-on with unaided PTA, aided-Speech-perception scores, Post-operative ECochG based automated-audiometry and open-ended feedbacks. Audiology protocols to be rendered at every 3 months interval.
Results
Complete electrode insertion was accomplished over 210 seconds. Post-operative ECochG showcased no significant (P>0.05) thresholds shift of 0 dB at 125 Hz and +5dB at 250, 500 Hz which reveals complete preservation of hearing as per Skarzinsky classification. ECochG objective-audiometry revealed consistent responses at 85–90 dBHL on 2000, 4000 Hz during surgery & switch-on as well, which was poorer on subjective puretone audiometry & may be attributed to suprathreshold responses of a child. Impedances & NRI were within normal limits. Aided speech perception scores improved significantly to 84% (P<0.05) in noise acutely at switch-on with M-Acoustic earhook-electro-acoustic stimulation. Quick responses to verbal questions in noise, identification of Ling's 6-sound at 5 feet-soft were obtained and performed qualitatively better bimodally. Results of 3 months will be presented at the conference.
Conclusion
Real-time ECochG feedback helps during electrode insertion for the attempt at structural or hearing preservation and AIM system helps to monitor cochlea health post-operatively. Future work will help widen extent of expertise against cochlear insertion trauma and functional effects to hearing preservation.

Keywords : Electrocochleography, cochlear microphonics, M-Acoustic earhook, electroacoustic stimulation, AIM system, objective audiometry, hearing preservation

Inner Ear Anomaly (Outcome)

PP 121

A novel Cochlear C-value: Predicts What ?

Tawfiq KHURAYZI

Cochlear Implant Center, King Fahad Central Hospital, Saudi Arabia

The objective was to determine the A-value reported in the literature, to assess the accuracy of the A-value measurement and to evaluate a novel cochlear measurement in distinguishing malformed cochlea. High resolution Computer Tomography images in the oblique coronal plane/cochlear view of 74 human temporal bones were analyzed. The A-value and novel C-value measurement were evaluated as predictors of inner ear malformation type. 26 publications report on the A-value; but they do not distinguish normal vs. malformed cochleae. The A-values of the normal cochleae compared to the cochleae with cochlear hypoplasia, incomplete partition (IP) type I, -type II, and -type III were significantly different. The A-value does not predict the C-value. The C-values of the normal cochleae compared to the cochleae with IP type I and IP type III were significantly different. The A-value is different in normal vs. malformed cochleae. The novel C-value could be used to predict malformed anatomy, although it does not distinguish all malformation types

Keywords : Cochlear morphology, Cochlear malformation, C-value

Inner Ear Anomaly (Outcome)

PP 122

The Effectiveness Analysis of Cochlear Implantation in Children with Incomplete Partition Type I

Xianqi LIU[1], Jianfei LUO[1], Xiuhua CHAO[1], Ruijie WANG[1], Min WANG[1], Jinming LI[1], **Lei XU[1]**

[1]Department of Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital,shandong University, China

Objective: To assess the hearing and speech rehabilitation effects after cochlear implantation in children with incomplete partition type I inner ear malformation.
Method: Eighteen children with IP-1 were selected. The implant age was 0.93-7.09 years old, with an average of (2.29±1.84) years. The follow-up time was 1-8 years, with an average of (3.39±1.97) years. In addition, 18 children with normal cochlea who were matched with preoperative hearing aid threshold, preoperative auditory and speech level, cochlear brand, implant age and cochlear use time were randomly selected as the control group. SPSS23.0 software was used to analyze the CI aided threshold, Categories of Auditory Performance (CAP) score, and Speech Intelligibility Rating (SIR) score of the two groups at 6, 12, 18, 24, 36 months and more than 48 months postoperatively. The speech recognition results at the last follow-up were compared between groups.
Result : The CI aided threshold in IP-1 group was higher than that in the control group at all time points after surgery, but the difference was statistically significant only at 36 months ($P < 0.05$). The CAP and SIR scores of IP-1 group were significantly lower than those of control group at each time point after surgery ($Ps < 0.05$), except SIR score at 18 months postoperatively. At the last follow-up, 9 children in the IP-1 group and 13 children in the control group were able to cooperate with the open-set speech recognition test. The mean monosyllabic word recognition was 54.29% and the spondee word recognition was 60.63% in IP-1 group; the results were 78.19% and 84.78%, respectively, in the control group.
Conclusion : CI was an effective treatment for children with IP-1 malformation, but the development of hearing and speech ability were slower than children with normal cochlea.

Keywords : Cochlear implant, Incomplete partition type I, Auditory and verbal ability

Inner Ear Anomaly (Outcome)

PP 123

Cochlear implant in child with absent of semicircular canals

Khalid Mahmoud BADR

Otology and Skull Base, King Abdullah Medical City, Saudi Arabia

cochlear implant in child with absent of lateral semicircular canal
how to confirm it radiologically
what challenges encounter intra-operatively
how to pass these challenges
other option can be done in such condition
possible complications
outcome after switch on the device

Keywords : Absent of semicircular canal, Syndromic child, Inner ear malformation

Inner Ear Anomaly (Outcome)

PP 124

Cochlear implant in syndromic inner ear outcome

Saeed Abdullah M ALGHAMDI

Ent, Kamc, Saudi Arabia

Objective: To analyse the benefit of cochlear implantation in young deaf children with syndromic inner ear) compared to a reference group of young deaf children without additional disabilities.

Method: A retrospective study was conducted on children with syndromic who underwent cochlear implantation at the age of 2 years or younger. The post-operative results for speech perception (phonetically balanced standard Dutch consonant-vocal-consonant word lists) and language comprehension (the Reynell Developmental Language Scales, RDLS), expressed as a language quotient (LQ), were compared between the WS group and the reference group by using multiple linear regression analysis.

Conclusions: Children with syndromic inner ear performed similarly to the reference group in the present study, and these outcomes are in line with the previous literature. Although good counselling about additional disabilities concomitant to the syndrome is relevant, cochlear implantation is a good rehabilitation method for children with inner ear syndrome .

Keywords : Inner ear, Syndrome, Cochlear implant

Inner Ear Anomaly (Outcome)

PP 125

Characters and laws of development on the auditory and speech ability of cochlear implantation in Children with cochlear nerve deficiency

Ying KONG[1], Lifang ZHANG[1], Simeng LU[1], **Yongxin LI[1]**

[1]Department of Otolaryngology Head and Neck Surgery, Beijing Tongren Hospital, China

Objective To evaluate the auditory and speech ability of cochlear implantation in Children with cochlear nerve deficiency, and compare the similarities and difference on the auditory and speech ability between CI children with CND and CI children with normal cochlear nerve. Method The subjects were divided into two groups: the group A with CND and normal inner ear structure (n=42) ,the group B with normal cochlear never and normal inner ear structure (n=189) .Their auditory and speech abilities were estimated at the different time points after switch-on (0th,1st,3rd,6th,9th ,12th ,24th and 36th month, respectively) using four questionnaire: IT-MAIS,MUSS,CAP,SIR . Results The four questionnaire scores of the two groups enhanced gradually with CI using time increasing. The increase trend of group B was more obvious than that of group A. For the IT-MAIS scores of two groups, there was a significant difference at after switch-on 6 month and 9 month (P<0.05) . For the MUSS scores of two groups, there was a significant difference at after switch-on 24 month and 36 month (P<0.05) .For the CAP scores of two groups, there was a significant difference at after switch-on 6 month , 9 month,12month an24month (P<0.05) . For the SIR scores of two groups, there was a significant difference at after switch-on 0month, 9 month,12month, 24month and 36month (P<0.05) . Conclusion CI Children with CND had delayed but similar development of auditory and speech, compared to normal cochlear never. They had the same level on auditory ability between the CI Children with CND and normal cochlear never after switch-on 36month, but there were still a gap in speech ability. Cochlear implantation could improve the auditory and speech ability of children with cochlear nerve deficiency.

Keywords : Cochlear nerve deficiency, Auditory ability, Speech ability

Inner Ear Anomaly (Outcome)

PP 126

Cochlear Implantation in Labyrinthitis ossificans- The etiology, challenges, and outcomes.

Dipika PRAKASH[1], **Vidhu SHARMA[1]**, Amit GOYAL[1]

[1]Otorhinolaryngology, All India Institute of Medical Sciences, India

INTRODUCTION:
Labyrinthitis ossificans is a complication resulting from multiple causes that may cause hinderance in cochlear implantation (CI) by making electrode insertion difficult. Several modifications in the operative techniques and implant models have eased the process, however, the outcomes are controversial.
AIM:
The aim of this study was to analyze the etiology, the peri-operative challenges and outcomes in patients presenting with labyrinthitis ossificans in a tertiary care hospital in North-Western India.
METHODOLOGY:
This study included cochlear implant candidates with labyrinthitis ossificans who underwent CI at the tertiary care hospital. The study was approved by the Institutional Ethics Committee; written informed consent was obtained from the subjects and clinical data was obtained from medical records.
RESULTS:
A total of 4 candidates were included in the study. Three candidates belonged to pediatric age group and one was an adult. The etiology of labyrinthitis ossificans was meningitis (1), post-traumatic (2) and systemic autoimmune inflammatory process (1). All candidates underwent single sided cochlear implantation by the same surgeon and serial follow up was done post- implantation along with speech rehabilitation. Intra-operative Neural Response Telemetry (NRT) depicted stimulation in all 12 electrodes in three patients and in 4 electrodes in one patient. The average revised Categories of Auditory perception (CAP) score of three patients was 5.7 and Speech Intelligibility rating (SIR) was 3.18 at one year follow-up. One patient had no improvement in audiological and speech scores in the post-operative period and ultimately underwent Auditory Brainstem Implantation (ABI).
CONCLUSION:
Cochlear Implantation is the rehabilitative treatment of choice in patients of bilateral Labyrinthitis ossificans. Although the reports on post-implant performance following CI are conflicting, encouraging results have been obtained with modifications in operative techniques and new electrode designs.

Keywords : Cochlear Implantation, Labyrinthitis ossificans, Audiological outcome

Inner Ear Anomaly (Outcome)

PP 127

Measurements of Cochlear Anatomical Parameters in Inner Ear Malformation and Prediction of Cochlear Implantation Outcomes

Shujin XUE[1], Xingmei WEI[1], Simeng LU[1], Biao CHEN[1], Danmo CUI[1], Ying SHI[1], Jingyuan CHEN[1], Lifang ZHANG[1], Mengya SHEN[1], Xinyue ZOU[1], Xinyi ZHANG[1], Ying KONG[1,2], **Yongxin LI[1]**

[1]Department of Otorhinolaryngology Head and Neck Surgery, Beijing Tongren Hospital, Capital Medical University, Beijing, China
[2]Key Laboratory of Otolaryngology Head and Neck Surgery, Ministry of Education, Beijing Institute of Otolaryngology, Beijing Tongren Hospital, Capital Medical University, Beijing, China

Objective: To visualize the structure of the malformed cochlea by image reconstructions, to summarize the characteristics of anatomical parameters of inner ear malformation and their correlation with postoperative outcomes, and to construct a prediction model for postoperative outcomes of cochlear implantation (CI) in patients with cochlear hypoplasia (CH) and incomplete partition (IP) malformation.
Methods: The clinical data of patients with CH and IP who underwent CI in Beijing Tongren Hospital between August 2018 and August 2020 were collected, including CH (n=14), IP-I (n=16), IP-II (n=49) and IP-III(n=3) according to the preoperative CT images. The preoperative temporal bone CT was reconstructed in three-dimensional (3D) with 3D slicer to measure and analyze the diameter, width, height, volume of cochlear, basal turn length, and cochlear duct length. Assessment of postoperative auditory speech rehabilitation using the categories of auditory performance (CAP) and the speech intelligibility rating (SIR). The relationship between cochlear parameters and postoperative outcome was investigated, and a prediction model of postoperative outcome was constructed by the support vector machine.
Results: The differences in cochlear diameter, cochlear width, cochlear height, cochlear volume, basal turn length and cochlear duct length were significant. There was a significant difference in the scores of CAP and SIR among groups at 2 years after the surgery. Cochlear diameter, cochlear width, and cochlear duct length were all positively correlated with postoperative outcomes. A support vector machine classifier was used to construct a predict model for postoperative outcome using cochlear diameter and cochlear duct length, and the f1-score of the obtained model was 0.82.
Conclusion: The measurements in the 3D reconstruction model has high clinical application value. The better develop of the cochlea, the better the postoperative outcome. A support vector machine classifier can be applied to obtain an effective postoperative outcome classification prediction model with limited cochlear anatomical parameters.

Keywords : Inner ear malformation, Cochlear implantation, Machine learning

Inner Ear Anomaly (Outcome)

PP 128

A case of cochlear implant surgery for cochlear ossification after meningitis

Wei CHEN[1], Xiaojun JI[1], Jianan LI[1]

[1]College of Otolaryngology Head and Neck Surgery, Chinese Pla General Hospital, China

Severe cochlear ossification after meningitis is a contraindication to cochlear implant surgery. Cochlear ossification after meningitis can lead to severe sensorineural hearing loss, and cochlear implants are the ideal treatment strategy, with early implantation. A 4-year-old female Tibetan child was diagnosed of bilateral severe sensorineural hearing loss. CT of the temporal bone suggests bilateral middle ear mastoiditis with ossifying labyrinthitis changes, with the right side being the most prominent. MRI of the inner ear suggests: bilateral middle ear mastoiditis, incomplete visualization of the basal turn of cochlea and vestibule bilaterally, and most of the right semicircular canal is not shown.The child received a left cochlear implant, electrodes are inserted from the middle turn of the cochlea. Stimulation electrode are all inserted. Intraoperative testing of all electrodes with normal impedance and good response to NRT testing. Postoperative temporal bone CT suggests electrodes in the cochlea. Fibrosis or ossification of the basal turn of cochlea that occurs after meningitis can make cochlear difficult or impossible insertion of implanted electrodes. Once meningitis is diagnosed, cochlear implantation should be performed as soon as possible to obtain better hearing outcomes.

Keywords : Cochlear ossification, Cochlear implant, Meningitis

Inner Ear Anomaly (Outcome)

PP 129

Cochlear Implantation with Rounded Insertion Technique: Successful Outcome for Cystic Inner Ear Malformation

Hou-Kuang CHEN[1], William Kuan-Hua CHEN[2], Mei-Jui HUANG[2], Chi-Ching LIN[2], Yen-Jung PAN[2], Kuan-Ju CHEN[2], **Joshua Kuang-Chao CHEN[2]**

[1]Otorhinolaryngology,head and Neck Surgery, China Medical University Hospital, Taiwan
[2]Holistic Hearing Healthcare Center, China Medical University Hospital, Taiwan

Objectives
This consecutive series study aims to assess the auditory performance and speech production outcomes of cochlear implantation using a rounded insertion technique (RIT) in children diagnosed with cochlear hypoplasia (CH) and/or common cavity (CC).
Methods
A retrospective analysis was conducted on a group of patients diagnosed with cochlear hypoplasia (CH) and/or common cavity (CC) who underwent cochlear implantation via rounded insertion technique at our department between January 2012 and December 2020. The postoperative evaluation compromised auditory performance through sound field testing with cochlear implantation, as well as speech perception using the word recognition score (WRS).
Results
In this study, 10 patients with a median age of 4.89 years and an age range from 11 months to 16 years underwent cochlear implantation using the rounded insertion technique (RIT) for cystic inner ear malformation. A total of 12 ears were analyzed, with three receiving a cochlear implant on the left side, five on the right side, and two receiving bilateral implants. Among the cases, five were CC, and seven were CH. All cochlear implant surgeries using RIT were successfully completed without complications. Postoperative evaluation showed that two children with autism spectrum disorder (ASD) demonstrated sound recognition but faced challenges in language development. Another one prelingually deafened, still unable to report speech recognition test in current study. The postoperative mean audiometric threshold, assessed by sound field testing, was 32.4 dB HL. The word recognition score (WRS) for open set monosyllabic words was 61% in word intelligibility by picture identification (WIPI).
Conclusion
This consecutive series study demonstrates the reliability and benefits of rounded insertion technique for CI using ordinary electrodes in patients with CH and/or CC. The study findings indicate that the outcomes of auditory performance and speech perception ability achieved through this technique are comparable to those of other surgical approaches.

Keywords : Rounded insertion technique, Cochlear hypoplasia, Common cavity

Sequential CI, Asymmetric/ SSD (Outcome)

PP 130

Event-Related Potentials of Single Sided Deaf Cochlear Implant Users – Using a Semantic Oddball Paradigm in Noise

Marcus Windsor Rao VOOLA[1,2], Andre WEDEKIND[1,2], An T NGUYEN[3], Welber MARINOVIC[3], Gunesh RAJAN[4], Dayse TAVORA-VIEIRA[1,2,3]

[1]Medical School, University of Western Australia, Australia
[2]Department of Audiology, Fiona Stanley Fremantle Hospitals Group, Australia
[3]School of Population Health, Curtin University, Australia
[4]Deptartment of Otolaryngology, Luzerner Kantonsspital, Switzerland

Background: Single sided deafness (SSD) is characterised by a profound hearing loss in one ear and normal hearing in the contralateral ear. A cochlear implant (CI) is the only way to restore functional hearing in the profoundly deaf ear, with previous literature demonstrating improvements in speech in noise intelligibility. However, we currently have a limited understanding of the neural processes that contributes to improved speech in noise intelligibility.

Objectives: Using a semantic oddball paradigm presented in the presence of background noise, this study aims to investigate how the provision of CI impacts speech in noise perception of SSD-CI users.

Methods: High density electroencephalography (EEG) from twelve SSD-CI participants was recorded whilst they completed a semantic acoustic oddball task. All participants completed the task in three different free-field conditions with the speech and noise coming from different speakers. The three tasks were 1) CI-On in background noise, 2) CI-Off in background noise and 3) CI-On without background noise (Control). We examined task-performance (RT, subjective listening effort, and accuracy) and measured N2N4 and P3b event-related brain potentials (ERPs) linked to the discrimination and evaluation of task relevant stimuli.

Results: Reaction time was significantly different between all tasks with CI-On having faster RTs than CI-Off and Control being the fastest condition. The Control condition exhibited a significantly shorter N2N4 and P3b area latency when compared to the other two conditions. However, despite these differences noticed in RTs and area latency, we observed similar results between all three conditions for N2N4 and P3b difference area.

Conclusion: The inconsistency between the behavioural and neural results suggest that EEG may not be a reliable measure of cognitive effort. Future studies should look to alternative measures of auditory processing (e.g., pupillometry) to get a deeper understanding of the underlying auditory processes that facilitate speech in noise intelligibility.

Keywords : Single Sided Deafness, Event Related Potentials, P3b

Sequential CI, Asymmetric/ SSD (Outcome)

PP 131

Exponential fitting of spread of excitation response measurements in cochlear implants

Tobias RADER[1], Pascal NACHTIGAELLER[1], Theresa LINKE[2], Tobias WEISSGERBER[2], Uwe BAUMANN[2]

[1]Division of Audiology, Department For Otorhinolaryngology, University Hospital, Ludwig-maximilians-university Munich, Germany
[2]Division of Audiological Acoustics, Department For Otorhinolaryngology, University Hospital Frankfurt, Germany

The goal of this study was to examine the spread of neural excitation (SoE) in MED-EL cochlear implants (CIs). Spread of Excitation (SoE) curves were measured using the using electrically evoked compound action potentials (ECAPs), recorded with a spatial forward-masking paradigm. For 17 patients, SoE profiles were measured at three locations, apical (electrode 3), medial (electrode 6) and basal (electrode 9). The SoE profiles classified with an analyzable response were fitted with two exponential functions for the apical and basal side respectively. Asymmetric SoE with measures, scaled for the apical and basal side separately, were used to parametrize the fitted curves. Significant differences between apical and basal distance measures were found for the apical and basal probe electrode (apical: difference in medians = 1.32 mm, Wilcoxon-test $z = -2.46$, $p = .014$, $r = .55$; basal: difference in medians = 0.62 mm, Wilcoxon-test $z = -2.31$, $p = .021$, $r = .52$), but not for the medial probe electrode. The basal distance measure was also found to significantly differ between recording sites. Further aim is to see whether these measures extracted from the parametrized SoEs are related to psychophysical measures like speech perception.

Keywords : Spread of excitation, Exponential fitting, Cochlear implants

Sequential CI, Asymmetric/ SSD (Outcome)

PP 132

The new SONNET 2 sound processor-outcomes with the new front-end processing technology ASM 3.0

Anja KURZ[1], Kristen RAK[1], Rudolf HAGEN[1]

[1]Comprehensive Hearing Center, Department of Otorhinolaryngology, University Hospital Wuerzburg, Germany

Understanding speech in noise remains challenging for many CI users. Different aspects of cochlear implants were optimized to support CI users in these situations: electrode design, automatic gain control and directional microphones. Further considerable improvements may also be reached by employing advanced front-end processing features.
The new MED-EL SONNET 2 audio processor has Automated Sound Management ASM 3.0 implemented, including the new features noise reduction and transient reduction. In addition, an automatic scene classifier allows to integrate microphone directionality and wind noise reduction with these new features without further user interaction. This study aims to determine the improvement in speech understanding by use of this new technology.
In this open label, prospective, longitudinal study, speech performance in quiet and noise in different conditions were assessed using the Freiburg Monosyllables test and the Oldenburg Sentence Test. In addition, subjective user benefit was measured with different questionnaires and sound quality ratings.
Results indicate improved sound perception and less listening effort with the new technology ASM3.0.

Keywords : Audio processor, Speech perception outcome, Listening effort

Sequential CI, Asymmetric/ SSD (Outcome)

PP 133

A Study of Event-Related Potentials During Monaural and Bilateral Hearing in Single-Sided Deaf Cochlear Implant Users

Marcus Windsor Rao VOOLA[1,2], Andre WEDEKIND[2], An NGUYEN[3], Welber MARINOVIC[3], Gunesh RAJAN[1,4], Dayse TAVORA-VIEIRA[1,2,3]

[1]Medical School, University of Western Australia, Australia
[2]Department of Audiology, Fiona Stanley Hospital, Australia
[3]School of Population Health, Curtin University, Australia
[4]Otolaryngology, Curtin University, Australia

Objective: Single sided deafness (SSD) is characterized by a profoundly deaf ear and normal hearing in the contralateral ear. A cochlear implant (CI) is the only method to restore functional hearing in a profoundly deaf ear. However, exactly how the brain integrates the electrical and acoustic signal is not well investigated. This study aims to understand how the provision of the CI in combination with the NHE may improve SSD CI users' ability to discriminate and evaluate auditory stimuli.

Design: Electroencephalography (EEG) from ten SSD-CI participants were recorded during a semantic acoustic oddball task, where they were required to discriminate between odd and even numbers. Stimuli were presented in four hearing conditions: directly through the CI, directly to the NHE, or in free field with the CI switched on and off. We examined task-performance (response time and accuracy) and measured N1, P2, N2N4 and P3b event-related brain potentials (ERPs). Sound localization and speech in noise comprehension was also examined.

Results: In direct presentation, task performance was superior during NHE compared to CI were enhanced for NHE suggesting greater signal saliency. However, the size of N2N4 and P3b target-standard effects did not differ significantly between NHE and CI. In free field, target accuracy was similarly high with the CI (FF-On) and without the CI (FF-Off) (~95%), with some evidence of CI interference during FF-On (more variable and slightly but significantly delayed RTs [~737 vs. ~709 ms]). Early neural responses and late effects were also greater during FF-On.

Conclusion: Direct conditions revealed that participants could perform the task with the CI alone, although performance was sub-optimal and early neural responses were reduced when compared to the NHE. For free-field, the addition of the CI was associated with enhanced early and late neural responses, but this did not result in improved task performance.

Keywords : High Density EEG, Single Sided Deafness, Cochlear Implants

Sequential CI, Asymmetric/ SSD (Outcome)

PP 134

A Comparative Analysis of the Effect of Cochlear Implantation and Bone Conduction Implant on Tinnitus in Patients with Asymmetric Hearing Loss

Jae Sang HAN[1], Yeonji KIM[1], Ji Hyung LIM[1], Young Jun SEO[1], Jae-hyun SEO[1], **Shi Nae PARK[1]**

[1]Department of Otorhinolaryngology-head and Neck Surgery, , College of Medicine, The Catholic University of Korea, Seoul, Korea

Objective: Implantable hearing devices, such as cochlear implants (CI) and bone conduction implants (BCI), are commonly used to manage asymmetric hearing loss (AHL) in patients. However, it is not yet clear how these devices impact tinnitus. This study aimed to evaluate the changes in tinnitus severity following CI or BCI surgery in AHL patients with tinnitus.
Methods: A retrospective study was conducted on 26 adult AHL patients with tinnitus who underwent either CI (Nucleus 622 or 632, Cochlear Ltd., Sydney, Australia) or BCI (BonebridgeTM 601 or 602, MED-EL, Innsbruck, Austria) between 2017 and 2022. Patients' clinical characteristics, pre- and post-operative audiologic test results, and tinnitus questionnaires (tinnitus handicap inventory, THI; visual analogue scale, VAS) were collected and analyzed.
Results: Of the 30 patients, 15 received CI and 15 received BCI. Following CI surgery, the mean THI score significantly improved from 54.2±26.1 to 28.4±24.5 ($P < 0.05$), and all VAS scores (loudness/awareness%/annoyance/effect on life) showed significant improvement ($P < 0.05$). In the BCI group, the mean THI score, VAS awareness score, and VAS effect on life score significantly improved ($P < 0.05$), while the VAS loudness and annoyance scores showed no significant change. Comparison analysis showed that the postoperative changes in the questionnaires were greater in the CI group, particularly in the VAS loudness score ($P < 0.01$).
Conclusion: Both CI and BCI surgeries were effective in reducing tinnitus severity in AHL patients. However, the study suggests that CI surgery may be superior in reducing the loudness of tinnitus.

Keywords : Asymmetric hearing loss, Single-sided deafness, Tinnitus

Sequential CI, Asymmetric/ SSD (Outcome)

PP 135

Single-sided deafness: the effect of cochlear implantation on emotional and social handicap, functional hearing and quality of life

Dayse TAVORA-VIEIRA[1,2,3], Andre WEDEKIND[1,2], Aanand ACHARYA[1,2]

[1]*Audiology / Ent, Fiona Stanley Fremantle Hospital Group, Australia*
[2]*School of Surgery, The University of Western Australia, Australia*
[3]*School of Population Health, Curtin University, Australia*

Background: Cochlear implants (CIs) are considered to be the only alternative devices capable of restoring binaural hearing and alleviating intractable tinnitus in individuals with single-sided deafness. CI use has been shown to improve hearing performance in noise, localization ability, and quality of life (QoL) for these individuals.

Objectives: This study aimed to evaluate the level of handicap, as well as the short- and long-term functional and subjective outcomes, in a large group of individuals with single-sided deafness who were treated with a CI.

Methods: Eighty-one adult CI users with single-sided deafness participated in this study. Functional assessments included speech-in-noise testing and localization. Subjective assessments consisted of the Speech Spatial Quality of Hearing Scale, Tinnitus Reaction Questionnaire, Abbreviated Profile of Hearing Aid Benefit questionnaire, Hearing Handicap Inventory for Adults questionnaire, The Glasgow Health Status Inventory and the Glasgow Benefit Inventory questionnaires.

Results: Single-sided deafness has a significant impact on QoL and imposes a substantial emotional and social handicap on affected individuals. Self-reported QoL improved after cochlear implantation, with tinnitus intrusion significantly reduced as early as three months post-implantation. Significant improvement was observed in all speech understanding in noise configurations and localization ability.

Conclusion: Our findings demonstrate that single-sided deafness reduces social and psychological quality of life and imposes a remarkable level of handicap as per general and specific self-assessment tools. Cochlear implantation provided significant improvements in function, including speech understanding in noise and localization ability, as well as improved quality of life and reduced tinnitus, both in the early and long-term.

Keywords : SSD, Handicap, CI

Sequential CI, Asymmetric/ SSD (Outcome)

PP 136

Single-Sided Deafness: can we close the asymmetry gap in cortical activation?

Dayse TAVORA-VIEIRA[1,2,3], Marcus VOOLA[1,2], Andre WEDEKIND[1,2], Aanand ACHARYA[1,2]

[1]Audiology / Ent, Fiona Stanley Fremantle Hospital Group, Australia
[2]School of Surgery, The University of Western Australia, Australia
[3]School of Public Health, Curtin University, Australia

BACKGROUND

A decade of research has demonstrated that in patients with single-sided deafness (SSD) a cochlear implant (CI) is the only treatment option capable of restoring binaural hearing, with the benefit improving hearing performance in noise, sound localisation and quality of life.

OBJECTIVES

The objective of the study was to evaluate the activation of the auditory cortex through normal hearing and compare this with electrical stimulation via a CI in the contralateral deaf ear.

METHODS

High-density electroencephalography (HDEEG) recordings were taken from patients with normal hearing in one ear and a CI in the contralateral deaf ear, while performing an oddball task using three different types of stimuli: pure tones, words in quiet and words in noise. Reaction time – the time taken for the participant to respond after the stimulus onset – was measured in each condition.

RESULTS

Overall reaction time increased with increasing stimulus complexity. While an increase in reaction time was also observed when the participant heard with the CI alone compared with the normal hearing ear alone for each condition, the difference was small: 32ms when differentiating two pure tones, 115ms for words in quiet and 65ms for words in noise.

CONCLUSION

This study suggests that the normal ear stimulates the auditory cortex more efficiently than the CI, however, the mismatch between the CI and the normal hearing ear is small. Future studies should focus on improving cochlear implant technology and programming to bridge this temporal asymmetry.

Keywords : SSD-CI, Auditory cortex, Reaction time

Sequential CI, Asymmetric/ SSD (Outcome)

PP 137

Comparison of Objective and Subjective Benefit of Second Cochlear Implantation in Children to Adolescent/Adult

William Kuan-Hua CHEN[1,2], Mei-Jui HUANG[1], Yen-Jung PAN[1,2], Chi-Ching LIN[1], Kuan-Ju CHEN[1], **Joshua Kuang-Chao CHEN[1,2]**

[1]Holistic Hearing Healthcare Center, China Medical University Hospital, Taiwan
[2]Ent Department, China Medical University Hospital, Taipei Branch, Taiwan

Purpose:
Bilateral CI is increasingly common in every age group. Some patients who had first CI in early childhood have their second CI in late teens or adulthood. Audiometric improvements for bilateral implantation have been well-proved in adolescent/adult group, but only few studies have shown benefits in quality of life. The aim of this study is to compare the reason of surgery, objective and subjective benefit of recipients who had second CI in different age.
Methods:
It's a retrospective followed-up study. Total 192 bilateral CI cases were evaluated. We use Comprehensive Cochlear Implant Questionnaire (CCIQ) to evaluate the subjective benefit of recipients. Eighty-four cases are simultaneously implanted, and one hundred and eight cases are sequential implanted. They are grouped by the age of first CI (<12 years-old: Early implant group vs. late implant group)
Results:
For goal of surgery, majority of them want to gain biaural benefit but nearly 20% of implantees follow other's wish. Overall, patients have significant improvements in all domains of questionnaires after second CI. However, sequential recipients prefer their first CI which could provide more benefit, better sound quality, and higher satisfaction. Compared early and late implant group, there was no significant difference in all domains. Besides, in early group, no significant QoL improvement if they switch from bimodal (CI+HA) to bilateral (CI+CI). Recipients who are lack of motivation performed significantly worse on the second CI.
Conclusion:
The objective and subjective benefits of biaural hearing are experienced by bilateral CI recipients. For quality of life-aspect benefits, the early implant group tends to gain less benefit from second CI if they had surgery in their late teens or adulthood. Besides, motivation and reasonable expectation plays key role in adolescent and adult recipients. The results imply the necessity of early implant of second CI.

Keywords : Bilateral CI, Implantation age, Quality of life

Sequential CI, Asymmetric/ SSD (Outcome)

PP 138

Evaluating Outcomes of Cochlear Implantation for Single-Sided Deafness Using a Standard Clinic Configuration

Kari L. SMILSKY[1,2], Joseph M. CHEN[1,2], Vincent Y.w. LIN[1,2,3], Trung N LE[1,2,3], John J.w. LEE[2], Kassandra KAMINSKAS[1], Salahaldin ALAMLEH[4]

[1]Otolaryngology, Sunnybrook Health Sciences Centre, Canada
[2]Otolaryngology, Head and Neck Surgery, University of Toronto, Canada
[3]Sunnybrook Research Institute, Sunnybrook Health Sciences Centre, Canada
[4]Faculty of Medicine, University of Toronto, Canada

The incidence of cochlear implantation (CI) for single sided deafness (SSD) has grown significantly in recent years with regulatory approval and greater awareness. Individuals with SSD experience difficulties hearing in noise and the inability to localize sound. Much of the published research investigating the benefit of CI for SSD involves testing with a multi-speaker array or using electrophysiological measures. These measures, while accurate, are challenging to replicate in a standard clinical setting. The purpose of this study was to evaluate benefit of CI for SSD using the two-speaker arrangement available at most CI clinics along with standardized questionnaires.

Methods: The study group included 98 adults aged 18-77 years with SSD. Subjects were evaluated pre-operatively and at 1, 3, 6, and 12 months post CI activation. At each of these time points, subjects underwent speech perception testing in the CI-only condition and they completed subjective questionnaires. Speech perception abilities were assessed using CNC words and AzBio sentences in quiet. Subjects completed the Tinnitus Handicap Inventory (THI) and the Speech and Spatial Qualities of Hearing Questionnaire (SSQ). Spatial hearing was assessed using a two speaker set-up using a challenging signal-to-noise ratio with speech and noise co-located (S0N0) and spatially separated by +90 degrees (S0Nci) and -90 degrees (S0Nnormal ear) with the CI on and off.

Results: Significant improvements over time were realized for CNC words and AzBio sentences in quiet ($P<0.001$). Significant benefits were noted for head shadow ($p<0.001$), squelch ($P<0.01$), and summation ($p<0.01$). Significant improvements were measured for all three subscales of the SSQ and for the THI ($p<0.01$).

Conclusion: Patients who receive a CI for SSD show improvement in their speech perception scores in the implanted ear, in spatial hearing, and in their self-perceived tinnitus handicap and hearing disability. These benefits can be measured using a conventional clinical configuration.

Keywords : Single sided deafness, Outcomes, Spatial testing

Sequential CI, Asymmetric/ SSD (Outcome)

PP 139

Factors influencing cochlear implant use in individuals with unilateral hearing loss

Catherine Mary SUCHER[1,2], Matthew ZIMMERMANN[1,2], Melanie FERGUSON[3]

[1]*Brain and Hearing, Ear Science Institute Australia, Australia., Australia*
[2]*Medical School, The University of Western Australia, Australia*
[3]*Curtin Medical School, Curtin University, Australia*

Objectives: Cochlear implantation for unilateral hearing loss has become more common in recent years. However recent research has indicated that long term use of cochlear implants (CI) in these cases is variable. This was a preliminary study to investigate factors which may influence ongoing CI use in cases of unilateral hearing loss.
Study Design: Cross-sectional study
Methods: Cochlear implant recipients implanted at a large Western Australian CI clinic, who had a unilateral hearing loss, normal hearing in the better ear, and a severe-profound hearing loss in the poorer ear, or a 4-frequency average hearing loss (4FAHL) asymmetry of >60 dB, were invited to complete an online Qualtrics survey. The survey consisted of validated questionnaires, such as the Short Grit Scale, Assessment of Quality of Life-6D, Speech and Spatial Qualities Questionnaire-12, in addition to perceived outcomes collated following discussion from experienced CI clinicians and CI recipients. Speech perception outcomes (CNC word and phoneme scores) at 3, 6 and 12 months post-operatively, were also collated.
Results: Eighteen experienced CI users completed the questionnaire. Significant correlations included; 3 months post-op self-reported device use negatively correlated with CNC word score ($r = -0.520$, $p = 0.039$), 12 months post-op self-reported device was positively correlated with 4FAHL in the good ear ($r = 0.491$, $p=0.038$), and QoL score ($r = 0.519$, $p = 0.033$), and current self-reported CI use positively correlated with perceived benefit score ($r = 0.586$, $p = 0.011$). Factors respondents commonly indicated as CI benefits were: improved hearing in quiet conditions (78%), increased overall sound level (61%), improved confidence and ability to localise sounds (56%). Common negatives included: 'weird' sound quality (33%), noise/static (28%).
Conclusion: Factors influencing CI use amongst adults with unilateral hearing loss can vary over time. Further research is required into "non-traditional" factors influencing device use.

Keywords : Unilateral hearing loss, Cochlear implant, Outcomes

Sequential CI, Asymmetric/ SSD (Outcome)

PP 140

Single-center experience in diagnosis and treatment of congenital single-sided deafness in children

xiao ZHANG[1], Hai Hong LIU[1], Ying LI[1], Jie BAI[1], Han Di LIU[1], Ni MA[1], Wei LIU[1], Jun ZHENG[2], **Yang YANG**[1]

[1]*Otolaryngology Head and Neck Surgery, Beijing Children's Hospital, Capital Medical University, China*
[2]*Otolaryngology Head and Neck Surgery, Beijing Toren Hopspital, Capital Medical University, China*

Objective To analyze the audiology, reason / discovery methods and imaging characteristics of children with congenital singe-sided deafness, and to share the experience of treatment cases.
Method After retrospective analysis of clinical data of children from January 2019 to December 2020 in our department and diagnosed with congenital monaural severe / extremely severe sensorineural deafness, all cases were collected, and the characteristics of audiology, reason / approach, imaging characteristics, and treatment cases were analyzed.
Results From January 2019 to December 2020, our hospital outpatient department diagnosed 172 children with single-sided deafness. (1)Age distribution was 0-13 years, with 102 females and 70 males. 89 people were present in the left ear and 83 people were present in the right ear. (2) Reasons and discovery methods: the proportion of children who failed the neonatal hearing screening was the highest. (3) Imaging: among 172 people, 112 people received imaging examination, among which 75 people had structural abnormalities, accounting for 67%, among which 62 cases were cochlear nerve hypoplasia, accounting for 83%.(4) Three patients underwent surgical intervention, one bone bridge implantation, and two cochlear implants.
Conclusion Children with congenital unilateral deafness should be paid more attention; neonatal hearing screening, kindergarten hearing physical examination and regular hearing examination are very important for detecting unilateral deafness. The proportion of inner ear structural abnormalities in the etiology is higher, and cochlear nerve hypoplasia is more common. Treatment needs to be more individual-dependent.

Keywords : Children, Single-sided deafness, Treatment

Sequential CI, Asymmetric/ SSD (Outcome)

PP 141

Auditory cortical plasticity in individuals with single-sided deafness following the use of bone-anchored hearing aid

Ji-Hye HAN[1], Jihyun LEE[1], **Hyo-Jeong LEE[2]**

[1]Laboratory of Brain & Cognitive Sciences For Convergence Medicine, Hallym University College of Medicine, Korea
[2]Department of Otorhinolaryngology-head and Neck Surgery, Hallym University College of Medicine, Korea

Individuals with single-sided deafness (SSD) the effectiveness of air-conduction hearing aids in overcoming asymmetrical hearing loss has been limited. Recently, as non-invasive bone-anchored hearing aids (BAHAs) have been developed, there is interest in evaluating the applicability of this amplification for SSD patients using cortical auditory evoked responses. The objective of this study was to determine if BAHA use alters the pattern and strength of cortical activities in SSD patients.

To see whether short-term BAHA use can yield neural and behavioral changes, 8 SSD subjects had used their BAHAs for 3 months. Electrophysiological and behavioral tests were administered 3 times at baseline, (pre-BAHA), the first day of BAHA fitting (1st-BAHA), and 3 months after BAHA use (2nd BAHA). Cortical activities were recorded during an active sound localization task. N1 and P2 responses were measured to discern the effect of BAHA use on the cortical activities at both sensor and source levels.

Behaviorally, the reaction time during sound localization were shorter for 1st- and 2nd-BAHA compared to pre-BAHA session. The use of BAHA substantially improved N1 amplitude; however, the improvement was diminished during 2nd-BAHA. The BAHA-induced changes on cortical activity were greater for the P2 than the N1 in that the P2 amplitudes increased gradually with BAHA use. At the source level, similar P2 enhancements with BAHA use were shown. Moreover, ipsilateral hemispheric dominance for hearing side was found before BAHA use, while the P2 activity was more symmetrical in the brain after BAHA use. Brain-behavior relations showed that N1 source activation was positively correlated with better sound localization performances.

The results of this study suggest that BAHA use enables to induce the brain plasticity to reorganize the cortical mechanisms of spatial processing in individuals with SSD. In addition, the P2 would be more responsive to BAHA-related neurophysiological changes than N1.

Keywords : Singlde-sided deafness, Cortical plasticity, Bone-anchored hearing aid

Sequential CI, Asymmetric/ SSD (Outcome)

PP 142

Long sequential cochlear implants and outcomes

Manoj Manikoth PUTHIYAPARAMBIL[1], Sasidharan PULIBALATHINGAL[1]

[1]Otoneurology, Mesiarc Ent Hospital, India

Cochlear implants are now established as the mode of care for severe to profound hearing loss. bilateral cochlear implantation is performed as a regular surgery in many centres across the world. lately, children who have had implants in one ear in the past are returning for implantation in the second ear. Many issues arise in this scenario. knowing that the plasticity of the brain is important for the development of good language and hearing. And as the second ear has been deprived of stimulation, can we assume that the decussation of the auditory pathway alone is enough to provide useful hearing from the second ear? Would the child benefit as much if the delay between the two ears is many years? There being no easy answers to these questions, we studied children who have had long sequential cochlear implantation to assess their acceptance of the technology

Keywords : Long sequential implantation, Cochlear implant, Hearing aid use

Sequential CI, Asymmetric/ SSD (Outcome)

PP 143

Clinical Effectiveness of Cochlear Implantation in Adult Patients with Single-Sided Deafness and Asymmetric Hearing Loss

Ga-Young KIM[1,2,3], Mini JO[2], Young Sang CHO[4], **Il Joon MOON[1,4,5]**

[1]Medical Research Institute, Sungkyunkwan University School of Medicine, Korea
[2]Hearing Research Laboratory, Samsung Medical Center, Korea
[3]Department of Digital Health, Saihst, Sungkyunkwan University, Korea
[4]Department of Otorhinolaryngology-head and Neck Surgery, Sungkyunkwan University School of Medicine, Samsung Medical Center, Korea
[5]Saihst, Sungkyunkwan University, Korea

Cochlear implantation is a surgical treatment option for patients with single-sided deafness (SSD) and asymmetric hearing loss (HL), providing benefits such as improved sound localization, speech understanding, and overall auditory experience. The objective of this study is to investigate the language and auditory performance of individuals with SSD and asymmetric HL.

A total of 13 participants were included in the study, with 5 males and 8 females. The average age of the participants was 52.08±11.34 years. The participants underwent retrospectively sound-field audiometry, sound-field word recognition score (WRS), Korean Hearing In Noise Test (K-HINT), sound localization and questionnaire. Statistical analysis was performed using the Wilcoxon signed-rank test.

The research findings revealed a significant improvement in sound localization hit rate (Z=-2.049, p=0.040), error degree (Z=-2.271, p=0.023), and speech perception (Z=-2.197, p=0.028) of the Speech, Spatial, and Qualities of Hearing Scale questionnaire items.

These results indicate that cochlear implantation can lead to positive outcomes in terms of sound localization, reducing errors, and improving language-related auditory performance for individuals with SSD and asymmetric HL. These findings support the effectiveness of cochlear implantation as a treatment option in improving the overall listening abilities and auditory experiences of this patient population.

Keywords : Cochlear Implant, Single Sided Deafness, Asymmetric Hearing Loss

Elderly CI & Cognition

PP 144

The study of non-verbal cognitive function and quality of life in postlingual deaf adults after cochlear implantation

Jinming LI[1], Jianfen LUO[1], Ming WANG[1], Xiuhua CHAO[1], Ruijie WANG[1], Xianqi LIU[1], Dianzhao XIE[1], Haibo WANG[1], **Lei XU[1]**

[1]Otolaryngology-head and Neck Surgery,, Shandong Provincial Ent Hospital, China

Aim: To evaluate the benefits of Cochlear implantation (CI) on non-verbal cognitive function in adults. To investigate the development of non-verbal cognition and quality of life in postlingual deaf adults before and after cochlear implantation.Methods: There were 25 people in this test, 14 boys, and 15 women. The average age before surgery was 37.98 ± 11.5, the average age after surgery was 39.13 ± 11.5, and the average deafness was 18.7 ± 12.7. Use the Leiter-3 non-verbal cognitive test, Nijmegen Cochlear Implantation Questionnaire(NCIQ) to evaluate the patient's postoperative non-verbal cognitive function and quality of life. The Leiter-3 is a test that does not require verbal engagement and is designed to assess non-verbal intelligence in children, adolescents, and adults aged 3-75 years. The main test completes a series of tests by the method of showing the subject (gesture, eyes and other physical movements). The test has a total of 10 sub -tests and 4 dimensions, namely cognition, memory, attention, and processing speed. The Leiter-3 test was performed in patients before surgery and one year after switch-on. Results: Using t-test, we found significant differences in the cognitive and processing speed tests of Leiter-3 before and one year after CI (P<0.001), indicating that the patients' nonverbal cognitive function had improved significantly after CI. At the same time, the quality of life of patients was significantly improved compared with that before operation (P<0.05). Conclusion: CI can improve the cognitive function and quality of life of adult postlingually deaf patients.

Keywords : Postlingual deaf adults, Non-verbal cognitive, Quality of life

Elderly CI & Cognition

PP 145

Alternative surgical approach of Cochlear implant in elderly patients

Subin KIM[1], **Ki-Hong CHANG[1]**, Seunghwa KIM[1], Da Hye MOON[1]

[1]Otolaryngology, Department of Otorhinolaryngology, Eunpyeong St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Korea

Purpose : In the aging society, CI for eldery is increasing. There are some differences in the operational process compared to the child due to altered anatomical structure and chronic inflammation. We reviewed 3 patients more than 60 years of age to introduce a modified surgical approach through the facial recess.
Methods : All of the patient's preoperative CT and MRI showed no signs of inner ear inflammation or ossification. Patient number 1 (#1) had a history of left chronic otitis media with frequent otorrhea and underwent subtotal petrosectomy with abdominal fat graft. Three months later, CI was done with a RW approach. Patient #2 had bilateral chronic otitis media with absence of otorrhea and long time use of hearing aid in left ear. Since patient #2 had a long period of silent mastoid, subtotal petrosectomy was not considered. Due to the narrow facial recess, posterior wall of external auditory canal was resected into a wedge shape. After inserting the electrode, resected EAC bone was repositioned. Patient #3 had a history of CWD mastoidectomy of the right side, but left side was free from symptoms or TM abnormality. Temporal bone CT showed sclerotic mastoid of the left side. She also had a narrow facial recess as patient #2, so the same EAC sedge shape removing method was done to expose a better sight of RW approach.
Result : All three of patient had no inflammation or electrode problem after the surgery, and are undergoing successful hearing rehabilitation. Patient #2 and #3 had no EAC problems after EAC wedge resection and reposition.
Conclusion : In elderly patients, cochlear implant surgery may be more challenging than in pediatric patients due to the anatomical variants. Therefore, being familiar with alternative methods to solve intraoperative anatomical barriers is important.

Keywords : Elderly CI, EAC wedge resection, Facial recess

Elderly CI & Cognition

PP 146

Cochlear Implantation in Elderly Patients: Survival Duration, Hearing Outcomes, Complication Rates, and Cost Utility

Neil DONNELLY[1], Any HAMMOND-KENNY[1], Daniele BORSETTO[1], Joseph MANJALY[1], Tsvetemira PANOVA[1], Ananth VIJENDREN[1], Manohar BANCE[1], James TYSOME[1], Patrick AXON[1]

[1]Cambridge Hearing Implant Centre, Cambridge University Hospitals, UK

Introduction: The prevalence of hearing loss and its consequences is increasing as the elderly population grows. As guidelines for cochlear implantation (CI) expand, the number of elderly CI recipients is increasing. We report complication rates, survival duration, and audiological outcomes for CI recipients aged 80 years and over and discuss the cost utility of CI in this age group.

Methods: A retrospective cohort study was undertaken of all CI recipients (126 cases), aged 80 years and over at the time of their surgery, implanted at our institution (Cambridge University Hospitals) during a period from January 1, 2001, to March 31, 2019. Data on survival at 1, 3, and 5 years post-implantation, post-operative complications and functional hearing outcomes including audiometric and speech discrimination outcomes (Bamford-Kowal-Bench sentence test) are reported.

Results: The mean age at implantation was 84 years. The mean audiometric score improved from 108 dB HL to 28 dB HL post-implantation. The mean Bamford-Kowal-Bench score improved from 14% to 66% and 73% at 2 and 12 months post-implantation, respectively. The complication rate was 15.3%. The survival probability at 1 year post-implantation was 0.95 for females and 0.93 for males, at 3 years was 0.89 for females and 0.81 for males, and at 5 years was 0.74 for females and 0.54 for males.

Conclusion: CI is safe and well-tolerated in this age group and elderly patients gain similar audiometric and functional benefit as found for younger age groups.

Keywords : Elderly, Cost-effectiveness, Survival duration

Elderly CI & Cognition

PP 147

Cochlear implantation outcomes in the elderly population in Singapore

Wen Chi SOM[1], Chun Suan ONG[1], Pei Shan LEEM[1], Ling Hui, Brenda SIM[2], Jia Hui NG[2], Ni Gin ONG[2], Yee Jueen, Vanessa TAN[2]

[1]Centre For Hearing and Ear Implants, Singapore General Hospital, Singapore
[2]Department of Otorhinolaryngology – Head and Neck Surgery, Singapore General Hospital, Singapore

Background and Objectives:
In the last 20 years, there has been an increasing trend of cochlear implantation (CI) performed on adults over the age of 60. A common question asked by patients and caregivers is whether the age of implantation will negatively affect outcomes. The aims of this study were to evaluate the outcomes of CI in elderly patients and to investigate if older age at implantation was correlated with poorer post-CI hearing performance.

Methods:
This is a retrospective chart review of 25 post-lingually deafened older adults who were implanted between the years 2017 and 2022 at a tertiary hospital. These patients were aged 60 to 86 years old at the time of implantation. The pre- and post-CI Category of Auditory Performance (CAP) scores were recorded and analysed for all patients. The pre- and post-cochlear implantation speech perception scores were also collected for English and Mandarin speaking patients. Speech perception tests were conducted using Arthur Boothroyd (AB) word lists and the Mandarin Monosyllable Recognition Test (MMRT) respectively. Statistical analysis was performed to investigate a possible correlation between age and CAP scores.

Results:
The median pre-CI cap score was 2 (Responds to speech sounds) and median post-CI CAP score was 5 (Understands common phrases without lip-reading). There was an average post-CI improvement of 2.9 on the CAP score ($p<0.05$). Post-CI speech perception scores increased by an average of 41% on the Mandarin speech test ($p<0.05$) and 38% for the English speech test ($p<0.05$). Pearson correlation analysis showed no linear correlation between the age of implantation and post-CI CAP score.

Conclusions:
This study suggests that elderly patients can benefit from cochlear implantation. The majority of patients achieved improved speech understanding after implantation. An overall improvement in listening function was observed regardless of their native language or age.

Keywords : Cochlear implants, Elderly, Speech perception

Elderly CI & Cognition

PP 148

Development of a Robust Cognitive Test for the Elderly

Vincent LIN

Otolaryngology - Head & Neck Surgery, Sunnybrook Health Sciences Centre, University of Toronto, Canada

Introduction: Our institution has adapted cognitive screening tests in the past for our hearing impaired patients. However, our clinical patient experiences demanded a more robust test battery that is more sensitive and could potentially be utilized for repeated testing. We assembled a more thorough battery of previously validated cognitive screening tests and have adapted these tests for the hearing impaired by presenting them visually. We have started validation in patients at our tertiary adult cochlear implant program. The new test battery consists of testing of word recall (immediate and delayed), clock drawing, forward and backwards number recall, abstraction, subtraction, verbal fluency, categorical semantic fluency, orientation and completion of a trails task. Our new test is scored out of 50.

Methods: Adult patients over the age of 60 undergoing cochlear implantation at the Sunnybrook Cochlear Implant Program were recruited to undergo testing. Patients were required to undergo a series of screeners to ensure those with neurological or signs of cognitive decline were excluded.

Results: Early results include 30 patients with an average age of 63. The average score was 38.4 with a standard deviation of 4.4. The minimum test score was 30 and maximum was 44.5. The average time of completion was 16 minutes.

Conclusions: Our pilot data suggests that our new cognitive test for our patients over the age of 60 is easy to administer and patients with normal cognitive demonstrate a narrow standard deviation with no ceiling effected noted. Future studies will increase our accrual numbers with repeat testing in patients post-cochlear implant to determine whether scores are significantly changed.

Keywords : Cognitive test, Dementia, Cochlear implant

Elderly CI & Cognition

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It is not only the speech testing that shows improvement following Cochlear Implantation

Janeen JARDINE[1], **Jackie MOON[1]**

[1]Mater Cochlear Implant Clinic, Mater Health Services Brisbane, Australia

Cochlear Implantation is offered to adults based on both their hearing loss and speech discrimination scores. It is predicted that in most cases there will be an improvement in a recipient's speech perception after receiving a Cochlear Implant.

Although many adults are within audiometric criteria to proceed with cochlear implantation they can be apprehensive and delay being referred to a cochlear implant clinic for many years. They are counselled that whilst they will not have normal hearing with a Cochlear Implant there will be a significant improvement in their hearing.

Post implantation the clients are tested with a speech perception assessment at 3 and 12 months in a sound proof booth to measure their improvement. However, speech recognition testing in a controlled testing environment does not always equate to the recipients experience in the real world.

Many clients with a longstanding hearing loss have developed coping strategies to make their life and communication as easy as possible. It is the comments from the clients of their lifestyle changes such as being able to use a phone, enjoyment from listening to music and interacting with family that show the biggest improvement in quality of life.

Although recipients report that a CI has improved their hearing, this study aims to identify if there have been any specific changes in their lifestyle or habits post implantation using self-report questionnaires and Client Oriented Scale of Improvement (COSI); It will also establish if the recipients report that they now feel they should have proceeded earlier to Cochlear Implantation

The information gathered from this study will be a valuable resource for future counselling to those with hearing loss.

Keywords : Quality of Life, Speech recognition, COSI

Elderly CI & Cognition

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Effects of cochlear implantation on cognitive decline in older adults: A systematic review and meta-analysis

Sora AN[1], Eunha JO[1], Sang Beom JUN[2,3,4], **Jee Eun SUNG[1]**

[1]Department of Communication Disorders, Ewha Womans University, Korea
[2]Department of Electronic and Electrical Engineering, Ewha Womans University, Korea
[3]Graduate Program in Smart Factory, Ewha Womans University, Korea
[4]Department of Brain and Cognitive Sciences, Ewha Womans University, Korea

Purpose

In the current study, we aim to systematically analyze the longitudinal effects of auditory rehabilitation via cochlear implants (CIs) on two different domains: speech recognition and cognitive function.

Methods

We searched relevant literature published from January 1, 2000 to April 30, 2022, using electronic databases (PubMed, EMBASE, and Web of Science), and selected studies in which CIs were performed mainly on older adults and follow-up assessments were conducted in both domains: speech perception and cognitive function. A random-effects meta-analysis was conducted for each domain and for each timepoint comparison (pre-CI vs. six months post-CI; six months post-CI vs. 12 months post-CI; pre-CI vs. 12 months post-CI), and heterogeneity was assessed using Cochran's Q test.

Results

Of the 1,918 retrieved articles, 20 research papers (648 CI subjects) were included. The results demonstrated that speech perception was rapidly enhanced after CI, whereas cognitive function had different speeds of improvement for different subtypes: executive function steadily improved significantly up to 12 months post-CI; verbal memory was significantly enhanced at six months post-CI and was maintained until 12 months post-CI; non-verbal memory showed no considerable progress at six months post-CI, but significant improvement at 12 months post-CI.

Discussion

The outcomes demonstrated that auditory rehabilitation via CIs could have a long-term positive impact on cognitive abilities as well as speech recognition. Based on the findings, we speculated that as "listening effort" is reduced through CIs, the functional reorganization of the brain is induced and cognitive resources are re-allocated, thereby improving overall cognitive function. Given that older adults' cognitive abilities are on the trajectory of progressive decline with age, these results highlight the need to increase the adoption of CIs among this population.

Keywords : CI, Cognitive decline, Older adults

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Improvement of Speech Perception and Quality of Life in Unilateral Cochlear Implants in Adult Recipient : A Case Study

Asma Fatimah RASLI[1], Goh Bee SEE[2], Fatimah Binti SAZARI[1]

[1]*Department of Medical Rehabilitation Services,, National University of Malaysia, Malaysia*
[2]*Department of Otorhinolaryngology,, Faculty of Medicine, National University of Malaysia, Malaysia*

This case report aims to examine the effectiveness of cochlear implantation in improving speech recognition abilities, listening skills and quality of life in older adult with severe to profound hearing loss. A 54-year-old patient presenting with a complaint of significant hearing difficulty for many years. Patient was diagnosed with severe to profound hearing loss bilaterally with a history suggestive of labyrinthitis that impacted his ability to communicate effectively. Imaging with CT scan and MRI showed labyrinthitis ossification (left worse than right). Prior to CI, Cochlear Implant Screening revealed that patient scored <50% for Analytic and Synthetic Training. Speech Spatial Qualities (SSQ) revealed that the patient scored 11/140 for Speech Hearing, 22/150 for Spatial Hearing and 18/180 for Qualities of Hearing. Ling-6 sounds revealed that the patient was able to identify /a/ and /i/ sounds at 1 meter distance. The decision was made to implant right ear. Intraoperatively, round window was ossified and cochleostomy was performed with some ossification noted in the beginning of the procedure. Contour advance electrode was used and fully inserted successfully.

After receiving the implant, significant improvement can be observed. In three months, the patient scored 43dBA in hearing in noise test (HINT) compared to none before implantation. Patient scored >80% in Synthetic and Analytic Training and >90% for identification of all Ling-6 sounds at 5 meter distance were achieved in five months with intensive speech therapy sessions. SSQ revealed scores of improvements 67/140 for Speech Hearing, 63/150 for Spatial Hearing and 107/180 for Qualities of Hearing.

This case shows that CI is able to provide better speech perception for severe and profound hearing loss even in the case of labyrhititis. Thus, CI is a precise solution even in fitting unilaterally to improve speech perception and boost up the quality of someone's life.

Keywords : Cochlear implant, Hearing loss, Quality of life

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Auditory sensory gating in children with cochlear implants

Yanxin CHEN[1], Jiaqiang SUN[1], Xiaotao GUO[1], **Jingwu SUN**[1]

[1]*Department of Otolaryngology-head and Neck Surgery, The First Affiliated Hospital of University of Science and Technology of China, China*

While a cochlear implant (CI) can restore access to audibility in deaf children, implanted children may still have difficulty in concentrating. Previous studies have revealed a close relationship between sensory gating and attention. However, whether CI children have deficient auditory sensory gating remains unclear. To address this issue, we measured the event-related potentials (ERPs), including P50, N100, and P200, evoked by paired tone bursts (S1 and S2) in CI children and normal-hearing (NH) controls. Suppressed amplitudes for S2 compared with S1 in these three ERPs reflected sensory gating during early and later phases, respectively. A Swanson, Nolan, and Pelham IV (SNAP-IV) scale was performed to assess the attentional performance. Significant amplitude differences between S1 and S2 in N100 and P200 were observed in both NH and CI children, indicating the presence of sensory gating in the two groups. However, the P50 suppression was only found in NH children and not in CI children. Furthermore, the duration of deafness was significantly positively correlated with the score of inattention in CI children. Auditory sensory gating can develop but is deficient during the early phase in CI children. Long-term auditory deprivation has a negative effect on sensory gating and attentional performance.

Keywords : Auditory sensory gating, Cochlear implant, Event-related potential

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Cochlear implantation in the elderly : speech performance, predictive factor, complication, and surgical safety

Da Jung JUNG[1], **Kyu-Yup LEE[1]**

[1]Department of Otorhinolaryngology-head and Neck Surgery, School of Medicine, Kyungpook National University, Korea

Background and Objectives: The guidelines for cochlear implants (CI) are expanding, and the number of CI
procedures performed on the elderly is increasing. The purpose of this study was to analyze the results and
safety of cochlear implantation in the elderly, as well as to evaluate the predictive factors on cochlear implant outcomes.

Subjects and Methods: 56 patients aged 40 years or older, received cochlear implants between 2009 and 2020, divided into two groups: 27 younger adults (40-64 years) and 29 elderly groups (>64 years). The study compared their pre and postoperative speech perception scores and category of auditory performance (CAP) scores, surgical complications, and hospitalization periods. It also evaluated associated factors in the elderly group by examining categorical and continuous variables and postoperative CAP score.

Results: There was a significant improvement in both speech recognition tests (word and sentence) and CAP scores in both groups compared to the pre-implantation scores. ($p<0.001$). Postoperative results were slightly lower in the elderly group than in younger adults in sentence recognition and CAP scores except for word recognition. No significant associated factors were found on postoperative CAP scores, except for etiology. Postoperative CAP significantly improved in the sudden hearing loss group compared to the other etiology groups ($p=0.045$). The elderly group had more comorbidities than the younger adult group ($p=0.026$), but there were no significant differences in postoperative complications or hospitalization periods.

Conclusion: While speech recognition and CAP scores were somewhat lower compared to the younger adults, even the elderly group showed significant improvements in audiological results after cochlear implantation. And cochlear implantation was sufficiently safe and well tolerated in elderly patients

Keywords : Cochlear implantation, Aged, Speech perception,

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Long-term use of cochlear implant in the late-stage elderly

Mami YASUMOTO[1,2], Yasushi NAITO[1], Norio YAMAMOTO[1], Hiroshi YAMAZAKI[2], Keizo FUJIWARA[1], Tetsuhiko MICHIDA[1], Saburo MOROTO[1], Tomoko YAMAZAKI[1], Rinko TAMAYA[1], Naoko FUJII[1], Koichi OMORI[2]

[1]Comprehensive Ear and Hearing Center, Kobe City Medical Center General Hospital, Japan
[2]Otolaryngology, Kyoto University, Japan

It is well known that hearing acuity and speech perception deteriorate with age. Previously, we have shown that speech-listening performance improves with experience using cochlear implants (CI), even in elderly patients, and that speech-listening performance is considered good enough to enable conversation using only hearing at 2 years postoperatively. However, the long-term outcome of elderly patients with CI remains to be fully investigated. In this study, we studied the usefulness and problems of CI in the late-stage elderly, i.e. aged 75 and older. The subjects were 21 post-lingually deafened CI users who underwent CI surgery in our department and were 65 years old or older ten years ago. We retrospectively examined the current use of CI in these patients, the effectiveness of CI 10 years after surgery, and changes in speech perception over time. Fifteen of the 21 patients are still using CI, and many maintained good speech perception in the long term. Three patients died during the study period, but all continued to use CI until the end. The three patients who stopped using CI had poor speech perception and were not able to fully utilize their CI. The age-related changes in the results of speech perception revealed that the results were stable and good until the late elderly, but after they reached the late elderly and beyond, it appeared that there may be an age-related decline in speech perception. CI can be used effectively even in the later stages of aging. On the other hand, there are cases in which long-term use is not possible due to dissatisfaction with the effectiveness of the CI, problems in operating the CI, and difficulties in hospital visits. It is important to fully explain these limitations when proceeding with cochlear implant surgery in the elderly.

Keywords : Cochlear implant, Late-stage elderly, Long-term use

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Long-term changes in cochlear implant electrical stimulation levels in the elderly and their effects on speech-perception performance

Naoko FUJII[1], Norio YAMAMOTO[1], Hiroshi YAMAZAKI[1,2], Mami YASUMOTO[1], Saburo MOROTO[1], Tomoko YAMAZAKI[1], Rinko TAMAYA[1], **Yasushi NAITO[1]**

[1]Comprehensive Ear and Hearing Center, Department of Otolaryngology, Kobe City Medical Center General Hospital, Japan
[2]Department of Otolaryngology, Kyoto University, Japan

In recent years, more elderly patients undergo cochlear implant surgery. The purpose of the current study was to examine the electrical stimulation setting results and its effect on speech-perception performance in elderly cochlear implant users.
The subjects were 16 adult patients with cochlear implantation who were 65 years of age or older and had been using a cochlear implant for more than 9 years (mean age at surgery: 71 years). The subjects were divided into two groups: those with a speech-perception performance of 60% or better (good group n=11) and those with a speech-perception performance of less than 60% (poor group n=5) at 9 years postoperatively. For each subject, the electrical stimulation setting results corresponding to T and C levels tested from the first sound input until 9 years after surgery were examined retrospectively.
T levels stabilized at 3 months postoperatively in the good group and at 6 months postoperatively in the poor group. C levels stabilized at 1 month postoperatively in the good group and at 1 year postoperatively in the poor group. After 1 year postoperatively, in the T level and C level there were no significant changes in either the good or the bad group. The good group showed significantly higher T and C levels than the poor group.
In summary, the electrical stimulation levels of the cochlear implant were generally stable over time in elderly cochlear implant users. In terms of speech perception performance, the good group had higher TC levels than the poor group, suggesting that higher TC levels are advantageous for speech perception. In the poor group, increasing the levels of electrical stimulation was often difficult due to discomfort in sound listening. We believe that these results may be helpful in better adjusting electrical stimulation levels for older cochlear implant users.

Keywords : Cochlear implant, Electrical stimulation, Elderly

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Analysis of outcomes for communication mode in cochlear implant in prelingually deafened adults.

Shogo OYAMADA[1], Masahiro TAKAHASHI[1], **Satoshi IWASAKI[1]**

[1]Otorhinolaryngology, International University of Health and Welfare, Mita Hospital, Japan

Objective: Recent studies have suggested that speech perception outcomes after cochlear implantation (CI) in prelingually deafened adults have improved with advances in CI technology and speech processing strategies. However, the outcomes vary from case to case. Communication mode has been reported in many studies as the factor that related to the post CI outcomes. This study aimed at investigating the post CI outcomes and the progress during 2 years for each communication mode.
Material and Methods: The subjects were 17 prelingually deafened adults undergoing CI at our hospital between April 2013 and March 2019. We investigated preoperative factors affecting post CI outcomes. Also we analyzed post CI outcomes for each communication mode.
Results: Communication mode and preoperative discrimination score were the factor affecting on postoperative discrimination score. The speech perception score after CI improved significantly in the oral and lip-reading group and total communication group. The speech perception scores in postlingually deafened adults improved significantly during the first six months and became to plateau after CI. On the other hand, the scores of prelingually deafened adults tended to improve gradually after six months postoperatively. Furthermore, the degree of improvement and progress differed by each communication mode.
Conclusion: The communication mode is important factors in predicting outcomes in prelingually deafened adults after CI. Long-term auditory training is important for prelingually deafened adults who use visual information as their preoperative method of communication.

Keywords : Prelingual deafened adults, Predictive factor, Communication mode

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A case report: Childhood fever and hearing loss for CAPOS syndrome

Shinsuke KANESHIRO[1], Hiraumi HARUKAZU[1], Yumiko KOBAYASHI[1], Tomoko KAN-NO[1], Hiroaki SATO[2], Kiyoto SHIGA[1]

[1]Department of Otolaryngology - Head and Neck Surgery, Iwate Medical University, Japan
[2]Department of Otorhinolaryngology, Kyoto Min-iren Chuo Hospital, Japan

Introduction
CAPOS (Cerebellar ataxia, Areflexia, Pes cavus, Optic atrophy and Sensorineural hearing loss) syndrome is a rare autosomal domestic genetic disorder, and caused by the heterozygous mutation, c.2452G > A, in the ATP1A3 gene. Neurological deterioration is triggered by stressful episodes, such as afebrile illness. It has been reported that recent hearing loss in CAPOS syndrome presents with auditory neuropathy spectrum disorder.

Case
An eight-year-old boy presented with two years history of hearing loss. He had repeated fever episodes. At the age of 6 years and 2 months, he developed fever and subsequently presented with a complaint of difficulty hearing. Pure-tone audiometry revealed bilateral moderate to severe sensorineural hearing loss. Speech intelligibility was 20% at 70dB. Both ears showed good responses on DPOAE. ABR showed no response on the right ear, and only a V wave response at 105 dB on the left ear. ASSR thresholds were about 70dB on both sides. No deformities were seen on the image. At the age of 7 years and 4 months, he started using hearing aids. ATP1A3 gene mutation was detected through genetic testing.

Discussion
The CAPOS mutation which causes missense of ATP1A3 compromises pump function by destabilizing the Na+ occluded state. This leads to Auditory Neuropathy Surrounding Disorder : synchronized activation of afferent SGNs by glutamate release at IHC ribbon synapses and/or propagation of spikes along the auditory pathway are impaired. We believe that this desynchronization in neural firing is responsible for the lack of response in ABR and the presence of a response in ASSR. Although the accuracy of frequency analysis in brain waves may vary, we attribute the response detection in ASSR to its greater tolerance for errors in timing of neural firing compared to ABR.

Conclusion
We experienced a case of retrocochlear hearing loss for CAPOS syndrome.

Keywords : ASSR, Auditory Neuropathy Surrounding Disorder, Retrocochlear hearing loss

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Structural covariance networks of the auditory cortex vary by the side of single-sided deafness

Leeseul SHIM[1,2], Ja Hee KIM[1], Gibbeum KIM[1], **Hyo-Jeong LEE[1,2,3]**

[1]Laboratory of Brain & Cognitive Sciences For Convergence Medicine, Hallym University College of Medicine, Korea
[2]Ear and Interaction Center, Doheun Institute For Digital Innovation in Medicine (d.i.d.i.m.), Hallym University Medical Center, Korea
[3]Department of Otorhinolaryngology-head and Neck Surgery, Hallym University College of Medicine, Korea

Many studies have reported neurofunctional alterations in patients with single-sided deafness (SSD), yet evidence of the relationship between the neuroplastic changes in the auditory cortex and the effect of the deafness side is still limited. In this study, the structural covariance networks (SCN) are analyzed in two patient groups of SSD with different sides of hearing loss.

The study involved 35 patients with SSD and 16 normal-hearing controls (NC, n = 16, age = 41.2 ± 13.6). The SSD patients were divided into two groups by the side of hearing loss (Lt SSD, n = 17, age = 45.5 ± 14.3; Rt SSD, n = 18, age = 52.7 ± 6.98). The T1-weighted image was acquired and processed by the CAT 12 and SPM 12 packages. Four cytoarchitectonically-defined ROIs were selected from each hemisphere for seed-based analyses of structural covariance. The ROIs include the medial geniculate body of the thalamus, the Te1, the Te2, and the Te3 of the auditory cortex. Areas of significant correlation were searched in the whole brain at p = 0.0001 (uncorrected), and clusters that passed the statistical threshold of p = 0.05 (FWE-corrected) were reported.

While the SCNs of TE1 and TE2 included the bilateral auditory cortex in the Lt SSD, those SCNs of Rt SSD were restricted in the same hemisphere. The SCNs of the TE3 revealed auto-correlation in both groups, but in the Lt SSD with left TE3, that showed a significant correlation in bilateral auditory regions. In the Lt SSD, the Lt MGB was structurally related to the right auditory cortex and the visual area.

The results of the study suggest that SSD-related neuroplasticity differs by the side of hearing loss. The SCN analyses reveal the strengthening of interhemispheric connection in the Lt SSD and increased local connection in the Rt SSD.

Keywords : Single-sided deafness (SSD), Structural covariance networks (SCNs), Neuroplasticity

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Comparison of Cortical Auditory Maturation Between Children with Cochlear Implants vs Normal-Hearing Children Attending Mainstream School

Noor Dina HASHIM[1], Nabihah ROSLLE[1], Asma ABDULLAH[1], Wan Fazlina WAN HASHIM[2], Khairul Farhah KHAIRUDDIN[3], Rosnah ISMAIL[4]

[1]Otorhinolaryngology - Head & Neck Surgery, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia
[2]Audiology Unit, Department of Medical Rehabilitation Services, Universiti Kebangsaan Malaysia, Malaysia
[3]Faculty of Education, Universiti Kebangsaan Malaysia, Malaysia
[4]Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia

Introduction: The cortical auditory evoked potential (CAEP) test is an objective and non-invasive method of assessment to quantify the development of central auditory pathways. Children with congenital hearing loss who received hearing restoration early have more neural plasticity opportunities than those without hearing assistance.

Objectives: We aimed to assess the auditory growth and learning abilities of children who had cochlear implants and were attending mainstream school and compare them with their normal-hearing peers through the cortical auditory maturation measurement.

Methods: This was a quasi-experimental design- post-test with control. Subjects were cochlear- implanted children and normal-hearing peers attending mainstream schools, as well as parents and teachers of the children. A total of 60 children from 7 to 12 years old were divided into intervention (n=30) and control groups (n=30) in this study. The P1 wave latency value of CAEP of each group was measured and compared. The auditory performances of the implanted children were performed using CAPS-II and SIRS. Educational performance measurements were done using a validated parents' questionnaire and Screening Instrument for Targeting Education Risk (SIFTER) from a teacher. The association of auditory speech perception with academic performance among children with CI was assessed.

Results: The results showed the P1 wave latency value of the CAEP in implanted children was prolonged as compared to their normal-hearing peers. However, there was a positive correlation between auditory speech perception with academic performance among children with CI.

Conclusion: CAEP is a useful test to quantify the development of central auditory pathway in implanted children. Cochlear implantation improves auditory speech perception as well as the academic performance of these children, putting them on par with their normal-hearing peers.

Keywords : Cortical auditory evoked potential, Cochlear implant, Central auditory pathway

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Positron emission tomography-computed tomography in patients with asymmetric hearing loss

Manuel MANRIQUE[1], Javier ARBIZU[2], Alicia HUARTE[1], Raquel MANRIQUE[1], Joan LORENTE[1], Marisela CARDIER[1], Elena PRIETO[2]

[1]*Otorhinolaryngology, Clinica Universidad De Navarra, Spain*
[2]*Nuclear Medicine, Clinica Universidad De Navarra, Spain*

Introduction. PET-scan studies offer vital information concerning the time process for hearing restoration in cases of severe-profound hearing impairment. Additionally, this exploration offers valuable data in order to take decisions in patients with long-lasting unilateral profound hearing loss combined with the contralateral ear having some functional hearing.

Purpose of the study
Aim of this study is to demonstrate that PET-CT helps us to settle the question of a possible indication for a cochlear implant in deaf ear in an asymmetric hearing loss (AHL).

Methods. We included 25 adults (>18 years) who have AHL, candidates for cochlear implant in the ear that is worse for hearing, with profound hearing loss. We have used isotopes 18F-FDG (Fluorine-18-Fluordeoxy Glucose) to assess basal and activation metabolic status of the auditory pathway, under different protocols: Rest situation, without acoustic visual stimulation and after acoustic stimulation, using speech 15 dB over the thresholds in the hearing ear. The metabolic activity obtained at baseline and post auditory stimulation is analyzed previous subtraction of baseline data. A map of Brodmann area associated with the PET was used to delimit the areas to be studied.

Results. There are no signs of hypermetabolism at baseline. Stimulation through the ear aurally better produced a significant increase in the activity of the ipsi and contralateral auditory cortex. This increase tended to be greater at the contralateral level in cases where there was better hearing in the stimulated ear and ipsilateral when the hearing levels were poorer. In general, there was an increase in activity in the visual, frontal and limbic areas before auditory stimulation through the better ear.

Conclusions. The study of regional cerebral metabolism by PET can be applied to the primary and associative auditory cortices, providing important information about normal hearing, hearing loss, and neuroplasticity processes of the auditory system.

Keywords : Asymetric hearing loss, Cortex,, Positron emission tomography

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Loop test to evaluate internal rhythmic clocking

Madhuri Sharad GORE[1], Heera THOMAS[2]

[1]*Hearing Studies, Dr Sr Chandrasekhar Institute of Speech and Hearing, India*
[2]*Speech, Swallowing and Hearing, Vps Lakeshore Hospital, India*

Rhythm perception in children with cochlear implants investigated with the perception of a rhythm pattern may not be sensitive to detect internal clock time. Listeners have a memory for the timing of beats if they have heard them before and have an expectancy for the same which can lead to better music perception. Purpose of the study was to investigate perception of rhythm and internal clocking.
Method: 40 children, 20 with unilateral cochlear implant and 20 neurotypical children aged 10-17 years were studied. Stimuli were prepared by a Hindustani musician and consisted of three rhythm patterns and a beat loop of one minute consisting of a beat repeating every 200ms. The beat loop recorded with the percussion beat was edited in Audacity software to create a loop of one minute. Participants tapped out the pattern of the beats. In the second task, they tapped along with the beat for the one minute of recording, and continued tapping at the same tempo after the recorded beat stopped playing. Practice trials were given to ensure the children understood the task. Responses were recorded and analyzed.
Results: All the children, with CI and those with normal hearing responded similarly to the imitation of the three beat patterns.
There was a difference between the normal-hearing children and those with cochlear implant with respect to the loop beat test. The children with CI were slower and had more errors when they tapped on their own. Age of implantation or duration of implant use was not a factor. The child who was a drummer had no errors.
Conclusion: The results suggest that although pattern of beats could be identified and replicated, the timing was off. Training of the same would improve perception.. The study of pattern of beats does not estimate the memory for the tempo.

Keywords : Rhythm, Loop test,, Internal clockin

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The effect of experience on indexical perception in children with cochlear implants

Madhuri Sharad GORE[1], **Litty ZACHARIAS[2]**

[1]Hearing Studies, Dr Sr Chandrasekhar Institute of Speech and Hearing, India
[2]Medical Affairs, Ent, Al Jalila Children's Hospital, Dubai, United Arab Emirates

Indexical properties of speech are those used to identify the voice of the speaker. Studies have shown that regions of the right hemisphere treat the voice as distinct from lexical aspects of speech in the left. Children with cochlear implant have difficulty identifying the voice.
Purpose of the study was to investigate the voice identification skills of children with cochlear implants.
Method: Twenty-six children aged 3-6 years, implanted with the Freedom cochlear implant between the ages of 2-4 years were participants. Twenty-five of the children were unilaterally implanted and one had a bilateral sequential implant after 3 years of the first. All the participants had full insertion and uneventful surgery, and no radiological abnormalities. The tasks were to identify a) gender, b) speaker from the sentence spoken by familiar and unfamiliar speakers, The familiar voices were the voices of the parents, the teacher, and the therapist. Sentences were both "fixed" sentences or variable sentences. Children initially had a training session to identify voices. The responses were to identify the picture or the name. In addition, parents were asked to score whether the children could identify voices at home.
Results: Children performed at a chance level to identify the gender of the voices. The identification improved with implant age. Male voices were easier to identify than female. Responses above chance were better for fixed sentences. Children in the implant ages of 13-19 months had difficulty in attending to both indexical and lexical properties of the speech. As implant age reached two years, scores to identify indexical properties increased. Those with experience greater than 4 years had no difficulty in the tasks. The responses of parents showed similar findings.
Conclusion: The study supports the dichotomy in the perception of indexical and linguistic parts of speech. Identification of linguistic content precedes indexical content.

Keywords : Indexical properties, Voice gender identification, Implant age

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Sensory and cognitive processing of speech sounds as revealed by auditory event-related potentials in children with cochlear implants

Zhe HU[1], Jiaqiang SUN[1], Xiaotao GUO[1], **Jingwu SUN[1]**

[1]Department of Otolaryngology-head and Neck Surgery, The First Affiliated Hospital of University of Science and Technology of China, China

Compared with children having normal hearing (NH), those with cochlear implants (CIs) perform poorly in spoken language comprehension which involves both low-level acoustic encoding and higher-level cognitive processing. Here, we performed an electroencephalography study to portray this brain dynamics of speech perception in CI children. We presented a Mandarin Chinese monosyllable or four-syllable idiom to CI and NH children, and infrequently varied its lexical tone to form a novel monosyllable or pseudo-idiom in an oddball paradigm. The tone contrast embedded in the monosyllables evoked similar mismatch negativities (MMNs) in CI and NH children at an early stage (~200 ms). However, the amplitude of the MMN evoked by the tone contrast in the idiom context was significantly lower in CI children than in NH children. Furthermore, robust late discriminative negativity (LDN) at a late stage (~500 ms) was found only in NH children, but not in CI children. The MMN and LDN findings indicate deficits of low-level acoustic encoding in a complex context (such as an idiom) and higher-level cognitive processing in CI children, respectively. Both deficient sensory and cognitive processing may contribute to the speech perception difficulties in CI children.

Keywords : Cochlear implant, Event-related potential, Speech processing

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Recording of cortical potentials evoked electrically directly through a cochlear implant: Association to speech understanding.

Tien-Chen LIU[4], **Attias JOSEPH[1]**, Chen CHEN[2], Suhail HABIBALLAH[3], Chen-Chi WU[4]

[1]Department of Communication Sciences & Disorders, University of Haifa, Israel
[2]Department of Research & Technology, Advanced Bionics Llc, USA
[3]Department of Audiology, Bnei-zion, Medical Center, Israel
[4]Department of Otolaryngology, National Taiwan University Hospital, Taiwan

Background: The auditory cortical evoked potential (ACEP) in cochlear implant (CI) users reflects central brain activity that is related to outcomes of cochlear implantation in children and adults. This brain response provides a useful objective assessment of outcomes in those who are unable to actively give feedback about their hearing, such as infant CI recipients. Current methods for measuring this brain response require additional hardware that is expensive and time-consuming. In this multi-center study, we investigated if the CAEP by electrical stimulation can be recorded utilizing the intra-cochlear implanted electrodes and backward telemetry in a clinically viable timeframe in a large sample of adults and pediatric CI users.

Methods: The recording system utilized the backward telemetry of the cochlear implant. We compared them to simultaneous recordings acquired with scalp-surface electrodes of an external evoked potential recording system that was synchronized using a trigger signal extracted from the CI system. The biological origin was also inferred by assessing the correlation between speech understanding and ACEP measures. Overall, we tested 37 using unilateral CI and 12 with bilateral CIs. Twenty ears were implanted at pediatric age, and 29 at adults' age (>18 years).

Results: The e-ACEPs evoked electrically were measured in less than 5 minutes, showing that the measurement could be done in a clinically viable amount of time. The e-ACEP recorded by scalp electrodes was similar to the e-ACEP recorded directly from the implant. A significant association was found between e-ACEP and speech discrimination scores in quiet and in noise after implantation.

Conclusion: e-ACEP can be recorded directly through the CI in a clinically feasible way. This innovative technology opens the door for widespread clinical adoption of cortical auditory responses for tracking brain development after cochlear implantation. In addition to saving time and increasing convenience

Keywords : E-ACEP, Speech perception, Backward telemetry

Central Auditory Pathway & Brain Plasticity

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Early Development of Auditory Cortex in Pediatric Cochlear Implant Users: Effects of Implantation Age, Implantation Side and Voice Emotions

Yuhe LIU

Department of Otolaryngology, Head and Neck Surgery, Beijing Friendship Hospital, Capital Medical University, China

Purpose: This study aimed to investigate the potential factors that influence the early auditory cortical development in prelingual deafness children with cochlear implants (CIs).
Method: Thirty-four prelingually deaf children with unilateral CIs with bilateral severe-to-profound sensorineural hearing loss participated in this study. Functional near-infrared spectroscopy (fNIRS) imaging was employed during postoperative tests to investigate the processing patterns and developmental trajectories of the early auditory cortex in response to speech stimuli (emotional: fear, anger, happiness, and neutral) and nonspeech stimuli (music and noise). Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS/MAIS), Categories of Auditory Performance (CAP), and Speech Intelligibility Rate (SIR) were used to assess speech perception and production abilities.
Result: The main effect of implantation age was significant at 6 months and 12 months after CI activation but not at 1 month after CI activation. The age at implantation was positively correlated with the temporal neurological response to speech and music stimuli. There was a significant positive correlation between the implantation age and SIR levels during 1-6 months after CI activation. Cortical processing of speech showed neither developmental progress nor influence of implantation side weeks to months after implant activation. For nonspeech stimuli, left implantation showed functional advantages over right implantation that were not yet discernable using clinical, questionnaire-based outcome measures. For vocal emotional stimulation, cortical response of right superior temporal gyrus, right middle temporal gyrus and left middle temporal gyrus was significantly different during 1-6 months after CI activation. The cortical response to anger was greater than other emotions when implantation after 24 months.
Conclusion: Implantation before 24 months has advantages in speech perception compared with implantation afterwards. The right hemisphere develops earlier and is better preserved from adverse environmental influences than its left counterpart. Postoperative neural processing was associated with vocal emotional stimulation.

Keywords : Cochlear implantation, Early auditory cortical development, Functional near-infrared spectroscopy

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Clinical Standardization for the Detection of Hemispheric Dominance for Steady-State Auditory Evoked Fields (SSAEFs) in Normal Hearing

Sophia Yung-Hsia LI[1], Tai-Shih CHI[2], **An-Suey SHIAO[3]**

[1]Morrison Academy, Taipei, Taiwan
[2]Department of Electrical and Computer Engineering, National Yang Ming Chiao Tung University, Taiwan
[3]Department of Otolaryngology, Cheng Hsin General Hospital, Taiwan

Background: Steady-state auditory evoked responses (SSAERs) can be one of the promising indicators for major auditory function. The improvement of accessibility in clinical setting depended on standardization and definition of the characteristics for SSAERs. There have been some insights with respect to changes in the inter-hemispheric dominance of SSAERs for some clinical entities. However, the hemispheric asymmetry of SSAERs for normal controls remained inconclusive.
Methods: Twelve right-handed healthy volunteers with normal hearing were recruited. Steady-state auditory evoked fields (SSAEFs) was measured by using magnetoencephalography (MEG) under auditory stimuli of pure tone at 1000 Hz with the amplitude-modulation (AM) frequency of 43 Hz binaurally. A laterality index made by the ratio of SSAEF strength over the right hemisphere to that over the left hemisphere were also analyzed.
Results: The SSAEFs source was localized bilaterally on the superior temporal plane with an orientation centripetal to the auditory cortex. The laterality index ranged between 1.1 and 2.3 and there was no gender difference. In all subjects, the strength of SSAEFs was significantly weaker in the left hemispheres than that in the right hemispheres (p=0.014).
Conclusions: Right-side dominance of SSAEFs was verified for normal hearing subjects. Acoustic sources clinically available in an audiometric test was used as stimuli. Such kind of simplification for parameters would be helpful for the standardization on the precise production and definition of the characteristics for SSAERs. Since MEG was still not an equipment easy to get access clinically, further studies by using electroencephalography (EEG) with a larger sample size will be necessary to address these issues.

Keywords : Auditory steady-state fields (SSAEFs), Hemispheric dominance, Magnetoencephalography (MEG)

Central Auditory Pathway & Brain Plasticity

PP 167

Neural mechanisms of auditory grouping in subjects with different auditory configurations

Nour ALSABBAGH[1], Phillip GANDER[2,3,4], Laura KISKUNAS[2], Bob MCMURRAY[1,2,5], Timothy GRIFFITHS[4,6], **Inyong CHOI[1,2]**

[1]Department of Communication Sciences and Disorders, The University of Iowa, USA
[2]Department of Otolaryngology–head & Neck Surgery, University of Iowa Hospital and Clinics, USA
[3]Department of Radiology, University of Iowa Hospital and Clinics, USA
[4]Department of Neurosurgery, University of Iowa Hospital and Clinics, USA
[5]Department of Psychological & Brain Sciences, The University of Iowa, USA
[6]Bioscience Institute, Newcastle University, UK

Speech-in-noise (SiN) perception requires grouping different auditory elements across time and frequency into a coherent unit to form auditory objects. However, hearing loss (HL) can affect auditory grouping (AG) abilities. Here, we investigated the neural underpinnings of AG mechanisms in subjects with different hearing conditions by using the stochastic figure-ground (SFG) stimlulus, a task that has been previously shown to correlate with SiN performance in normal hearing (NH) and cochlear implant (CI) listeners. We hypothesized that electric and acoustic hearing might contribute differently to AG. Hence, we tested the following four groups: 20 NH listeners, 23 bilateral CI (BiCI) users, 14 bilateral hearing aid (BiHA) users, and 31 bimodal (HACI) listeners. The SFG task required determining whether auditory figures were heard. The auditory figures were composed of tone pips coherently presented across time and frequency within other tone pips that occur at random time and frequency. 64-channel EEG was recorded while the subjects performed the task. Along with measuring detection sensitivity (d') to determine the performance, the following EEG analyses were done: Evoked responses (ER), event-related spectral perturbation (ERSP), and inter-trial phase coherence (ITPC). Behavioral results showed statistically significant differences between the groups, with the NH showing the superior performance. Neurophysiologically, ER following the onset of figures was present only in the NH group. ERSP showed distinct patterns across the groups: At the figure's onset, alpha desynchronization was only observed in the NH and HACI groups, and delta synchronization was only seen in the NH and BiHA groups. ITPC analyses showed absent responses to the onset of figures in the HL groups that were otherwise present in the NH group. In conclusion, depending on the HL configuration, distinct neural indices of AG were observed, indicating that acoustic and electric hearing components contribute differently to the perception of auditory objects.

Keywords : Auditory grouping, EEG, Cochlear implants

Tumor

PP 168

Challenges in Removal of the intralabyrinthine schwannoma and simultaneous cochlear implantation

Abdullah ALMUTAWAH[1], **Jong Woo CHUNG[1]**

[1]Otorhinolaryngology-head and Neck Surgery, asan Medical Center, University of Ulsan College of Medicine, Korea

Intralabyrinthine schwannomas are uncommon tumors that develop inside the inner ear and can lead to hearing loss. Cochlear implantation has been used as a treatment for hearing loss associated with these tumors, and several studies have evaluated the effectiveness of this procedure.

Based on the available evidence, cochlear implantation appears to be a safe and effective treatment option for patients with hearing loss due to intralabyrinthine schwannomas. However, due to the rarity of this condition, there are only a limited number of studies on this topic.

The purpose of this study was to investigate the outcomes of cochlear implantation combined with tumor removal in patients with intralabyrinthine schwannomas. The study analyzed four cases of intralabyrinthine schwannoma, some with involvement of the internal auditory canal and cerebellopontine angle.

Two of the patients had intralabyrinthine schwannomas without involvement of the internal auditory canal and cerebellopontine angle. After the surgery, their aided hearing threshold was 24 dB and 47 dB, and speech discrimination was 76% and 52%, respectively.

The other two patients had a tumor in both the intralabyrinthine and internal auditory canal. Their aided hearing threshold after surgery was 54 dB and 60 dB, and speech discrimination was 0-10%. Although their communication skills improved, the results were worse compared to the patients with intralabyrinthine schwannoma only. Therefore, the study suggests that auditory brainstem implants may be a better option for these patients.

In summary, this study supports the use of cochlear implantation in patients with intralabyrinthine schwannoma-related hearing loss. However, the presence of a mass in the internal auditory canal and cerebellopontine angle may indicate the need for an auditory brainstem implant instead.

Keywords : Vestibular schwannoma, Cochlear implantation, Speech discrimination

Tumor

PP 169

Cochlear implantation outcome in neurofibromatosis type 2 patients

Zhihua ZHANG[1,2,3], Jianqing CHEN[1,2,3], Yun LI[1,2,3], Zhaoyan WANG[1,2,3], Hao WU[1,2,3]

[1]Department of Otolaryngology, Shanghai Ninth People's Hospital, Affiliated To Shanghai Jiaotong University School of Medicine, China
[2]Ear Institute, Shanghai Jiaotong University School of Medicine, China
[3]Shanghai Key Laboratory of Translational Medicine On Ear and Nose Diseases (14dz2260300), Shanghai, China

Objective: This study was to ascertain outcomes of cochlear implantation (CI) in patients with neurofibromatosis type 2 (NF2).

Methods: All patients with NF2 underwent CI at our single tertiary care referral center from Jan 2017 to Dec 2018 were recruited in this study. Patient demographics, tumor features, treatment parameters, and pre- and postimplantation audiometric and clinical outcomes are recorded.

Results: Seventeen patients with NF2 underwent CI (20 CIs) during the study period. Mean age were 37.17±18.38 YO (range 9.59-80.92 YO). Fourteen patients had unilateral implant, including 6 CIs with intact tumor, 3 ipsilateral CIs with simultaneously unilateral tumor total or partial resection, 4 contralateral CIs with simultaneously unilateral tumor total resection, 1 sequential contralateral CI with unilateral tumor total resection. And 3 patients underwent bilateral implants, two CIs with simultaneously unilateral tumor total resection, and another one was sequential CIs with intact tumor. During the 36 months follow-up, the average aided PTA was 36.98±6.67dB. The mean CAP of all patients in 6 months, 12 months, 24 months and 36 months was 2.73±2.22, 3.07±2.40, 3.07±2.34 and 3.23±2.45. Six patients (No. 2,3,9,14,15,16) had 0 in CAP, the mean CAP in each follow-up of remain 11 patients was 3.61±1.98, 4±2.04, 4.08±2.06, 3.82±2.18. The mean Mandarin lexical neighborhood test(MLNT) in only lip reading, in only CI and in both was 10.59±7.26, 28.29±34.26, and 42.35±35.71, respectively. There was significant difference between MLNT in both CI and lip reading and only lip reading (p=0.001). During the follow-up, eight CIs (40%) were totally abandoned in 7 patients, and remain CIs were used between 2 to 8 hours(7±2 hours) each days.

Conclusions: CI is a feasible hearing rehabilitation option for NF2 patients with severe or profound sensorineural hearing loss. Both using CI and lip reading could help patients improving their hearing function and hearing related QoL.

Keywords : Neurofibromatosis type 2, Cochlear implant, Hearing rehabilitation

Tumor

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Exploring management approaches for cochlear implantation in patients with nasopharyngeal carcinoma

Ting-Ya KANG[1], Chee-Yee LEE[1], **Hung-Pin WU[1]**

[1]Department of Otolaryngology Head and Neck Surgery, Taichung Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Taichung, Taiwan, Taiwan

Objectives: Cochlear implantation (CI) has been successfully used to restore hearing in patients with severe to profound hearing loss. In addition to hearing loss, irradiated patients with nasopharyngeal carcinoma (NPC) also often have chronic otitis media and Eustachian tube (ET) dysfunction. These features may result in difficulties in CI.

Methods: We conducted this study to review the management options for irradiated patients with NPC undergoing CI. Furthermore, we investigated the results of CI in irradiated patients with NPC with chronic otitis media and obstructive ET dysfunction, according to different treatment strategies. Our study retrospectively reviewed the data of patients with NPC who underwent CI in our hospital between 2006 and 2020. All subjects were found to be eligible according to the following inclusion criteria: patients who have NPC, received irradiation, underwent cochlear implant surgery, and have chronic otitis media with obstructive ET dysfunction.

Results: A total of 9 patients with obstructive ET dysfunction and chronic otitis media underwent cochlear implant surgery. Seven patients with an inflamed ETs underwent a 2-stage operation. Two patients with obliterated ETs, we performed a single-stage CI surgery. Only 1 patient had otitis media effusion after the surgery.

Conclusion: With the proper management of chronic otitis media and ET dysfunction, cochlear implant is an effective treatment for irradiated patients with NPC when conventional hearing aids failed.

Keywords : Cochlear implantation, Nasopharyngeal carcinoma, Eustachian tube dysfunction

Tumor

PP 171

Long-term Hearing Outcome of Endoscopic Infrapromontorial vestibular Schwannoma Removal and Simultaneous Non-Mastoidectomy Cochlear Implantation

Ludovica BATTILOCCHI[1], Gerard Francia LAPINA[1], **In Seok MOON[1]**

[1]Otorhinolaryngology-head and Neck Surgery, Yonsei University College of Medicine, Korea

Background:
Hearing restoration after vestibular schwannomas removal may be a challenge, and several techniques have been proposed to overcome this issue. In recent years, the simultaneous cochlear implantation (CI) and tumor removal has become increasingly popular. The introduction of minimally invasive surgical techniques capable of cochlea sparing have made it possible the use of CI even with the endoscopic techniques. This case series aims to present our preliminary experience of the infrapromontorial approach and simultaneous cochlear implantation in patients affected by small vestibular schwannomas.
Materials and methods:
This is a retrospective case series; six patients affected by vestibular schwannoma underwent endoscopic infrapromontorial approach and simultaneous cochlear implantation. Data collected included age, gender, tumor size and location, pre- and post-CI activation Pure tone average (PTA) and facial nerve status.
Results:
All tumors were successfully removed without major complications and patients were discharged after a mean of 6,8 days. CIs were activated after a mean of 17.5 days post-surgery. Five patients out of six patients showed improvements in PTA.
Conclusion:
The infrapromontorial approach and simultaneous cochlear implantation is a reliable and efficient option for treating small vestibular schwannomas. This procedure allows total tumor removal while preserving the cochlea, allowing hearing restoration.

Keywords : Cochlear implant, Acoustic schwannoma, Minimally invasive surgical procedures

Intraoperative Monitoring

PP 172

Personalizing Cochlear Implantation: Combining Fluoroscopy with Electrically Evoked Compound Action Potential for Enhanced Electrode Positioning

Thomas LENARZ[1,2], **Eugen KLUDT[1]**, Rolf SALCHER[1], Kerstin WILLENBORG[1], Andreas BÜCHNER[1], Andrej KRAL[2]

[1]Ent, Hannover Medical School, Germany
[2]Institute of Audioneurotechnology, Hannover Medical School, Germany

Introduction
Fluoroscopy uses X-rays to guide the positioning of the electrode array inside the cochlea during cochlear implantation, ensuring its optimal placement. The combination with functional intraoperative measurements, such as evoked compound action potential (ECAP), provide feedback on the cochlear health and position of the electrode array during insertion. This information may help to optimize and personalize the implantation.

Methods
We combined fluoroscopy, ECAP, and transimpedance measurements for 14 adult cochlear implantations. The electrode array was initially inserted to its maximal depth, after which electrophysiological measurements were taken. Under fluoroscopic guidance, the array was slightly retracted to achieve optimal proximity to the modiolus and electrophysiological measurements were repeated. Using both pre- and postoperative CT scans, along with intraoperative fluoroscopic images, we conducted a postoperative analysis to correlate functional and anatomical data. Six months post-implantation, the electrode position was further compared with the patient's word recognition score (WRS).

Results
Our implantations, using fluoroscopy and the pull-back method, achieved a deeper average insertion depth (399° ± 52°) than a conventionally inserted control group. After pull-back, electrodes moved an average of 0.1 ± 0.17 mm closer to the modiolus. A significant decrease in ECAP thresholds was observed, correlating with the movement towards the modiolus (average change of 17 CL/mm, $R^2 = 0.4$, $p < 0.001$).

Discussion
Real-time visual control of the electrode array pull-back enables exact assessment of the electrode positional information and its influence on functional outcomes of cochlear implantation. It allows achieving a high insertion angle and minimizing the distance between the electrode contacts and modiolus for each patient. Given the outcome it is likely that the approach improves speech intelligibility. Combining imaging and intraoperative measurements can provide additional insight into the neural health of the cochlea and help explain the variability of CI outcomes.

Keywords : Fluoroscopy, ECAP, Electrode Positioning

Coding Strategy

PP 173

Mandarin lexical tone, word and sentence perception in cochlear implant recipients using the OPAL strategy

Jianfen LUO[1], **Lei XU[1]**, Ruijie WANG[1], Xiuhua CHAO[1], Fangxia HU[1], Yi ZHENG[2], Andrew E. VANDALI[3]

[1]Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital, China
[2]Research, Cochlear Medical Device (beijing) Co., Ltd,, China
[3]Research, Cochlear Limited, Australia

Aim: To compare performance of the clinical Advanced Combination Encoder (ACE) strategy to the experimental Optimized Pitch and Language (OPAL) strategy in experienced native-Mandarin speaking cochlear implant (CI) users.
Methods: Thirty-two CI users with an average age of 24 (range 7 to 57) yrs were enrolled. All users had at least 1 yr of experience using ACE. Each subject attended two sessions. A period of approximately 4-6 weeks of take-home acclimatization with both programs was then provided and subjects were asked to use OPAL as much as possible. The tests included: Mandarin lexical tone in quiet and in noise (SNR +5dB) using natural produced tones and duration/ intensity normalised versions of the tones; Mandarin sentence in adaptive noise; Mandarin monosyllabic and disyllabic word in quiet; a subset of Speech, Spatial, and Qualities of hearing questionnaire (SSQ12 speech hearing scale); and subjective preference for strategy in quiet and noise.
Results: For both the natural and normalised lexical tone tests, significant benefits of OPAL compared to ACE of approximately 2.8 and 7.3 percentage points in quiet and in noise, respectively, were observed. Significant effects of the addition of noise and of tone normalisation were also observed. Monosyllabic word recognition in quiet using OPAL was significantly higher than ACE by approximately 6.8 percentage points. Average SSQ12 ratings for OPAL were significantly higher than ACE by approximately 0.5 points on a 10-point scale. In quiet conditions, 14 subjects preferred OPAL, 7 ACE, and 10 reported no preference. In noise, 19 preferred OPAL, 7 ACE, and 5 had no preference. Average daily take-home use of ACE and OPAL was 4.9 and 7.1 hrs, respectively.
Conclusions: OPAL was shown to provide significant benefits compared to ACE for Mandarin lexical tone perception and monosyllabic word perception in quiet.

Keywords : Cochlear implant, Coding strategy, Lexical tone

Coding Strategy

PP 174

Investigations of ElectrodeNet - Factors on the Performance of a Deep Learning Based Coding Strategy

Enoch Hsin-Ho HUANG[1,2], Yu TSAO[2], **Chao-Min WU[1]**

[1]Department of Electrical Engineering, National Central University, Taiwan
[2]Research Center For Information Technology Innovation, Academia Sinica, Taiwan

The rapid development of artificial intelligence (AI) and deep learning technologies has a promising potential to improve the sound processing of the cochlear implant (CI). In the trend of transforming CI sound coding strategies from conventional to deep learning based approaches, a number of factors related to neural networks need to be investigated. Therefore, ElectrodeNet, a deep learning based coding strategy proposed previously, was thoroughly investigated for various experimental factors, including network architecture, reference data, loss function, noise type, and reverberation. Using the objective evaluation predictors of short-time objective intelligibility (STOI) and normalized covariance metric (NCM) with vocoded speech, ElectrodeNet was compared with the advance combination encoder (ACE) coding strategy for objective speech intelligibility. The correlation coefficients were also examined between the ACE strategy and the ElectrodeNet strategy under the aforementioned factors. The results indicated that ElectrodNet and its customized networks may adapt to various languages types and interferences with comparable performance to the ACE strategy in terms of objective speech intelligibility and correlation coefficients. Furthermore, several network architectures and training targets, such as formats of reference data and loss functions, appeared to outperform others. The relative superior network architectures and factors in the objective evaluation were chosen for further listening tests with normal-hearing native Mandarin speakers. The outcomes showed that the ElectrodeNet strategy was capable of converting speech envelopes into electrode stimulation patterns under sentence recognition tests. It appeared that a customized version of ElectrodeNet may extract speech features effectively for subsequent processing of channel selection. The findings of this study may provide useful insights into the development of AI-driven coding strategies.

Keywords : Coding strategy, Deep learning, Vocoder simulation

Coding Strategy

PP 175

How much pitch-related information is contained in cochlear-implant signals?

Takanori ASHIHARA[1], Shigeto FURUKAWA[2,3,4], Makio KASHINO[4]

[1]*Ntt Human Informatics Laboratories, Ntt Corporation, Japan*
[2]*Graduate School of Public Health, Shizuoka Graduate University of Public Health, Japan*
[3]*Hearing Center, Shizuoka General Hospital, Japan*
[4]*Ntt Communication Science Laboratories, Ntt Corporation, Japan*

Cochlear implant (CI) users, even with sufficient speech recognition, are generally known to have poor sensitivities to pitch (or fundamental frequency, F0), probably due to limited spectral and temporal information in the CI signals. In fact, however, the pitch sensitivities vary among individuals, and some exhibit fairly good performance. This implies that the CI signal by itself contains sufficient information about F0, and the users' performance is predominantly limited by other physiological factors. This study evaluated how much F0 information is contained in the CI signal, by using a deep neural network model, which was trained to decode simulated CI signals (multi-channel pulsatile signals) to estimate F0 (referred to as the CI model). We varied the number of electrode channels and the pulse rate, which should affect, respectively, spectral and temporal resolutions of stimulus representations. The F0 estimation performance generally improved with the increasing number of channels and pulse rate. For the sounds presented in quiet, the model performance at best was comparable to that of a control model, which received raw-waveform inputs (simulating a "normal ear"; referred to as normal-ear model). Under conditions in which background noise was imposed, the performance generally degraded, by a greater degree in the CI than in the normal-ear model. The pulse rate had a particularly large effect. These observations indicate that the CI signal itself contains sufficient F0 information, particularly for targets in quiet. The temporal resolution (represented as pulse rate) plays a critical role in listening under noisy conditions. Detailed analyses in noisy conditions revealed a positive linear correlation between the performance and signal-to-noise ratio. Also, we found that most of the erroneous estimations were concentrated around one octave higher or lower than the ground truth. That is, many incorrect cases can be regarded as "correct" in terms of pitch class.

Keywords : Pitch, Computational model, Simulated cochlear-implant signal

Coding Strategy

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Self-reported satisfaction of hearing ability and usability of the Nucleus® 7 sound processor featuring ForwardFocus among Chinese cochlear implant users: a 12-month real-world evaluation

Lin WU[1], Jiyun LU[1], Chenjiong WU[1], Colleen PSARROS[3], **Jin ZHANG[2]**

[1]*Medical Affair Depart, Cochlear Great China, China*
[2]*Department of Otolaryngology and Head and Neck Surgery, Boao Super Hospital, China*
[3]*Medical Affairs, Cochlear Asia Pacific, Sydney, Australia*

Purpose:
To assess long term hearing performance, satisfaction, and usability of the Cochlear™ Nucleus® 7 sound processor (N7) featuring a spatial noise reduction algorithm (ForwardFocus) in everyday environments among Mandarin-speaking adults and children fitted with cochlear implants (CI).

Methods
This was an open label, single-centre, single arm study including 29 CI recipients aged ≥ 5 years recruited from a previous N7 study. Participants had previously upgraded from the Freedom, Nucleus 5 or Nucleus 6 sound processor and had 12 months experience with the N7., Participants completed a customised 37-item questionnaire that assessed satisfaction of hearing ability and functionality using a 5-point Likert scale from 1 'very dissatisfied' to 5 'very satisfied'. Telephone and accessory use and audio and music streaming with the N7 sound processor, were also assessed.

Results
Mean (SD) age of participants was 25.8 years (±2.7) for adults (n=5) and 10.1 years (±3.4) for children (n=24).
The primary endpoint of hearing performance was rated high for most participants, with 72.3% satisfied/very satisfied with the N7 sound processor. Satisfaction in different hearing contexts ranged from 62.1% for understanding on the phone to 93.1% for understanding a 1:1 conversation in quiet. Up to a third of participants felt satisfied/very satisfied in complex noisy situations, such as hearing/understanding conversations in background noise.
Satisfaction with streaming music/audio directly to the N7 sound processor was rated highly with 76.9% feeling satisfied/very satisfied. Most participants (79.3%) used their N7 sound processor with the telephone. One third streamed telephone audio directly; fewer used a smart device on loudspeaker or a telecoil. Three key features of the N7 sound processor listed by the participants were clarity and quality of sound, ease of use, and size and comfort.

Conclusion
This study demonstrates the longer term real-world benefits of using the N7 sound processor across different hearing environments.

Keywords : ForwardFocus, Sound processor, Cochlear implant

Mapping, Rehabilitation & Speech Therapy

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Simultaneous bilateral cochlear implantation in very young children improves adaptability and social skills: a prospective cohort study

Ying CHEN[1], Yun LI[1], Huan JIA[1], Zhihua ZHANG[1], Wenxi GU[1], Zhaoyan WANG[1], Jingjie LI[2], Olivier STERKERS[1], **Hao WU[1]**

[1]Department of Otolaryngology-head and Neck Surgery, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, China
[2]Department of Anesthesiology, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, China

Objective: To investigate the value of using the Gesell Development Diagnosis Scale (GDDS) to predict developmental outcomes in very young children who undergo simultaneous bilateral cochlear implantation.
Design: A total of 62 children receiving simultaneous bilateral cochlear implantations were enrolled from April 2017 to August 2018. They were divided into two groups depending on the operative age: "Infants" group (6-12] months, N=38 or "Children" group [12-36) months N=24. Data on the surgical outcomes, auditory development, speech production, and developmental indicators were collected until two years after the initial fitting. The primary outcome measure was the GDDS, a neuropsychological development examination. Secondary outcomes included the following: complication rate, aided pure tone average, Infant-Toddler Meaningful Auditory Integration Scale, Categories of Auditory Performance-II, Meaningful Use of Speech Scale (MUSS), Speech Intelligibility Rating, and the LittlEARS Auditory Questionnaire.
Results: The mean ages at implantation in Infants and Children groups were 9.2±1.17 and 16.6±3.60 months, respectively. Significant differences were found in the social skills (p=.001) and adaptability (p=.031) domains of GDDS. The younger the age of bilateral cochlear implants (BiCIs) surgery, the higher developmental quotient (DQ) of language, social skills and adaptability the child could achieve after two years. The complication rates in the Infants and Children groups were 0% vs 2.1% (p=0.57). There was no surgical complication in the Infants group. In the Children group, one case with EVA and Mondini malformation had a receiver-implant misplacement on the right side (2%, 1/48). In the two groups, auditory performance and speech production had improved similarly. In the Infants group, social skills DQ at baseline had a significant positive relationship with MUSS after two years.
Conclusion: Simultaneous bilateral cochlear implantation in younger children improves adaptability and social skills.

Keywords : Simultaneous bilateral cochlear implantation, Very young children, Gesell Development Diagnosis Scale

Mapping, Rehabilitation & Speech Therapy

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"Hearing loss Quality of Life" questionnaire – Development and Validation

Angelika ILLG[1], Edda AMANN[2], Karin KOINIG[2], Ilona ANDERSON[2], Thomas LENARZ[1], Mareike BILLINGER-FINKE[2]

[1]Ent-department, Medical School Hannover, Germany
[2]Elektromedizinische Geräte, Medel, Austria

Patient self-reported outcomes (PROs) have gained importance and attention as part of an increased focus on patient-first medicine.
Several QOL questionnaires specific to the situation of individuals with hearing loss often have a strong focus on auditory abilities (in terms of hearing performance) at the undue expense of other dimensions, e.g., emotional impact. Furthermore, because these questionnaires were developed many years ago, the question arises how applicable they still are. Based on the definition of health and the WHO definition of QOL as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns", a new questionnaire was developed to assess the QOL in hearing loss in various everyday situations. When formulating the items, we also considered the International Classification of Functioning, Disability and Health, better known as ICF/WHO.
84 patients completed the HL-QOL questionnaire for validation purposes. The questionnaire consists of 23 items on a seven-point Likert scale (always (>95%) to never (≤5%)). Items' characteristic values were assessed; reliability was determined using internal consistency (Cronbach's α). Factor analysis was used to examine the factor structure of the questionnaire. Test-retest reliability was tested in 63 subjects. Criterion validity was tested with the Nijmegen Cochlear Implant Questionnaire (NCIQ). In addition, the correlation between age at implantation and duration of hearing loss was tested with the HL-QOL total score.
The results confirm the HL-QOL as a valid and reliable instrument to assess perceived quality of life for German-speaker with a hearing implant. Its general clinical applicability will still be evaluated in further studies.

Keywords : Life-quality questionnaire, ICF modell, Validation

Mapping, Rehabilitation & Speech Therapy

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Receptive and expressive language in Hindi-speaking children with post-cochlear implantation at one-year intervals

Vijay KUMAR

Audiology & Speech-language Pathology, Amity University Haryana, India

Individual variability in language outcomes of children with Cochlear Implantation (CI) is the major concern. In CI rehabilitation, there is lack of a protocol regarding uniform post-CI language assessment interval duration. The trajectory of language growth post-CI is yet not comprehensively understood. There is huge variability in CI literature regarding post-CI assessment interval duration. It was aimed to evaluate the language ability score in Hindi speaking children at one year interval with up to two years of CI experience using revised receptive expressive emergent language test-3eds (REELT-3) and to compare it with children with normal hearing (NH). Thirty-two children each with CI (14.8±2.7months) and age-matched NH (21.3±6.2 months) participated in this study. The children who were implanted within 24 months of chronological age participated in this study. Cross-sectional, prospective study design was used to measure the language ability score (LAS) at an interval of one year activation of CI. LAS was compared at pre-implant, one year post implant and two years after implant. LAS was calculated using REELT-test. LAS was calculated by adding the receptive and expressive score. One-way ANOVA analysis revealed that the LAS after 2 years of CI usage increased significantly compared to one year and baseline score (F (2, 30)=6.63, p=0.02) across children with NH. However, no significant difference was observed among two years of CI usage and chronological age matched children with NH (t(1,31)=1.93, p=.505). Findings of this study supports that the early CI can facilitate better access of speech acoustic input to fine-tune auditory neural pathways. Early implantation shortens the auditory deprivation period thus leading to better establishment of aural-oral language development. Present study advocates the need for periodic assessment in children with post-CI. A protocol on specific duration of periodic assessment of language shall be explored and established.

Keywords : Cochlear Implantation,, REELT-3, Receptive and Expressive Language

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A Questionnaire Survey: Feedback from Advanced Bionics users after upgrading to Marvel at Novena-ENT Head & Neck Surgery Specialist Centre, Singapore.

Win Nie NG[1], Wong Kein Christopher LOW[1], Sean LO[2]

[1]Novena Ent Head & Neck Surgery Specialist Centre, Mount Elizabeth Novena Hospital, Singapore
[2]Advanced Bionics, Southeast Asia, Singapore

OBJECTIVES - To evaluate the benefits of the newly introduced Marvel system from Advanced Bionics for adults and children in everyday listening situations, ease of wireless connectivity and comfort compared to the previous generation sound processor system that they were using.

MATERIALS AND METHODS - Advanced Bionics users at Novena-ENT Head & Neck Surgery Specialist Centre Singapore, who have upgraded and actively used the Marvel system for at least four weeks were recruited to participate in this study. A comparative questionnaire has been generated comprising 22 questions looking at various aspects of everyday hearing which include sound quality, hearing experience, wireless connectivity, comfort of use, aesthetics, ease of handling, and open-ended questions/comments was administered for participants to indicate their personal preferences.

RESULTS - The preliminary data shows a positive trend towards the new Marvel system in benefiting Advanced Bionics patients in the aspects of sound quality, wireless connectivity, comfort and ease of use, aesthetics, and handling.

CONCLUSION - The Advanced Bionics Marvel system provides a high level of user satisfaction in the areas evaluated compared to predecessor systems. A long-term study can also be initiated to look at the long term benefits of the Marvel system.

Keywords : Marvel, Connectivity, Wireless

Mapping, Rehabilitation & Speech Therapy

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Exploring individuals' ability to recognize the suprasegmental aspects of speech

Eun Yeon KIM[1], Il Joon MOON[2,3], **Hye Yoon SEOL[4]**

[1]Arts Psychotherapy, Graduate School of Interdisciplinary Therapy, Myongji University, Korea
[2]Hearinge Research Laboratory, Samsung Medical Center, Korea
[3]Otolaryngology-head & Neck Surgery, Sungkyunkwan University School of Medicine, Samsung Medical Center, Korea
[4]Department of Communication Disorders, Ewha Womans University, Korea

When it comes to oral communication, along with phonemes, understanding speech prosody changes also plays a critical role in speech comprehension as the meaning of the speech can change based on the various aspects of speech prosody, such as pitch, stress, and intonation. This study investigated individuals' ability to comprehend speech based on speech prosody changes.
A total of 26 participants were recruited for the study. Among the 26 participants, 13 of them were cochlear implant (CI) users with pre-lingual hearing loss and 13 of them were normal hearing (NH) listeners. The participants completed speech prosody perception, pitch discrimination, and melody contour identification tests and the results were compared with their speech recognition performance.
The speech prosody perception test had words with positive and neutral meaning and the CI group showed significant performance difference with the NH group except for some words with neutral meaning. Correlations were also observed between the two groups on other tests.
Although the CI group was able to compensate for their hearing loss through CIs, their ability to understand suprasegmental aspects of speech was different from that of the NH listeners. Currently, speech tests that are widely used in the clinical settings mostly focus on the evaluation of the segmental aspect of speech. Findings of the study demonstrate the need for a clinical test that can also examine the suprasegmental aspects of speech.

Keywords : Audiology, Cochlear implant, Speech prosody

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Evaluation of a wireless Contralateral Routing of Signal (CROS) system in unilateral cochlear implant users

Hong-Joon PARK[1], Ho-Ki LEE[1], Seung-Chul LEE[1], Jung-Wook SIN[1], Won-Sun YANG[1], So-Yeon KIM[1], Su-Min SONG[1], Seung-Yeon HAN[1], Jin-A HA[1]

[1]Otology, Soree Ear Clinic, Korea

Purpose: Cochlear implants (CI) are known to provide satisfying benefits for hearing impaired with bilateral severe to profound hearing loss in quiet environment even with single-side implantation. However, it becomes challenging when background noise is present. Recently, a Contralateral Routing of Signal (CROS) system was developed to detect the sound from the non-implanted side and then wirelessly transmit it to the CI processor, which could possibly overcome the limitation of unilateral CI. The effect of such a CROS system in both quiet and noisy environments was evaluated in this study.
Methods: 11 unilateral Naída Q CI users with at least six months of CI use were included in this study. All of them were native Korean speakers. Speech intelligibility was measured using monosyllable lists from Korean speech audiometry. Two loudspeakers were positioned at 90°/270° azimuth. The speech signal was presented from the non-implanted side, while noise was presented on the CI side. Subjective preference ratings were measured using a customized questionnaire.
Results: The Wilcoxon signed rank test was applied to all paired samples. Significant benefit of speech intelligibility in both quiet and noise with CI+CROS were observed (p=0.025, p=0.004) compared to CI only. For the subjective questionnaire, there was a trend of significant improvement in speech understanding and direction awareness. Seven out of 11 subjects considered the CROS device to be generally beneficial in noisy listening situations. All benefits were shown in an acute test session.
Conclusion: Speech intelligibility benefits in both quiet and noise as well as participants' positive subjective impression demonstrated that a CROS system could successfully compensate hearing deficits with unilateral CI in different listening environments.

Keywords : Unilateral Cochlear Implant, Speech intelligibility, Contralateral Routing of Signal

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A Study on Intra-operative Neural Response Telemetry In Cochlear Implant

Wan Fazlina WAN HASHIM[1], Bee See GOH[2], Fatimah SAZARI[1]

[1]*Medical Rehabilitation Services, Hospital Canselor Tuanku Muhriz, Malaysia*
[2]*Otorinolaryngology, Faculty of Medicine Ukm, Malaysia*

Introduction: The programming of cochlear implant (CI) is essential for good performance after surgery. Currently, neural telemetry has become a standard method in programming. Thus this study aimed to look at the relationship between intra-operative neural response telemetry (NRT) values with post-operative NRT, surgical approach, type of implant used and imaging findings of the cochlea anatomy.

Material and methods: NRT threshold values intra-operatively and at switch-on were reviewed retrospectively. The thresholds were analysed and compared to the surgical approach, implant used and cochlear findings.

Results: 86 patients (91 ears) that underwent cochlear implantation from 2010 to 2022 were enrolled (mean age 20 years old; SD: 18.36). Out of 91 ears, only 72 records of surgical approach, 81 records of electrode used and 87 records of cochlear findings were available. 51 out of 72 recorded of using cochleostomy approach and 58 out of 81 recorded of using perimodiolar electrodes. For cochlear findings, 55 showed normal cochlear findings while 32 ears showed abnormal findings.

In general, intra-operative NRT values (183.24 ± 22.44) were higher than NRT values obtained at switch- on (172.92 ± 15.95) with a moderate correlation (P value < 0.001, r = 0.424). Both intra-operative and switch-on NRT values were higher in the round window approach as compared to cochleostomy approach ($p<0.005$). For implant used, lateral wall electrodes showed significantly higher intra-operative NRT values than perimodiolar electrodes ($p<0.01$) but not the switch-on NRT values. When comparing both NRT values between normal and abnormal cochlear findings, the result did not show any significant difference.

Conclusion: NRT is a quick tool in cochlear programming. There is significant difference between intra-operative and switch-on NRT values thus re-measurement of NRT during switch-on is recommended prior setting mapping values. This study also showed that cochleostomy approach and perimodiolar electrodes could reduce intra-operative NRT values.

Keywords : Cochlear implant, Intra-operative, NRT

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Evaluation of long-term auditory rehabilitation and hearing preservation after unilateral cochlear implantation with two different types of electrodes

Jinwei CUI[1], Shunnian ZENG[1], Xiaohui ZHOU[2], Yifei NI[2], Xiguang TIAN[1], **Jin ZHANG**[1]

[1]*Ent, Hainan Boao Super Hospital, China*
[2]*Clinical Research Department, Advanced Bionics China, China*

Background and objective: the HiRes™ Ultra cochlear implant (CI) developed by Advanced Bionics, was approved in the Hainan Lecheng Medical Tourism Pilot Zone and a real-world study was completed in 2022. By comparing participants' postoperative speech and hearing performance, the feature of different electrodes and their ability to preserve residual hearing were investigated in the current study.
Methods: 77 patients with unilateral cochlear implant (Ultra MS 42 and SlimJ 35) were enrolled in this study. All subjects completed the preoperative baseline assessment, speech and hearing test at 12 months ±30 days after CI activation. Infant-Toddler Meaningful Auditory Integration Scale/Meaningful Auditory Integration Scale (IT-MAIS/MAIS) were applied to assess the auditory abilities for children aged 1-6 years at 12-month follow-up session; for participants over 6 years old, pure tone audiometry was performed to evaluate hearing preservation after surgery. Mann-Whitney U test was used to compare the results between different electrodes.
Results: The average aided hearing threshold and speech test results of all subjects showed significantly difference compared with preoperative results ($p<0.05$). At the 12-month follow-up session, the average aided hearing threshold of patients with SlimJ implanted was significantly higher than that of those implanted with MS ($p<0.05$). There was no significant difference shown between the two electrodes ($p>0.05$) in either speech test or subjective questionnaire. Most patients can obtain good hearing preservation after surgery.
Conclusion: HiRes™ Ultra cochlear implant can significantly improve the hearing and speech ability for patients with severe to profound sensorineural hearing loss, while no significant difference was observed between the two electrodes. Both electrodes can preserve a certain amount of low-middle frequency residual hearing.

Keywords : Real world study, Speech rehabilitation, Residual hearing

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Communication Strategies of Twin Sisters with Bilateral Cochlear Implants in Educational Settings: A Case Study

I-Hsiu CHEN[1], **Pey-Yu CHEN[1,2]**, Hung-Ching LIN[1,2]

[1]Otolaryngology, Mackay Memorial Hospital, Taiwan
[2]Audiology and Speech-language Pathology, Mackay Medical College, Taiwan

Purpose
Cochlear implantation (CI) has been shown to benefit deaf children in terms of speech and language development. However, challenges related to hearing and communication can still impact academic performance and communication skills, even with the assistance of cochlear implants. This study aims to investigate the communication and stress coping strategies adopted by a pair of twin sisters with congenital hearing loss who received bilateral cochlear implants at a young age.

Methods
We conduct a retrospective review on a pair of 21-year-old twin sisters who received their first cochlear implant at the age of four and their second implant at the age of sixteen. Due to single-parent families without adequate support, their auditory habilitation was irregular.

Results
Despite similar upbringing, the twin sisters developed different communication and stress coping strategies. The elder sister relies more on sign language and communication software, while the younger sister is more willing to use oral communication and participates in activities in mainstream college. The elder sister tends to respond emotionally, while the younger sister takes a problem-solving approach. Better communication strategies lead to greater confidence and proactivity in interpersonal interactions.

Conclusion:
The attitude towards communication and social interaction plays a crucial role in the fluency of spoken language and integration into the hearing community for individuals with cochlear implants.

Keywords : Stress coping strategy, Spoken language, Communication skill

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Towards a standard measure of listening effort from pre-adolescence to adolescence

Katie NEAL[1,2], Pia WATKINS[1,2], Tess ANSELL[1,2], Sarah HUGHES[3]

[1]Research and Clinical Innovation, The Shepherd Centre, Australia
[2]Linguistics, Macquarie University, Australia
[3]Centre For Patient Reported Outcome Research (cpror), Institute of Applied Health Research,, University of Birmingham, UK

Background: Individuals with hearing loss frequently describe their experience of effort in relation to listening, particularly in challenging acoustic and linguistic environments. Despite recognition of this impact on an individual's communication ability, an effective and meaningful clinical measurement of listening effort remains difficult. There are external indicators to the presence of listening effort that may be observed by communication partners, such as timing delays and changes in proximity to a speaker, however the consequences and perception of effort experienced by individuals with hearing loss is largely internal. Assessment and evaluation of these internal experiences are complex particularly in adolescent and younger children and may prevent accurate representation of listening effort leading to limited clinical considerations.

Methods: An existing standardised patient reported outcome measure (PROM) of LEQ™-CI validated in an adult population was completed by n= 60 adolescence and n=30 parents.

Results: Findings from this pilot indicate that adolescents easily recognise and experience listening effort in their daily lives. Results indicate that the level and impact of this recognition appears to change in relation to age. It also highlights that a parent's observation of effort may contrast to their child's own experience, and that our clinical understanding in this space may be lacking.

Conclusion: For listening effort to be considered in our clinical assessments we require robust, measures validated with end-users. Adapting the LEQ™-CI for adolescents will enhance its utility and validity, making a clinical tool specifically for this age group available. An increased capacity to measure and understand listening effort within younger populations will enable us to support meta-cognitive development related to communication. Similarly, this knowledge will enable us to develop targeted intervention throughout this critical phase.

Learning outcomes: To understand the usability of the LEQ™-CI for adolescents to enhance support in a rehabilitation setting.

Keywords : Listening Effort, Adolescence, Meta-cognition

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Investigation of the Marvel Sound Processor in Everyday Life Situations: Results from Mainland China

Yifei NI[1], Martina BRENDEL[2], Anne MÜLLER[2], Laure ARNOLD[3], **Xiaohui ZHOU[1]**

[1]Clinical Research, Advanced Bionics, China
[2]European Research Center, Advanced Bionics Gmbh, Germany
[3]Clinical Research, Advanced Bionics Sarl, France

Introduction
The Naída CI M (Marvel) sound processor was launched into the global market in 2020 and got introduced in Hainan Lecheng Medical Tourism Pilot Zone (China) in 2021. To evaluate the hearing performance and the usability of this newly released processor as well as the related fitting software in Chinese population, CI recipients and professionals all over mainland China were asked to take part in this anonymous survey.

Methods
42 CI users with at least three months of experience with Marvel CI, 17 Marvel users who had recently upgraded to Marvel and 20 CI professionals participated in this survey so far. All participants came from 21 provinces or municipalities across the country. Three custom questionnaires were distributed online for experienced users, upgrade users, and professionals. Questions mainly include the comparison between Marvel CI and their previous sound processor on speech clarity, sound quality and hearing impression with different features.

Results
Overall results showed that Marvel CI experienced users were highly satisfied with this new sound processor, rating their general satisfaction as 9 (median) out of 10. Bluetooth streaming capabilities of Marvel solution were also highly rated as 9 (median) out of 10 for phone calls, TV and media. Compared with previous devices, 81% upgrade users reported improvement in hearing impression, and 71% in comfort and aesthetics. AutoSense OS, integrated Bluetooth and Real Ear Sound were the top three features preferred by the professionals.

Conclusion
The Marvel sound processor can improve CI recipients' hearing impression and quality of life. The new features integrated in Marvel, especially the wireless connectivity, provide remarkable benefits for CI users as well as professionals.

Keywords : Cochlear implant, Sound processor, Marvel CI

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Importance of ear-specific auditory training in cochlear implant recipients of asymmetric hearing loss

Hyesook KIM[1], Minjo KWON[1], **Iljoon MOON[2]**, Wonho CUNG[2]

[1]Department of Otololaryngology-head and Neck Surgery, Samsung Medical Center, Korea
[2]Department of Otololaryngology-head and Neck Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Korea

Introduction
Nowadays, cochlear implantation(CI) in asymmetric hearing loss(AHL) patients has been increased as there are many advantages of binaural hearing. However, it is difficult for AHL CI users to adapt new sound through the device during the early adaptation period because of interaural sound interference and dependency on the better hearing ear.
Therefore, AHL needs specific training to improve speech perception after CI. In this study, we investigated the method and effect of auditory training in AHL who underwent CI at SMC.

Methods
72 adult patients with AHL were included in this study. We tried to apply ear-specific auditory training to all patients, however some patients did not participate in this specific training program during their early adaptation period. Ear-specific auditory training is as follows. An experienced speech therapist recorded educational sentences and words in advance. By directly connecting the CI and iPad with Bluetooth, ear-specific auditory training is conducted in a listening environment excluding the opposite ear. The educational sentences and words are provided to the patients so that the patients can conduct the daily training at home.

Results
There was a significant difference in speech perception(Mono&Bi syllables and Sentence recognition test) at 6months f/u between the group of patients who received auditory training and those who did not(mono : p=0.006, bi : p=0.002, Sentence : p=0.009).

Conclusion
Patients with AHL needs ear-specific auditory training following CI, and listening ability of patients who received specific training was higher than patients who did not receive it. However, Short duration of deafness can be another important prognostic factor especially among the group of not receiving the auditory training. So, Further research is needed in the future.

Keywords : Asymmetric hearing loss, Cochlear implantation, Auditory training

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Relationship between electrically evoked compound action potential thresholds and behavioral T-levels in implanted children with cochlear nerve deficiency

Xiuhua CHAO[1], Jianfen LUO[1], Ruijie WANG[1], Zhaomin FAN[1], Haibo WANG[1], **Lei XU[1]**

[1]Department of Otolaryngology-head and Neck Surgery, Shandong Provincial Ent Hospital, Shandong University, China

Objective : It is challenging to program children with cochlear nerve deficiency (CND) due to limited auditory and speech abilities or concurrent neurological deficits. Electrically evoked compound action potential (ECAP) thresholds have been widely used by many audiologists to help cochlear implant programming for children who cannot cooperate with behavioral testing. However, the relationship between ECAP thresholds and behavioral levels of cochlear nerve in children with CND remains unclear. This study aimed to investigate how well ECAP thresholds are related to behavioral thresholds in the MAP for children with CND.

Methods: This study included 29 children with CND who underwent cochlear implantation. For each participant, ECAP thresholds and behavioral T-levels were measured at three electrode locations across the electrode array post-activation. The relationship between ECAP thresholds and behavioral T-levels was analyzed using Pearson's correlation coefficient.

Results: The results showed that ECAP thresholds were significantly correlated with behavioral T-levels at the basal, middle, and apical electrodes. ECAP thresholds were equal to or higher than the behavioral T-levels for all tested electrodes, and fell within MAP's dynamic range for approximately 90% of the tested electrodes. Moreover, the contour of the ECAP thresholds was similar to the contour of T-levels across electrodes for most participants.

Conclusion: ECAP thresholds can help audiologists select stimulation levels more efficiently for children with CND who cannot provide sufficient behavioral response.

Keywords : Electrically evoked Compound Action Potential, Cochlear Nerve Deficiency, Cochlear Implant Programming

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Verification of remote checking application in Japanese population

Hiroshi YAMAZAKI[1,2], Naoko FUJII[1], Saburo MOROTO[1], Tomoko YAMAZAKI[1], Rinko TAMAYA[1], Keizo FUJIWARA[1], Norio YAMAMOTO[1], Yasushi NAITO[1]

[1]Otolaryngology, Kobe City Medical Center General Hospital, Japan
[2]Department of Otolaryngology-head and Neck Surgery, Kyoto University, Japan

Purpose of study

Demand for telemedicine is increasing worldwide in the field of cochlear implants (CIs). To evaluate whether CI programming is appropriate, CI users must undergo audiometric and speech discrimination tests. These tests are typically performed in a soundproof room in the outpatient unit, however, telemedicine allows home examinations as an alternative to these. "Remote check" (Cochlear Ltd) is a smartphone application that allows CI users to self-check the CI function and hearing performance at home, and its usefulness has been reported in English-speaking countries. The aim of this study was to verify the use of Remote Check in Japan.

Methods

In this study, we first applied the Japanese version of the Remote Check application to 40 Japanese-speaking CI users. We compared the results of the Japanese version of the Remote Check on the same day as the outpatient examination. Furthermore, we compared the results of the Remote Checks performed at the hospital and at home.

Results

There were significant correlations between the Remote Check results and the outpatient examination results for all measures - impedance, audiometric threshold, and speech discrimination ability test ($p<0.0001$). These results indicate that the Remote Check is a valid alternative to the hospital examination. and found significant correlations in all measures ($p<0.0001$), confirming the reproducibility of the Remote Check results.

Conclusion

These results indicate that the Japanese version of Remote Check is as useful for telemedicine in Japan as the English version.

Keywords : Remote Check, Telemedicine, Cochlear implant

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Picture book read by a nursery teacher to hard of hearing child (HHC): Effects of the display of the child's gaze point using an eye-tracker

Yuiko HIRASHIMA[1], **Masae SHIROMA[1]**

[1]Speach and Hearing Sciences, International University of Health and Welfare, Japan

Storytelling of picture books has been used to develop the language skills of hard of hearing children (HHC). Hearing loss makes it difficult for teachers to understand if a child is listening to what is being read. Hearing children look at a picture according to the words they hear. Therefore, we thought that by displaying the gaze point of a HHC when reading a picture book, it would be possible for the teacher to understand HHC's interests in the story. The subjects were five HHC aged 5 to 6 years old, and one experienced nursery teacher read a picture book on personal computer (PC) to those HHC individually twice, and displayed the gaze point using PC with an eye-tracker in one of twice. When the teacher read the picture book with an eye-tracker, the teacher could see the child's gaze point and knew the child's interests. The level and contents of the picture books were adjusted to match the target children, and the same series of picture books were prepared so that the sentences being read would be same level. Then, we investigated how the nursery teacher's reading changes depending on the gaze point indicator. In the analysis, we transcribed the nursery teacher's utterances and calculated the number of words. In addition, the characteristics of utterances, for example some exclamations other than the text were obtained. As a result, in picture books with little text, the number of uttered words increased and words representing pictures were added. In picture books with more text, the number of uttered words was the same, but utterances that matched HHC's interests increased. The display of the gaze point makes the teacher to pay more attention to the child's interests and adjust her reading accordingly, so the display of the gaze point was effective.

Keywords : Hard of hearing children, Picture book, Eye-tracking

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Multicentric evaluation of the Marvel CI Sound Processor Technology: Survey from cochlear implant recipients in India

Aninda Duti BANIK[1], Martina BRENDEL[2], Neevita NARAYAN[3], Meenakshi WADHERA[4], Saloni PIPLANI[5], Srikant INNAMURI[6], Kannan T[7], Priyanka ENDAL[8], Amit ANAND[9]

[1]Clinical & Research - Audiology, Advanced Bionics India Pvt Ltd, India
[2]Clinical Research, Advanced Bionics Gmbh-european Research Center, Germany
[3]Audiology & Speech Language Pathology, Sphear-speech & Hearing Clinic, India
[4]Audiology & Speech Language Pathology, Meenakshi Speech & Hearing Clinics Pvt Ltd, India
[5]Audiology & Speech Language Pathology, Asha Kiran Speech and Language Habilitation Center, India
[6]Audiology & Speech Language Pathology, Apollo Hospitals-hyderabad, India
[7]Audiology & Speech Language Pathology, Mcv Ent City Clinic, India
[8]Audiology & Speech Language Pathology, Big Ears, India
[9]Audiology & Speech Language Pathology, Apple Speech and Hearing Clinic, India

Purpose
A global multi-centric survey adapted for culturally diversified India was conducted to measure the recipient's gratification on upgrading to the latest Marvel CI sound processor(SP) technology from Advanced Bionics.
Method
A 27-item-scaled & open-ended online survey questionnaire was administered on 39 recipients(7-85 yrs) & families who upgraded to Marvel CI across two categories of experience i.e. 4–12 weeks and >12 weeks.
Results
On qualitative analysis, 72% recipients reported 'much better' speech understanding, sound quality and comfort in noisy environments. Better music & speech perception lead to 61% increased & sustained activity of streaming wirelessly music & phone calls via BlueTooth or Roger. Recipients felt comfortable within 9-12 days of using AutoSense OS 3.0 which adapts to various environments with noise-reduction technologies without having to toggle programs manually. Parents feel their children have become more confident to have conversations with new people, speak longer length of utterances, needs less repetitions, sound localization is better and listening to whisper & far-off soft sounds have radically improved.
91% feel Marvel CI processor are more comfortable especially using the curved battery which clings & balances well on the pinna making it feel light, aesthetic and easy to use with majority having rated it at highest 10-points. The top 5 features reported were direct streaming of music & phone calls via BlueTooth, AutoSenseOS3.0, synchronized Marvel-Link Bimodal hearing aid technology, Real-Ear-Sound which mimics the pinna functions and M-waterproof battery for water-sports & freestyle off-the-ear wear. Having all these features with a decent 15 hours+ of standard battery real-life capacity made them feel mind-free for a full-day school or office routine.
The satisfaction increased from 68% acute stage to 94% as they got acclimatized at more than 12-weeks of wearing experience with the Marvel CI SP as compared to previous processors.

Keywords : AutoSense OS 3.0, BlueTooth; Roger wireless, Marvel CI sound processor

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Marvel CI sound processor, Target CI programming & universal wireless programming: A multicentric survey by Cochlear Implant Professionals in India

Aninda Duti BANIK[1], Martina BRENDEL[2], Neevita NARAYAN[3], Meenakshi WADHERA[4], Saloni PIPLANI[5], Srikant INNAMURI[6], Kannan T[7], Priyanka ENDAL[8], Amit ANAND[9]

[1]Clinical & Research - Audiology, Advanced Bionics India Pvt Ltd, India
[2]Clinical Research, Advanced Bionics Gmbh-european Research Center, Germany
[3]Audiology & Speech Language Pathology, Sphear-speech & Hearing Clinic, India
[4]Audiology & Speech Language Pathology, Meenakshi Speech & Hearing Clinics Pvt Ltd, India
[5]Audiology & Speech Language Pathology, Asha Kiran Speech and Language Habilitation Center, India
[6]Audiology & Speech Language Pathology, Apollo Hospitals-hyderabad, India
[7]Audiology & Speech Language Pathology, Mcv Ent City Clinic, India
[8]Audiology & Speech Language Pathology, Big Ears, India
[9]Audiology & Speech Language Pathology, Apple Speech and Hearing Clinic, India

Purpose
Advanced Bionics developed a new software Target CI for programming Marvel CI sound-processors. A global multi-centric survey was conducted in India to investigate fitting practices and efficiency of the new technologies amongst CI professionals.
Methods
A 20-item scaled independent survey with both closed & open-ended questionnaire was administered on CI professionals who fitted CI+hearing aids across <3years to 80+ years recipients.
Results
CI professionals were confident to fit AutoSenseOS 3.0 as 86% of their recipients preferred automatic and noise-reduction features giving them more balanced hearing, better speech perception and sound quality, perception of soft-voices, easier phone conversations, less listening efforts, and comfort in challenging listening situations as compared to previous generation processors. Professionals rated these features at an average 8.5/10 whereas Bluetooth streaming scored the highest-10-point.
Marvel CI is programmed via Target CI using the Universal wireless programming system-Noah Link Wireless made it exceptionally pediatric friendly. Although, the usual M & T levels with IDR are often altered in upgrades, but they were confident to program fully automatic AutoSenseOS 3.0 which does >200 blends of programs with a backup off-the-ear program at switch-on, unlike previous generation processors. Bimodal & Bilateral fitting, easy activation, visual appearance, ease of workflow, toggling microphone modes & noise-reduction features, streaming program optimization, and universal wireless programming were rated the highest by the CI professionals making the software very user-friendly & intuitive.
Although, there are few more programming features which need to be integrated into Target CI from the earlier SoundWave 3.2, overall, 92% CI Professionals feel more confident with the ease of using the new Target CI software for Marvel CI & Bimodal Marvel-Link Hearing aid programming. Thus, there is a high satisfaction amongst CI professional's school of thought of fitting the new Marvel CI SP algorithms via the new fitting software-Target CI.

Keywords : AutoSense OS 3.0 ; Wireless programming, BlueTooth, Marvel CI; Target CI

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Using the cochlear implant electrode array to direct evoke cortical auditory response: an objective tool for optimisation and better outcomes

Dayse TAVORA-VIEIRA[1,2,3], Aanand ACHARYA[1,2]

[1]*Audiology / Ent, Fiona Stanley Fremantle Hospital Group, Australia*
[2]*School of Surgery, The University of Western Australia, Australia*
[3]*School of Public Health, Curtin University, Australia*

Cochlear implants (CIs) are the primary treatment option for severe-profound hearing loss. However, the outcome of this treatment varies greatly among individuals, as the mapping technique used to program the device is subjective and relies on the clinician's expertise and patient feedback. To address this issue, researchers investigated the use of electrically-evoked cortical auditory evoked potentials (eCAEPs) via direct stimulation of the CI electrode as an objective tool for CI verification.

The study enrolled 85 adult unilateral CI users with postlingual hearing loss. Stimuli were presented via the cochlear implant fitting software at the behaviorally-measured most comfortable loudness (MCL) and directed to apical, medial, or basal electrodes. CAEPs were recorded from scalp electrodes and evaluated by two electrophysiologists.

Results showed that eCAEPs could be detected in the majority of users and at various electrode sites. Furthermore, eCAEP latencies and amplitudes were not affected by age, duration of deafness prior to CI surgery, or laterality of hearing loss. eCAEPs were also found to be a useful, objective method to evaluate sound perception in CI users.

Keywords : CI optimisation, ECAEP, Improved outcomes

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Understanding the False Beliefs of Preschoolers with Cochlear Implants

Hye Min KIM[1], **Mi-Sun YOON[2]**

[1]*Speech Therapy, Hanulsam Child Development Center, Korea*
[2]*Communication Disorders, Korea Nazarene University, Korea*

Purposes: This study aims to assess the level of Theory of Mind(ToM) development of children with cochlear implants by comparing their ability to understand false beliefs with the peers of normal hearing.
Method: Ten children with cochlear implants (CIs), ten children of normal hearing with same chronological age (CA) and ten children with same language age (LA) were participated. A false belief test consisted total of eight tasks: four Maxi tasks for moving locations and four smarties tasks for replacing content. One task consisted of a story and three questions: a reality question, a memory question, and a belief question. The child looked at the pictures, listened to the stories, and answered three questions.
Results: The CIs, CA, & LA groups had significant differences between groups, with mean of 1.70, 6.40, and 5.70, respectively ($F = 12.175$, $p<.001$). Children with CIs showed significantly lower performance on false belief tasks with CA and LA group. Analysis of the correlation between false belief tasks with language age, and chronological age in CIs showed a higher correlation with language age (.76 vs. .54).
Conclusions: The children with CIs in this study were preschoolers aged 4-5 years, with 9 children CAP 7 and one CAP 6. Most of them were able to talk on the phone. Nonetheless, they showed significantly lower performance not only with the same chronological age but also with the same language age group. Since 4-5 years of age is known to be the time when false belief development is completed in children with normal hearing. It can be assumed that low levels of ToM development in children with CIs will lead to difficulties in peer relationships. Therefore, attention should be paid to diagnosis and intervention in the development of ToM in children with cochlear implants.

Keywords : Theory of Mind, False beliefs, Preschoolers

Mapping, Rehabilitation & Speech Therapy

PP 197

The comparisons of the indirect speech acts between children with CIs and normal hearing

Yoonha BAEK[1], **Mi-Sun YOON[2]**

[1]Graduate Program, Korea Nazarene University, Korea
[2]Communication Disorders, Korea Nazarene University, Korea

Objectives: It has been reported that children with cochlear implants (CI) have difficulties with pragmatic knowledge to recognize the speaker's intention and figure out the context of a given situation for interactions. The purpose of this study was to examine the characteristics of the ability to understand indirect speech acts in children with CIs.

Method: The subjects are 10 children with CIs had linguistic abilities of 7-10 years old in formal test and 10 children with normal hearing (NH) matched as same language age. An inventory was used to assess the abilities to understand indirect speech acts, and it was comprised of 26 items in total including 2 practice items, 6 items on direct speech acts, and 18 items on indirect speech acts. The recording tasks were short conversations between a man and woman to be close to natural situations. Children were asked to give open-end answers.

Results: The findings show that children with CIs were lower in the abilities to understand indirect speech acts than children with NH with statistical significance. Both the groups were lower in understanding indirect speech acts in the interrogative sentence form than the declarative one with statistical significance. While children with NH made no non-related errors, children with CIs made more non-related errors than related ones.

Conclusion: It is thus estimated that children with CIs suffer pragmatic difficulties even though they have no big difficulties in terms of listening and linguistic abilities compared with their peers. An intervention focused on pragmatic abilities, connected meanings based on situational and contextual information, in the daily life and clinical field of children with CIs will be necessary.

Keywords : indirect speech acts, Pragmatic knowledge, Situational and contextual information

Mapping, Rehabilitation & Speech Therapy

PP 198

Effectiveness of Script-Based telepractice Program for children with Cochlear Implants and Parental Satisfaction

Mi-Sun YOON[1], Gyung-Hun HONG[1],
Young-Myoung CHUN[2], **Song Jun CHOI[3]**

[1]Communication Disorders, Korea Nazarene University, Korea
[2]Ent, Soree Ear Clinic, Korea
[3]Department of Otolaryngology-head and Neck Surgery, Soonchunhyang University College of Medicine, Korea

purpose: A script-based telepractice program developed for children with delayed language development was administered to children with cochlear implants to determine the effectiveness of the intervention, to survey parental satisfaction, and to confirm the feasibility of telepractice for them.
Methods: The participants received the intervention twice a week for 6 weeks in their own homes and at their own time. In the intervention, the center and the home were connected remotely, and the SLP interacted with child and mother in real time. Each session lasted 15-20 minutes. The entire program consisted of four scripts of familiar situations as animations, each with one script presented in one session. Each script had three levels, adjusting the starting level according to the child's language level. Target words & target sentences were evaluated before and after the intervention, and parental satisfaction was evaluated on a 5-point scale after the intervention.
Results: Average pre and post intervention performance increased from 9% to 53% for target words and from 1% to 44% for target sentences. Individual outcomes also showed an increase after the intervention in all participants. The average of parental satisfaction was as high as 4.4, and the mother who reported the lowest score was the mother of the youngest participant.
Conclusions: We found that children with cochlear implants who had good speech perception abilities can proceed with script-based telepractice programs just like children with delayed language development and help them develop language. Overall parental satisfaction was also high, similar to that of children with delayed language development. However, it has been shown that younger children have difficulty progressing the program and lower parental satisfaction. In children with cochlear implants, diagnosis and intervention begin in infancy. Therefore, it is considered that consideration of children at a young age is even more necessary.

Keywords : telepractice, Script-based, Parental satisfaction

Mapping, Rehabilitation & Speech Therapy

PP 199

The relationship between psychological assessments and auditory perception of cochlear implant subjects

Kuan-Ju CHEN[1], Yen-Jung PAN[2], Mei-Jui HUANG[1,2], Chih-Ching LIN[1], Kuan-Hua CHEN[1,2], Kuang-Chao CHEN[1,2]

[1]Holistic Hearing Healthcare Center, China Medical University Hospital, Taiwan
[2]Department of Otolaryngology, China Medical University Hospital Taipei Branch, Taiwan

Objective:
Accumulating evidence implicates that the outcome of implantation may influenced by physical and psychological health status of patients. However, since 2020, social distance increased because of the pandemic of COVID-19, which had significantly influenced communication effectiveness. The purpose of this study was to discuss the relationship pre- and post- operative psychological assessments and audiological evaluations based on the experience of child cochlear implant recipients during the epidemic.
Design:
All the subjects aged from 7 to 12 years-old were included and underwent cochlear implant surgery, pre- and post-operative evaluations in China Medical University Hospital and Taipei branch, gender and manufactures were chosen randomly. We investigated the correlation between the results of preoperative psychological assessment using Wechsler Adult Intelligence Scale 4th Edition (WISC-IV) and speech discrimination score using close-set or open-set speech test materials in quiet and in noise environment, also collected Children Home Inventory Listening Difficulties (CHILD) questionnaire scores one year after implantation. Moreover, we discussed house-tree-person test (HTP) to collate subjects' cognitive, emotional, and social functioning.
Result:
We report a positive relationship (r = 0.79) between the Working Memory Index of the WISC-IV and word recognition scores in quiet environment. The total score of questionnaires also having a positive relationship (r = 0.81) with the WMI. According to HTP test, most of the child cochlear implant recipients have negative traits such as escaping from reality, depression, or flinch.

Keywords : Cochlear implant, WISC-IV, Audiological evaluations

Mapping, Rehabilitation & Speech Therapy

PP 200

Clinical application of electrically-evoked stapedial reflex threshold (eSRT)

Mei-Jui HUANG[1,2], Chi-Ching LIN[1], Yen-Jung PAN[1], William Kuan-Hua CHEN[1], Kuan-Ju CHEN[1], Joshua Kuang-Chao CHEN[1]

[1]Holistic Hearing Healthcare Center, China Medical University Hospital,taichung, Taiwan
[2]Department of Special Education, National Kaohsiung Normal University, Kaohsiung, Taiwan

- Background and Aim
The correlation between eSRT and M/C Level had been confirmed. However, which time point of eSRT could be used as a reference for M/C Level settings didn't be specified. One of the aims of the study was to investigate the relationship between eSRT at different time points and the M/C Level. CI recipients' subjective preference and performance for MAP set by eSRT (eSRT Map) and by subjective responses (Sub. Map) would also be explored.
- Method
A total of 90 CI recipients in the age above 12 years were included in the study. The eSRT was performed intra- and post- operatively between December 2014 and March 2023.
- Results
The eSRT analysis revealed a statistically significant difference between the intra- and postoperative thresholds. The eSRT of CI activation within 24 hours postoperatively would be stable within 3 months postoperatively. The eSRT within 10 days postoperatively could predict stable M/C Level. There were no significant difference betweene SRT Map and Sub Map in Sound Field Threshold and WRS. Most recipients preferred Sub Map. However, most recipients found Sub Map more uncomfortable than eSRT Map.
- Conclusions
Determining M/C Levels in CI recipients is usually difficult even for adults. The eSRT could be used as the basis for Mapping. The eSRT also could be applied in some special situations, such as some consonants and vowels cannot be heard clearly, searching / eliminating unpleasant or odd sound. It is recommended that at least 1-2 eSRT measurements should be performed routinely within 3 months postoperatively.

Keywords : ESRT, Cochlear Implant, M/C Level

Mapping, Rehabilitation & Speech Therapy

PP 201

Improving Cochlear Implant Use and Speech Perception in Children with Additional Disabilities: A Case Study

Sangyong SHIM[1], Yukyoung KIM-LEE[2], Heesun PARK[3], Bongil PARK[4], **Jongmin JUNG[5]**

[1]National Education Support Center For The Hearing Impaired, National School For The Deaf in Seoul, Korea
[2]Research Laboratory, O Hearing Center & Laboratory, Korea
[3]Department of Speech & Language Therapy, Gimpo Yonsei Speech & Language Center, Korea
[4]Department of Otorhinolaryngology, Korea University Anam Hospital, Korea
[5]Institutes of Humanities, Chosun University, Korea

When CI users have additional disabilities such as autism or developmental delay, they have often experienced difficulties wearing CIs or low performance. However, very little is known about how to address these challenges.

This study aimed to identify and discuss the challenges and solutions for helping CI users with additional disabilities wear CIs consistently and perceive speech input better. The study included intervention cases involving five CI users with additional disabilities.

In an effort to reduce the inconvenience of using CI and to increase CI performance, all participants received CI programming optimized for speech perception and also language therapy sessions periodically. We observed better compliance with CI use among all students after adjusting for CI mapping. Speech perception levels varied, but all users demonstrated clinically meaningful improvements, with some who could not recognize Ling 6 sounds being able to identify the sounds as auditory-only. Notably, one student's perception of open-set monosyllabic words improved from 48 % to 90%. However, there are other challenges in retaining improved speech perception skills or generalizing the level to different task types.

These findings suggest that adjusting CI mapping and providing therapy sessions can improve the compliance and speech perception abilities of CI users with additional disabilities. Some users showed much higher performance than those reported in previous studies. However, further research is required to determine the long-term effectiveness of these interventions and address the challenges associated with retaining improved speech perception levels.

Keywords : Cochlear implant, Additional disabilities, Speech perception

Mapping, Rehabilitation & Speech Therapy

PP 202

Outcomes of cochlear implantation in children with multiple disabilities

Tamer MESALLAM[1], Medhat YOUSEF[1], Ayna ALMASAAD[1]

[1]Ent, King Saud University/ King Abdulah Ear Specialist Center, Saudi Arabia

BACKGROUND:
Cochlear implantation (CI) in children with additional disabilities can be a fundamental and supportive intervention. Although, there may be some positive impacts of CI on children with multiple disabilities such as better outcomes of communication skills, development, and quality of life, the families of those children complain from the post-implant habilitation efforts that considered as a burden.
OBJECTIVE:
To investigate the outcomes of CI children with different co-disabilities through using the Meaningful Auditory Integration Scale (MAIS) and the Meaningful Use of Speech Scale (MUSS) as outcome measurement tools.
METHODS:
The study sample comprised 25 hearing-impaired children with co-disability who received cochlear implantation. Age and gender-matched control group of 25 cochlear-implanted children without any other disability has been also included. The participants' auditory skills and speech outcomes were assessed using MAIS and MUSS tests.
RESULTS:
There was a statistically significant difference in the different outcomes measure between the two groups. However, the outcomes of some multiple disabilities subgroups were comparable to the control group. Around 40% of the participants with co-disabilities experienced advancement in their methods of communication from behavior to oral mode.
CONCLUSION:
Cochlear-implanted children with multiple disabilities showed variable degrees of auditory and speech outcomes. The degree of benefits depends on the type of the co-disability. Long-term follow-up is recommended for those children.

Keywords : Children with disabilities, Hearing impairment ·, Cochlear implants

Mapping, Rehabilitation & Speech Therapy

PP 203

Cochlear implantation programming characteristics and outcomes of cochlear nerve deficiency

Xingmei WEI[1], Ying KONG[1], Simeng LU[1], Shujin XUE[1], **Yongxin LI[1]**

[1]Department of Otorhinolaryngology Head and Neck Surgery, Capital Medical University, China

Purpose: Due to the specificity of cochlear implantation (CI) programming parameters and outcomes in cochlear nerve deficiency (CND) patients, this study aimed to investigate the correlation between programming parameters and outcomes and further compare the difference between normal and CND groups.
Methods: Ninety (95 ears) CND patients (normal cochlea, 39; malformed cochlea, 56) and seventy-nine (81 ears) normal cochlea patients who underwent CI surgery with either Med-El or Cochlear devices were included. The programming parameters and outcomes evaluated by the questionnaires were collected and compared among the normal CND, malformed CND, and normal groups in the two device groups, and their correlation was analyzed.
Results: In the CND group, a reduced stimulation rate, higher pulse width, and triphasic pulse were needed in some cases. The stimulus levels of the CND group were significantly higher than that of the normal group ($p < 0.05$), but the outcomes of the CND group were significantly worse than that of the normal group ($p< 0.05$), and the stimulus level was significantly correlated with the outcomes ($p < 0.05$). However, there was no difference between normal and malformed CND groups. The non-auditory response was observed in the CND group, especially the ones with malformations.
Conclusion: The CI programming parameters of some CND patients need to be adjusted, and a slower stimulation rate and higher pulse width are required sometimes. CND patients need a higher stimulus level than normal patients but their outcomes are poorer. Non-auditory response should be noticed in CND patients during programming.

Keywords : Cochlear nerve deficiency, Cochlear implantation, Programming parameters

Mapping, Rehabilitation & Speech Therapy

PP 204

Korean Mothers' Speech to Young Children with Cochlear Implants in Parent-Child Interaction

Heesun PARK[1], **Youngmee LEE[2]**, Gangeun LEE[2]

[1]Speech Therapy, Gimpoyonsei Speech-language Therapy Center, Korea
[2]Communication Disorders, Ewha Womans University, Korea

Purpose:
Infant-directed speech is the particular form of spontaneous speech observed in interactions between parents and their young children. There are reasons to believe that infant-directed speech may help language acquisition easier for young children. Thus, this study investigates the effects of cochlear implantation on mothers' speech to their young children.

Method:
Fourteen children with cochlear implants (CIs) and 14 age-matched children with normal hearing (NH), aged 12 to 35 months, participated in this study. We recorded mothers' utterances through a parent-child interaction task. Mothers' speech features such as fundamental frequency, utterance length, speech rate, and pause duration were measured across utterances in the speech samples.

Results:
There were no significant differences between the CI and NH groups in fundamental frequency, utterance length, and pause duration variables. However, the mothers' speech of the CI group showed marginally significantly slower than that of the NH group.

Conclusion:
Mothers used typical infant-directed speech styles when speaking to their children with CIs. Additionally, mothers of the CI group tended to speak more slowly than mothers of the NH group in the parent-child interactions. Given that the language skills of children with CIs are significantly lower than those of children with NH in this study, mothers of the CI group may speak to their children at a slower rate than those of the NH group to provide their linguistic input more efficiently. These findings suggest that children with CIs are exposed to infant-directed speech with similar acoustic qualities as children with NH.

Keywords : Infant-directed speech, Cochlear Implants, Mothers

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PP 205

Adult cochlear implantation at a tertiary hospital

Shih-Lung CHEN[1], Kai-Chieh CHAN[1], **Che-Ming WU[1]**

[1]Department of Otorhinolaryngology & Head and Neck Surgery, Chang Gung Memorial Hospital-linkou, Taiwan

Background: Prevalence of adult cochlear implant (CI) surgery has been increasing. However, the relevant adult CI data in Taiwan are insufficient due to the small number of adult implant patients. We demonstrate data regarding adult CI outcomes from a single tertiary hospital.

Methods: A total of 116 consecutive adult CI recipients (≥18 years old) who completed at least 12 months of speech perception tests (words and sentences) between January 1999 and December 2020 were enrolled in this retrospective population-based cohort study. Thirty patients completed speech perception (words and sentences) testing as well as three questionnaires relating to quality of life, and 71 completed full tinnitus suppression studies. Subjects' pre- and post-CI questionnaires were evaluated to assess overall CI outcome.

Results: The scores of easy sentences (ES), difficult sentences (DS), and phonetically balanced (PB) word recognition tests reached a plateau at 3 months post-CI ($p = 0.005$, 0.001, and 0.004, respectively) in most subjects. The post-CI scores of bodily pain, mental health, and social role functioning were significantly higher than corresponding pre-CI scores on the SF-36 Health Survey–Taiwan version ($p = 0.036$, 0.019, and 0.002, respectively). CI improved tinnitus in approximately 65.1% of 71 adults. Based on the Tinnitus Handicap Inventory, 66.7% of patients were in grade 3–5 before surgery. However, after CI, only 34.4% of patients remained in THI grade 3–5.

Conclusion: This study present that CI can improve speech perception (words and sentences), physical health, mental health, social interaction, and self-esteem in adult patients with profound hearing loss. CI can also alleviate tinnitus significantly. The outcomes of ES, DS, and PB tests at 3 months post-CI were non-inferior to other longer post-CI periods.

Keywords : Adult, Cochlear implant, Quality of life

Mapping, Rehabilitation & Speech Therapy

PP 206

Outcome of cochlear implantation in adult patients with single-sided deafness/ asymmetrical hearing loss

Iljoon MOON[2], Miso RHEE[1], Soyoung JIN[1], Yang Sun CHO[2], Won Ho CHUNG[2], Young Sang CHO[2]

[1]Department of Otololaryngology-head and Neck Surgery, Samsung Medical Center, Korea
[2]Department of Otololaryngology-head and Neck Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Korea

Introduction

Nowadays, cochlear implantation (CI) in patients with single-sided deafness (SSD) or asymmetric hearing loss (AHL) is becoming popular. However, the outcome of CI in this specific population has been mostly reported in a small number of patients. The authors aim to explore the efficacy of CI for adult patients with SSD or AHL.

Objectives and methods

A total of 34patients with SSD and 35 with AHL were enrolled, and their medical information was retrospectively reviewed.Duration of deafness, speech processer usage time, cochlear implant programming, postoperative speech perception, change of quality of life, and auditory spatial processing abilities were evaluated following CI.

Result

The mean deaf duration for 34 people with SSD was 11.7 years (age at implantation :50.6 years).The mean hearing loss period for 35 AHL patients was 17.1 years (ate at implantation : 61.0 years old).

The mean time of daily use was 9.02 hours for SSDs and 10.89 hours for AHLs, respectively.

There was no significant difference regarding the CI control programs between SSD and AHL groups,

With regard to speech perception ability, hearing loss period does not affect the outcome. However, device usage time was a significantly predictor for speech perception outcome.

Structured questionaaires including SSQ and HHIE showed improved sound quality as well as auditory spatial processing ability.

Conclusion

CI is an effective treatment foradult patients with SSD and AHL. ,The postoperative outcome was significantly improved especially in patients who reguraly use the device.

Keywords : Cochlear implantation, Single-sided deafness, Asymmetric hearing loss

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PP 207

Effects of Face Masks on Perception of Emotion from Facial Expression and Voice in Preschool-Age Children with Cochlear Implants and Hearing Aids

Haena YUN[1], **Youngmee LEE[1]**, Youngjoo LEE[2]

[1]*Communication Disorders, Ewha Womans University, Korea*
[2]*Speech Therapy, Chungeum Rehabilitation Center, Korea*

Purpose:
Understanding others' emotions is an important part of our daily interpersonal communication. Emotional cues in speech communication are delivered in several sensory modalities, including the auditory modality and the visual modality. Since the onset of the global COVID-19 pandemic in January 2020, masking wearing has become ubiquitous internationally. In this study, we investigated the effects of face masks on the perception of emotional speech in children with deaf and hard of hearing (DHH) compared to children with normal hearing (NH).

Method:
Thirteen children with DHH, aged 6;0 to 7;9 years old, participated in the study. Six children were cochlear implant (CI) users and 7 children used hearing aids (HAs). Thirteen children with NH participated in this study as the control group. They completed the emotion perception tasks, which are based on stimuli presenting three categories of emotional expressions (happiness, sadness, and anger). The emotion was shown in the videos with a woman actor displaying different facial and voice expressions.

Results:
There were no significant differences between the DHH and NH groups in mask-wearing and unmasked conditions. However, the CI group showed lower emotion perception scores than the HA group in unmasked-sad and unmasked-anger conditions. Among communication-related factors, speech perception scores at the sentence level were highly related with the emotion perception scores in the DHH group.

Conclusion:
These results indicate that children with DHH can accurately perceive others' emotions compared to children with NH, even in situations when facial expressions are limited. In the children with DHH, children with CIs have more difficulty perceiving sad and anger emotions in the unmasked condition than children with HAs. This endeavor will help an optimized treatment plan for children with CIs who have relatively poor ability to perceive others' emotions.

Keywords : Perception of Emotion, Cochlear Implants, Hearing Aids

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PP 208

The Use of the Ling Sound Test in Japan

Rebecca CLARIDGE[1], Seiichi TAKEDA[2]

[1]*Rehabilitation, Med-el, Australia*
[2]*Clinical Support, Med-el, Japan*

Background: The Ling Sound Test, created by Daniel Ling in the 1970s, was designed to assess speech sound audibility by children using hearing aids. With the advent of cochlear implants, the Ling Sound Test is recognized as a quick and effective screening tool employed diversely by hearing industry professionals world-wide.
Purpose: This project aims to investigate the use of the Ling Sound Test in Japan relative to other countries in the Asia Pacific and contribute to the development of evidence-based guidelines for the use of Ling Sounds by Japanese speakers.
Method:
1. A literature review was carried out to identify studies mentioning the Ling Sounds Test in Asia Pacific Countries.
2. The acoustic characteristics of American English Ling vowels were compared to Japanese vowels. The production of the Ling consonants in Japanese speech was analyzed.
Results:
The literature review identified papers from Australia, New Zealand, China, Malaysia and Korea. No publications were identified from Japan however informal reports* suggest the Ling Sound Test is utilized in Japan.
*70% of participants self-reported using the Ling test in a 2021 webinar 'Ling Sound Test and Mapping Implications'
'Long' Japanese vowels /aa/, /ii/ and /uu/ more closely match the formants of American English vowels used in the Ling test than 'short' Japanese vowels. The delivery of the consonants /m/, /sh/ and /s/ is not native for Japanese speakers as these sounds are typically produced in syllables.
Discussion & Conclusion:
Used across Asia Pacific countries to verify cochlear implant fittings and inform programming adjustments, the Ling test is a simple and effective method that can contribute to improving hearing outcomes. Administration guidelines for native Japanese speakers include the use of 'Long' vowels and instruction on delivering consonants in isolation.

Keywords : Ling Sounds, Japan, Cochlear implant programming

Mapping, Rehabilitation & Speech Therapy

PP 209

Development and evaluation of Remote Assist for CI aftercare

Saji MARUTHURKKARA

Global Clinical and Medical Affairs, Cochlear Ltd, Australia

Background: Distance to the CI clinic is possibly one of the most important barriers that prevent CI recipients from attending their follow up sessions. Remote Assist is a new tool that allows the clinician to perform counselling using a video call and make MAP and sound processor adjustments via the recipient's Nucleus® Smart App installed on their smartphone to overcome the barrier of distance.

Objectives A clinical study was conducted to evaluate the ease of use and user experience of Remote Assist.

Methods: Fifteen adults using Nucleus cochlear implants were programmed using Remote Assist, and subjective experiences were reported using the Telehealth Usability Questionnaire.

Results: The clinical consideration that went into the development of Remote Assist will be discussed. The clinical study findings on the ease of use and user experience with Remote Assist will be presented and discussed.

Conclusion:
Remote Assist is the first app-based synchronous remote programming tool for cochlear implant recipients that may further support clinicians to provide personalised and convenient care as needed.

Keywords : Remote Programming, Fitting, Aftercare

Mapping, Rehabilitation & Speech Therapy

PP 210

Parental Verbal Responses to Prelinguistic Vocalizations of Toddlers with Cochlear Implants

Yesol JEON[1], **Youngmee LEE[1]**

[1]Department of Communication Disorders, Ewha Womans University, Korea

Purpose: Parental verbal responsiveness positively influences the child's speech and language development in children with typical and delayed language development. Considering the bi-directionality of parent-child interactions, the speech and language skills of the child also influence parental verbal responses. The purpose of the current study was to investigate the features of parental verbal responses that appear after children's vocalizations in children with cochlear implants (CIs) compared to chronological age-matched (CA) and hearing age-matched (HA) children with normal hearing.

Methods: Thirteen children with CIs, aged 16 to 25 months, participated in this study. Thirteen CA children and thirteen HA children participated in this study as control groups. We collected parents' utterances and children's vocalizations through a parent-child interaction task. Children's vocalizations were classified into canonical and non-canonical vocalizations depending on including consonant-vowel syllables. Parental verbal responses were divided into contingent response, non-contingent response, and no response related to children's vocalizations.

Result: The three groups were not significantly different in the ratio of parental verbal response according to the response type and the vocalization type. However, there was a significant difference in the ratio of parental verbal response according to the response type, indicating that contingent responses were significantly higher than non-contingent responses and no responses. Additionally, there was a significant difference in the ratio of parental verbal response according to the vocalization type, indicating that parents responded more frequently to non-canonical vocalizations than canonical vocalizations.

Conclusion: Parents of the CIs group responded contingently to their children's vocalizations at a similar level as the CA and HA groups. Additionally, parents of the CIs group tended to respond sensitively to children's vocalizations regardless of children's vocal development. These findings suggest that parents of the CIs group contingently and sensitively respond verbally to their children's vocalizations as active partners in early parent-child interaction.

Keywords : Parental verbal responses, Young Children, Cochlear Implants

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PP 211

A Qualitative Study on the Perceptions of Parents Participating in Auditory Verbal Therapy

Sang Hee PARK[1], **Ok Bun LEE[2]**

[1]Speech and Language Pathology, Daegucyber University, Korea
[2]Speech and Language Pathology, Daegucyber University, Korea

1. Purpose: Auditory verbal therapy (AVT) is a representative method of parent-participation therapy for hearing impairment. This study aimed to find out the effect of AVT felt by parents rather than the therapy effect of children on AVT. A qualitative study was conducted to investigate the parents' feelings through participation in therapy through interviews. Based on this, we intend to create a questionnaire for future quantitative research.
2. Method: A total of 7 parents participated in the interview. Seven were parents of four children. For one child, only the mother participated. The 4 children were 2 children with cochlear implants and 2 children with hearing aids. The duration of AVT was 19 months for child A, 18 months for child B, 39 months for child C, and 20 months for child D. Interviews were conducted face-to-face. Three children had AVT and general therapy experience, and one child had only AVT experience.
3. Results & Conclusion : All 7 parents said that learning about strategies that can be generalized at home was effective and that parental participation therapy was necessary continuously. As a result of confirming through the questionnaire, it was found that the change in parents' behavior was achieved through parent participation therapy. Parents were using the listening strategy accurately for their children and tried to apply the method steadily in daily life. However, it was found that the strategies used by parents varied according to the age of the child, and the therapist needed to emphasize more on the strategies that parents should use every week. Cases in which both parents experienced AVT were more actively used at home for children.

Keywords : Auditory Verbal Therapy, Parents Participating, Qualitative Study

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PP 212

Correlation between Japanese Speech Perception Test (iCI2004) Results and Subjective Evaluation (NCIQ) in Cochlear Implant users

Yusuke MATSUDA[1], Ai KAMIE[2], Yusuke YAMADA[1], Shogo TSUMAGARI[2], Nao NOJIRI[1], Sakura ICHIHARA[1], Manami KAMITOMAI[1], Tetsuya TONO[1]

[1]Otorhinolaryngology, International University of Health and Welfare Hospital, Japan
[2]Otorhinolaryngology, Head and Neck Surgery, Kagoshima City Hospital, Japan

Objective:
We have developed iPad-based Japanese language speech perception tests (iCI2004) for cochlear implant (CI) users and finished its validation in 2020. The Nijimegen Cochlear Implant Questionnaire (NCIQ) has been widely used as a quantifiable self-assessment health-related quality of life (QOL) questionnaire for CI users all over the world. In this study, we utilized the NCIQ in Japanese to correlate with the results from the iCI2004 for monosyllables and words and from the original CI2004 for Japanese sentences.

Methods:
Thirty unilateral CI users aged between 15 and 82, with stable hearing thresholds in the implanted ear were included. We collected audiological data using iCI2004 for monosyllable and word tests and the original version of the CI2004 for the sentence test. Administration of the NCIQ was performed at routine visits to the departments of otolaryngology. The NCIQ has a 5-point scale in which CI users rate everyday-listening, with 60 questions divided into 6 subdomains.

Results and Discussion:
A significant correlation was found in one subdomain for monosyllables, in five subdomains for words and in three subdomains for sentences. The strongest correlation among all subdomains was obtained between words and "sound recognition" which consisted of questions about listening environments, such as conversations on a one-to-one basis or among several people, conversations in noise and speech comprehension.
These results seemed to be consistent with the fact that most conversations in daily life take place in words and sentences. In fact, monosyllable tests have been the first choice among speech perception tests available in Japan until recently. We thus recommend using word test more routinely, that may reflect more of the quality of life for CI users in Japan as already a standard test in many countries. The iCI2004 would be a suitable tool for assessing speech understanding in CI users in Japan.

Keywords : Cochlear implant, ICI2004, NCIQ

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PP 214

AN ASSESSMENT OF SPOKEN LANGUAGE DEVELOPMENT AND ITS PREDICTORS FOLLOWING COCHLEAR IMPLANTATION IN CHILDREN WITH CONGENITAL BILATERAL PROFOUND SENSORINEURAL HEARING LOSS.

Dipika PRAKASH[1], **Amit GOYAL[1]**, Vidhu SHARMA[1]

[1]*Otorhinolaryngology, All India Institute of Medical Sciences, India*

INTRODUCTION: Cochlear implantation (CI) as an effective modality for habilitation, enhances auditory perception and plays a pivotal role in overall cognitive, behavioural and language development.
OBJECTIVES:
Firstly, to assess the development of spoken language using standardized scales for Indian population, in children undergoing CI in a tertiary care hospital in Western India. Secondly, to gain insight into the factors associated with variability in the language developmental outcomes, to optimize rehabilitation process. Thirdly, to compare the applicability and accountability of two scales used for spoken-language assessment standardized for Indian population.
METHODOLOGY:
After ethical approval and written informed consent from the subjects/ parents, Auditory and Spoken-language development of 40 CI recipients was analyzed in an ambispective cohort study. Pre-operative language assessment was done using Scales for Early Communication Skills for Hearing-Impaired children (SECS). Serial audiological assessment was done using revised CAP score and Speech Intelligibility rating (SIR); spoken language development was assessed using the Communication Developmental Eclectic Approach to Language Learning (Com DEALL) and Assessment checklist for speech-language skill (ACSLS) at 3-monthly intervals post device switch-on for a total duration of 9 months. Statistical analysis was done to determine the impact of various factors on the variability of language outcomes.
RESULTS:
A total of 40 candidates (Male:Female = 3:2) were included. Unilateral CI was done in 29 candidates; bilateral in 11 by a single surgeon. The independent factors assessed were classified as Pre-operative factors: Age at implantation, hearing aid usage, pre-implantation audio-verbal therapy (AVT), etiology of deafness, comorbidities; Intra- and Post-operative factors: duration of device usage, frequency of attending AVT and parental involvement. The average CAP was 7.8 and SIR was 3.48 at 9 months post-operatively with improvement in language of 62.5%.
CONCLUSION:
Early age at implantation, bilateral implantation, good parental involvement and regular and frequent AVT are associated with better spoken-language outcomes.

Keywords : Cochlear Implant, Spoken-Language development, ComDEALL

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Parental Perspective on Parent-Clinician partnership: What parents of children with Cochlear Implants really want?

Pooja BEHERA[1], Shefali K.C[2], Yashika TYAGI[1], Nandini Dave MAINGI[3]

[1]Rehabilitation, Med-el India Pvt Ltd, India
[2]Education & Training, Med-el India Pvt Ltd, India
[3]Research & Special Projects, Med-el India Pvt Ltd, India

Abstract- Parents of children with cochlear implants (CI) are considered an important part in the auditory habilitation. From identification of hearing loss to attending mandatory auditory (Re)-habilitation sessions, to waiting until the child gets mainstreamed, and continue support while the child attains further education into adulthood, parents remain the most active members of the team. However, in recent times, there seems to be a mismatch between parental expectations and clinical reality, and the overall support that the parents feel they need.

Aim- To find out the needs of parents of children with CI from clinical as well as real life perspectives and suggest a parent child centred service delivery guideline based on the findings.

Method- A survey form was designed and rated by 3 hearing healthcare professionals including an audiologist, a speech language pathologist, and a CI surgeon for appropriateness of content. Suggested changes were incorporated, and the final survey was circulated among 500 families of children with cochlear implants. The same survey was circulated among CI professionals with more than 5 years of experience or to a CI clinic with audiologists and habilitationists with more than 5years of experience. Gap analysis was done by comparing overall results of survey from both the groups. A guideline was formulated based on the same.

Results- There was a difference between clinical recommendations and perceived benefit by the parents especially in the areas of setting and managing expectations, scheduling and attendance of therapy sessions, handholding for rehab at home and integration into schools and outside clinical settings. The need of a community as a safe space to share and learn from each other was another highlighted need.

Conclusion- A CI system should have a fool-proof protocol for parental engagement and empowerment following guidelines as suggested by this study and encourage community building.

Keywords : Parent empowerment, Community, expectations

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Investigating Engagement of Parents of Children with Hearing Loss on Speech Intervention

Paul William Digsay JACINTO[1], Russell Marrion ROMERO[1], Gerhilda Marie ADUANA[1], Jana Maitina BATOY[1], Julian Mark CARRASCAL[1], Nicole GARGANERA[1], Shane Ashley LEGASPI[1], Janna Elisse PADLAN[1], Marie Therese URGEL[1]

[1]Speech-language Pathology, University of Santo Tomas, The Philippines

Background: Aural Habilitation is vital for children who are Deaf and Hard of Hearing (DHH) to develop auditory, speech, and language skills, primarily through cochlear implants. In-person therapy has traditionally been used for rehabilitation services, but the pandemic necessitated a shift to telepractice. Parental engagement plays a crucial role in optimizing therapy outcomes by fostering collaboration between therapists and parents.

Objective: This study explores parental experiences in the telepractice delivery of their child's aural habilitation services in the Philippines.

Methods: An interpretative phenomenological study design was employed, involving semi-structured interviews to gather parental narratives on their engagement and experiences with aural habilitation via telepractice. Thematic analysis was used to analyze the gathered responses.

Results and Discussion: Three main themes emerged: (1) Activities Requiring Parental Engagement, (2) Facilitators in Parental Engagement, and (3) Barriers in Parental Engagement. These themes shed light on parental experiences in aural habilitation telepractice in the Philippines. Positive relationships between therapists and parents were found to be significant motivators for sustained parent engagement, while technical challenges posed barriers.

Conclusion: This study provides initial insights into factors influencing parental engagement in telepractice. Strong parent-therapist relationships were identified as key motivators, despite challenges such as internet connectivity issues. Telepractice continues to gain preference due to its convenience in service delivery.

Keywords : Parental Engagement, Speech Intervention, Telepractice

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The obstacle of aural rehabilitation in adult: A case study of bilateral cochlear implant recipient

Chun-Yi LIN[1], Wanyin ZHAO[2], Lian LIU[2], Chih-Yueh LEE[2]

[1]*Department of Audiology and Speech-language Therapy, Asia University, Taiwan*
[2]*Clinico Inc., Taiwan*

Purpose
The goal of the study is to reveal the factors that influence motivation and the progress of adult aural rehabilitation (AR).
Methods
A 26-year-old adult with bilateral cochlear implants (CIs) was recruit in the study. Four times per week for 6 months, the participant was scheduled in an hour-long AR course.
Results
At the first course, the participant expressed that he expected that he could understand all speech and speak well after implantation. However, he still felt uncomfortable about his CIs after 3-month post-surgery. In this course, he can detect Ling's six sound, except /s/ and /sh/. However, only /a/ could be reliably identified. By adding visual signals, he was able to comprehend and repeat the familiar sentences that he had trouble understanding by just listening. After three months of training, he was able to identify all of Ling's six sound, two to four words accurately, but not phrases. He continued to express his depression throughout the three-month training and refused to practice listening after course because he lived alone and lacks communication partners. After six months of training, he detected and distinguished Ling's six sounds accurately at a distance of two meters and repeated short sentence correctly. Because he believed he had no oral communication partners and always texted his friends, his motivation to communicate to others orally did not improve during the six-month courses. However, despite his unrealistic expectations prior to surgery, the audiologist made an effort to encourage him and present appropriate AR content in each class. As a result, he became more motivated to practice "listening" and his listening abilities improved.
Conclusion
The current study shows that pre-surgery expectations and consultation are crucial for the AR's effectiveness. However, it could be changed throughout the AR courses. Nevertheless, having "oral" communication partners also affects individuals' motivation.

Keywords : Cochlear implantation, Consultation, Communication partners

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Acquisition profile of voice emotion perception in Mandarin speaking children with cochlear implant

Wei-Hsiang SU[1], **Yung-Song LIN**[1]

[1]*Otolaryngology, Chi Mei Medical Center, Taiwan*

Cochlear implants (CIs) have revolutionized auditory rehabilitation for severe sensorineural hearing loss, but speech emotion recognition and intonation perception remain challenges in CI-implanted children. This study investigates the correlation between tone perception and emotional sound recognition in normal-hearing and CI-implanted children.

The study enrolled 113 participants, including 60 CI recipients (ages: 6.41–17.38) and 53 normal-hearing children (ages: 6.52–16.78), with age and intelligence comparisons made. Using stimuli sentences from the Hearing In Noise Test (HINT) corpus, emotions were recorded and acoustically analyzed with Praat v. 5.3.56. Participants matched emotions to sentences.

Results showed F0 pitch and duration variations. CI recipients had notably lower F0 variation coefficients than normal-hearing peers ($p < .0001$). Average fundamental frequency (F0) height emerged as a pivotal acoustic marker for both groups. Speech emotion recognition correlated significantly with pitch perception in CI recipients ($p < 0.01$), not in normal-hearing children. Furthermore, emotional perception improved with age ($p < 0.01$) and duration of CI usage.

In conclusion, voice emotion and tone perception are interlinked. Cochlear-implanted children exhibit concurrent sound emotion perception development. These findings deepen understanding of auditory processing intricacies, aiding enhanced auditory rehabilitation strategies.

Keywords : Voice emotion, Tone perception, Cochlear-implanted children

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Working Memory in Cochlear Implant Users: Exploring Auditory and Visual Modalities

Hyunjoo LEE[1], Kisung LEE[1], Aeji HEO[1], Sodam KIM[1], **Hyunsook JANG[1,2]**

[1]Division of Speech Pathology & Audiology, Hallym University, Korea
[2]Research Institute of Audiology and Speech Pathplogy, Hallym University, Korea

Working memory refers to the ability to temporarily hold, manipulate, and process various pieces of information. This ability might vary in individuals with cochlear implants (CIs) due to limited exposure to auditory stimuli. This study aimed to examine working memory in CI individuals across auditory and visual modes using digit span tests, while also establishing links between digit span scores and sentence recognition skills. Sixteen CI subjects, matched in age with sixteen normal-hearing subjects (aged 16-24), participated in digit span tests. These tests, encompassing forward and backward subtests, were carried out in auditory-only (AO), visual-only (VO), and auditory-visual (AV) conditions. AV tests were performed in both congruent (AV-Congruent) and incongruent (AV-Incongruent) modes.

The study uncovered that CI participants had lower working memory capacities compared to their normal-hearing counterparts. This difference was evident in both auditory and visual digit span tests. Notably, the cochlear implant group demonstrated better performance in the AV-Congruent condition when focusing on auditory stimuli. However, they didn't benefit from auditory input in the AV-Congruent condition when focusing on visual stimuli. This implies that when cochlear implant users engage in tasks concentrating on auditory input, the presence of corresponding visual input can enhance working memory. Conversely, in tasks emphasizing visual input, auditory stimuli have no impact, regardless of correspondence. Furthermore, the results suggest a relationship between working memory and sentence recognition abilities in CI individuals. This underscores the importance of working memory in speech-language rehabilitation programs.

Keywords : Working Memory, Auditory and Visual Modalities, Sentence recognition

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Quality of life and spatial hearing post cochlear implantation in adults

Md Noorain ALAM[1], Sanjay Kumar MUNJAL[1], Naresh K PANDA[1]

[1]Ent Department, Post Graduate Institute of Medical Education and Research Chandigarh, India

Purpose: The purpose of the present study was to evaluate the quality of life using NCIQ tool, and spatial hearing using Speech, Spatial, and Qualities of Hearing scale (SSQ) in adults with cochlear implant (CI) post six months of CI usage.

Method: 10 post-lingual subjects with severe to profound sensorineural hearing loss with no benefits from hearing aids with a minimum of six months CI usage were enrolled. The average age at implant was 39.22(SD 12.50) years. Nijmegen Cochlear Implant Questionnaire (NCIQ) and Speech, Spatial, and Qualities of Hearing scale (SSQ) were translated into Hindi using forward backward method and were administered on the subjects with at least 6 months of CI usage.

Results: : The scores on NCIQ significantly improved from 64 (3) to 198.57 (25.19) on single sample t test ($p<.05$). While on SSQ the scores increased from 62 (13) to 250(89.70) ($p<.05$). Post six months implant usage NCIQ values were in the social 67.57(11.83), physical 101(11), and psychological 29.71(6.7) domains. On SSQ post implant usage subdomains showed values of 70.11 (26.98) for speech, 76.11(36.02) for spatial and 104.11(35.87) for qualities. The spearman correlation measures showed a significant positive correlation of 0.79 between the hearing age and NCIQ score and .68 for hearing age and SSQ total score ($p<.05$).

Conclusions: The scores showed a significant improvement in the scores for NCIQ and SSQ and their domains in adults with cochlear implantation showing improvement in quality of life and spatial hearing abilities. There was a significant correlation between hearing age and NCIQ scores and SSQ scores.

Take home message: Cochlear implants facilitate spatial hearing and overall quality of life among adults.

Keywords : Spatial Hearing, Quality of life, SSQ and NCIQ

Vestibule & Tinnitus

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"Vertigo, likely peripheral", the dizzying rise of ChatGPT

Jeremy CHEE[1], Eunice Dawn KWA[1], Xueying GOH[1]

[1]*Otolaryngology-head and Neck Surgery, National University Hospital, Singapore*

The use of artificial intelligence (AI) in medical decision-making has once again come to the forefront with the prevalence of Natural Language Processing (NLP). In this exploratory article, we tested one such model, ChatGPT, for its ability to identify vestibular causes of dizziness. Eight hypothetical scenarios were presented to ChatGPT, which included varying clinical pictures and types of prompts. The responses given by ChatGPT were evaluated for coherence, clarity, consistency, accuracy, appropriateness, and recognition of limitations. ChatGPT provided coherent and logical responses. The model accurately provided differentials for both vestibular and non-vestibular causes of dizziness, with the correct diagnosis presented first in six of the cases. However, in one scenario, a purposefully vague prompt was provided, and the first differential diagnosis presented was incorrect. We found ChatGPT to be a useful tool in the primary care and emergency physician's armamentarium in diagnosing dizziness. It should however not be taken as a source of truth, nor would it absolve the medical practitioner from medicolegal responsibility. Being an AI tool, it lacks the ability to process certain nuances in clinical decision making, in both identifying atypical dizziness, as well as in recommending further examination steps to elucidate a clearer diagnosis. However, we believe that AI will continue to forge ahead in the medical field. Merging the immense knowledge base of AI programming with the nuances of clinical assessment and knowledge integration will surely enhance patient care in the years to come.

Keywords : Vertigo, Artificial Intelligence, Natural Language Processing

Vestibule & Tinnitus

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Investigating Vestibular Function in Cochlear Implant Candidates: Our Experiences in Hospital Kuala Lumpur

Azreen Zaira ABU BAKAR[1], Roshila BUJANG[1], Hafeza AHMAD[1], Amirah SUFIAN[1], Ainoor Shafinaz BUYONG[1], Marina Abdul MALEK[1]

[1]*Department of Otorhinolaryngology, Hospital Kuala Lumpur, Malaysia*

Introduction: Cochlear implant (CI) can improve hearing but may cause vestibular system disturbances resulting in dizziness. Vestibular testing plays an essential role in identifying pre and post operative vestibular function changes.

Objective: To evaluate the vestibular function of cochlear implant recipients before and after surgery.

Methods: This retrospective case series was conducted at the Otorhinolaryngology Clinic, Hospital Kuala Lumpur from 2020 till 2022. A total of 10 patients that met the set criteria were enrolled. Medical records were reviewed, and data were analyzed descriptively and statistically.

Results: Of 10 patients, 7 were in pre-lingual group (age range 1.1 – 3.3 years), and 3 were in post-lingual group (aged range 27 – 44 years). One post lingual patient had pre-operative imbalance clinically, while others were asymptomatic. Pre-operative Video Head Impulse Test (vHIT) and Cervical Vestibular Evoke Myogenic (cVEMP) test showed that all patients had abnormal results in either one or both tests. Thirty percent had unilateral and 70% had bilateral vestibular hypofunction. Post-operatively, only one post lingual patient had imbalance during clinical assessment. Vestibular test result showed similar findings in 80% of patients for vHIT and 50% for cVEMP test as of the pre-operative results, while a better response was seen in one patient (10%) for both tests. Worsening results were identified in the prelingual group, one patient in vHIT and 4 patients in cVEMP, non of these patients experience any imbalance during bedside post-operative clinical assessment.

Summary: The vHIT and the cVEMP test play an important role in evaluating cochlear implant patients. These tests can detect vestibular dysfunction more accurately post-operatively than clinical assessments. This study showed that pre existing vestibular hypofunction is common among CI candidates. CI surgery may improve or worsen vestibular function, hence pre-operative vestibular test should be incorporated in CI candidacy assessment.

Keywords : Balance, Cochlear implant, Vestibular testing

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The Effects of Very Early Cochlear Implant Activation on Tinnitus

Ivy Yenwen CHAU[1,2], Sophia Yung-Hsia LI[3], An-Suey SHIAO[1,2], Albina ISLAM[4], Daniel H. COELHO[4], **Lieber Po-Hung LI[1,2]**

[1]Department of Otolaryngology, Cheng Hsin General Hospital, Taiwan
[2]Faculty of Medicine, School of Medicine, National Yang-ming Chiao-tung University, Taiwan
[3]Morrison Academy, Taipei, Taiwan
[4]Department of Otolaryngology - Head & Neck Surgery, Virginia Commonwealth University School of Medicine, Virginia Commonwealth University, USA

Background: Cochlear implantation (CI) has been the standard care for patients with severe-to-profound hearing impairment. Yet the benefits of CI extend far beyond speech understanding, with mounting recent literature supporting its role in tinnitus abatement. However, those studies have analyzed the effects of CI device on tinnitus 3-4 weeks after activation. So far, little is known about tinnitus abatement very early in the post-operative period. The aim of this study is to compare pre- and post-operative tinnitus handicap in this unique but growing population of very early activated patients.

Methods: Twenty-seven adults with severe-to-profound hearing impairment with chronic tinnitus (> 6 months) were included. All patients were implanted with the same array and were switched on within 24 hours after the surgery. Tinnitus Handicap Inventory (THI) was recorded pre-operatively, immediately after activation at 24 hours post-operatively, at 1 week, 2 weeks, and 1 month after activation. Wilcoxon signed-rank test was used to compare values between pre-operative assessment and respective fitting sessions.

Results: Mean THI 24 hours after implantation increased in comparison to that assessed pre-operatively (77.6 vs. 72.5 vs. 77.6, $p = .001$). By one week after surgery, the THI had decreased to 54.9 ($p < 0.001$). This trend continued and was statistically significant at 2 weeks (36.0, $p < .001$) and 1 month (28.5, $p < .001$).

Conclusion: Most patients with tinnitus will note a significant improvement in their tinnitus handicap when activated within 24 hours of cochlear implantation. However, tinnitus increase between surgery and 24 hours, most likely reflecting not only intracochlear changes, but modulation of the entire auditory pathway. Following this early rise, the tinnitus continues to abate over the following month. Patients with tinnitus may benefit from early activation, though should be counseled that they may experience an exacerbation during the very early post-operative period.

Keywords : Cochlear Implantation, Tinnitus, Electrical stimulation

Vestibule & Tinnitus

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A Protocol for Patient-Managed Tinnitus Counselling Using ChatGPT

Khang Wen PANG[1], Jui May YONG[2]

[1]Department of Otolaryngology - Head & Neck Surgery, National University Hospital, Singapore
[2]Department of Otolaryngology - Head & Neck Surgery, Ng Teng Fong General Hospital, Singapore

Tinnitus is a chronic condition that affects millions of people worldwide, causing significant distress and impairment of quality of life. Traditional tinnitus counselling involves face-to-face sessions with a trained professional, which can be time-consuming and costly. The aim of this study was to develop a protocol for patient-managed tinnitus counselling using ChatGPT, a language model-based chatbot.

The protocol was developed based on a review of the literature on tinnitus counselling. It consists of a series of modules covering different aspects of tinnitus management as part of cognitive behaviour therapy, including education, coping strategies, and relaxation techniques. The chatbot guides the patient through the modules using a set of questions and prompts.

The use of ChatGPT for tinnitus counselling has several advantages over traditional counselling methods. It is accessible to patients 24/7, allowing for more flexible and convenient counselling sessions. The chatbot supports multiple languages for use around the world: English, Spanish, French, German, Portuguese, Italian, Dutch, Russian, Arabic, and Chinese. It is also cost-effective and does not require trained professionals to be physically present during the counselling sessions. It only requires a mobile phone or computer with internet connection. The use of a chatbot eliminates the stigma associated with seeking counselling for tinnitus.

In conclusion, the protocol for patient-managed tinnitus counselling using ChatGPT has the potential to revolutionize the way tinnitus is managed. Further research is needed, via a pilot study, to confirm that ChatGPT can be an effective and convenient way to deliver tinnitus counselling and to determine the optimal use of ChatGPT in tinnitus management. The use of technology in healthcare is rapidly evolving, and the development of ChatGPT for tinnitus counselling represents an exciting new approach to managing this common condition.

Keywords : Tinnitus, ChatGPT, Cognitive behaviour therapy

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Characteristics of Vestibular-Evoked Myogenic Potentials in Children with Vestibular Malformation

Mengya SHEN[1], Shujin XUE[1], Xingmei WEI[1], Lifang ZHANG[1], Jingyuan CHEN[1], Biao CHEN[1], Danmo CUI[1], Ying SHI[1], Ying KONG[1,2], **Yongxin LI[1]**

[1]*Department of Otorhinolaryngology Head and Neck Surgery, Beijing Tongren Hospital, Capital Medical University, Beijing, China*
[2]*Key Laboratory of Otolaryngology Head and Neck Surgery, Capital Medical University, Ministry of Education, Beijing, China*

Objective: To measure the vestibular-evoked myogenic potential (VEMP) response rate and describe the waveform characteristics among children with sensorineural hearing loss (SNHL) with vestibular malformation,and to identify VEMP values for the diagnosis of inner ear malformations.

Methods: This study enrolled 182 ears from 91 children, including those with vestibular malformations (VM) (46 ears), large vestibular aqueduct syndrome (LVAS) (48 ears), and SNHL without inner ear malformations (88 ears; control group). All groups were subjected to ocular and cervical vestibular-evoked myogenic potential (oVEMP and cVEMP) testing, respectively; the response rates and VEMP parameters were compared between groups, and the wave characteristics were further analyzed.

Results: The cVEMP response rates were 26.09%, 79.17%, and 68.18% in the VM group, LVAS, and control group, respectively, and significantly differed between groups (X^2=31.950, P<0.001). The oVEMP testing was completed for 96 ears due to limitations related to age or degree of fit, and response rates were 42.86%, 78.95%, and 77.27% in the VM group, LVAS, and control group, respectively, and significantly differed between groups (X^2=7.528, P=0.023). The P1 latency, N1 latency, amplitude, and rectified amplitude of the cVEMP in the VM group were 13.42±2.24 ㎳, 21.20±3.39 ㎳, 85.22±53.93 ㎶, 1.64±0.75 ㎶, respectively. Significant inter-group differences were observed for the cVEMP P1-latency, amplitude, and rectified amplitude (P<0.05), as well as for the oVEMP N1-latency (P=0.027) and N1-P1 amplitude (P=0.024). The LVAS group exhibited a waveform characterized by a prolonged latency and increased amplitude compared to the other groups (P<0.05).

Conclusion: Patients with SNHL are highly susceptible to otolith dysfunction, regardless of whether comorbid vestibular malformations exist. The VEMPs test is a simple and rapid evaluation technique for the clinical assessment of vestibular function and can provide a basis for vestibular rehabilitation training regimens for children with SNHL.

Keywords : Vestibular-evoked myogenic potential, Vestibular malformation, Children

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An increase in the auditory steady-state response amplitudes after a period of listening to binaural beat stimuli in tinnitus patients: a pilot study

Maryam SADEGHIJAM[1], Abdollah MOOSSSAVI[2], Mahdi AKBARI[1], Hamid HAGHANI[3], Abbas YOUSEFI[4], Samer MOHSEN[5]

[1]Department of Audiology, Rehabilitation Research Center, School of Rehabilitation Sciences, Iran University of Medical Sciences, Iran, Islamic Republic of
[2]Department of Otolaryngology and Head and Neck Surgery, Iran University of Medical Sciences, Iran, Islamic Republic of
[3]Department of Biostatistic, Iran University of Medical Sciences, Iran, Islamic Republic of
[4]Department of Medical Physics and Biomedical Engineering, School of Medicine, Tehran University of Medical Science,, Iran, Islamic Republic of
[5]Department of Otolaryngology, Faculty of Medicine, Damascus University, Syrian Arab Republic

Background Tinnitus impact on persons' lifestyle, function, and emotion is of significant importance that has been the leader for conducting an increasing amount of research in the field of tinnitus pathophysiology, assessment, and management. Binaural beats (BB) are one of acoustic neuromodulation approaches used in psychological disorders, such as distress and anxiety. Thus, we hypothesized that binaural beat could be helpful in the relief of tinnitus distress and annoyance.

Methods Seventeen chronic tinnitus subjects participated in this quasi-experimental (quantitative research) study. In this study, the effect of binaural beat stimuli was evaluated subjectively using the tinnitus handicap inventory (THI) scores, the visual analog scale for loudness and annoyance (VAS_L, VAS_A), and objectively by the 40-Hz ASSR after 1 month of listening to binaural beats, and the correlation between these two assessments was evaluated.

Results After 1 month of binaural beat stimuli listening, all of the subjective findings were significantly improved, and the amplitude of 40-Hz ASSR was increased in the right auditory and anterior frontal regions at 2000-Hz carrier frequency. Besides, there was a high correlation between the decreasing of the subjective scores with the rising of the amplitude of 40-Hz ASSR.

Conclusion The use of binaural beat as an acoustic neuromodulation method for tinnitus management may be recommended according to the current study findings. However, more investigations on the effectiveness supported by data from controlled clinical trials and more correlations with ASSR alteration are highly suggested.

Keywords : Tinnitus, 40-Hz Auditory Steady-state Response,, Binaural Beat

Vestibule & Tinnitus

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Analysis of Highly Contributing Gait features and Fall Scales related to Vestibular Disorder using Machine learning

Hwan Ho LEE[1], Dong Woo LEE[1]

[1]*Department of Otolaryngology-head and Neck Surgery, Kosin University College of Medicine, Korea*

The purpose of our study is to analyze fall scales of vestibular disorder patients, predict correlation of fall scales and, analyze feature importance of gait patterns related to those scales through machine learning.
Methods
The authors choose dizziness handicap inventory(DHI), performance oriented mobility assessment(POMA), five times sit to stand test(FTSTS test), korean fall efficacy scale(KFES) and modified romberg test as scales related to fall.
The gait data and those scales' score of 525 participants with vestibular disorder from Kosin University Gospel Hospital were used to make machine learning algorithm. Each participant wore an IMU sensor and walked 10 meters. 140 features of gait data were obtained. 16 features were excluded for the reason that over 50% of data was non-applicable. After preprocessing and normalization of those data, the XGBoost was used as an algorithm model for machine learning which is the most popular gradient boosted decision trees. The authors obtained inspective usefulness of those scales through precision, recall and F1 score of each scales and feature importance of gait data.
Results
The highly contributing scales were POMA and FTSTS test. Precision of POMA was 0.8298, recall was 0.9070 and F1 score was 0.8667. Precision of FTSTS test was 0.8350, recall was 0.6804 and F1 score was 0.7137.
Significant gait data features of POMA were both TOP, both peakswing, left HSP and both swidth. And for FTSTS test, those were left HS, right minTC and right swidth.
Conclusions
It presents POMA and FTSTS test may be the predictive scales for fall risk of vestibular disorder patients.
It shows relation between those scales and specific gait features.
It helps to have insight into create quantitative diagnostic methods by providing highly contributing features and scales.

Keywords : Gait, Vestibule, Fall scales

Psychoacoustics

PP 228

The effect of rehabilitation training base on temporal fine structure in speech in noise perception performance on elderly with mild to moderate hearingloss

Parisa RASOULI FARD[1], Farnoush JAROLLAHI[2], Jalal SAMENI[2], Mohammad KAMALI[2]

[1]*Audiology, Shahid Beheshti University of Medical Sciences, Iran, Islamic Republic of*
[2]*Audiology, Iran University of Medical Sciences, Iran, Islamic Republic of*

Age related hearingloss is a term used to describe hearing loss with age. It can be said that the auditory system is a spectrum analyzer that consists of a series of auditory filters. The output of each filter is like a bandpass filter that contains two forms of information: Envelope, which is the slow fluctuation of the amplitude over time. Fluctuations in the temporal fine structure (TFS). The most important role of TFS is to understand speech in noise. One way to study the role of TFS is to preserve TFS cues and discard envelope cues in speech. This creates TFS speech, which contains only TFS information, and is used to examine the role of TFS in speech perception.
Materials and Methods: The study population was the elderly with mild to moderate hearing loss in the age range of 60 to 75 years old. The present study was conducted in four separate sections. Development of stimulus and rehabilitation software by the engineering team, evaluations before the start of the rehabilitation intervention including TFS assessment, word in noise test, questionnaire, implementation of rehabilitation training.
Results: The mean thresholds of TFS-LF in all three frequencies before the intervention and after the intervention are significantly different and in all three frequencies after the intervention the thresholds are better and lower and at a frequency of 250 Hz to 58.40 degrees and It has reached 74.33 degrees at 500 Hz and 94.66 degrees at 750 Hz. In addition,
Conclusion: Aging reduces the ability of speech processing in both temporal and spectral coding. In the elderly, even with normal peripheral hearing thresholds, the central auditory system may show defects in speech processing and speech perception in the presence of noise due to poor temporal spectral processing.

Keywords : TFS, Speech perception, Rehabilitation

Music Perception & QOL

PP 229

Investigation of the Effect of Pediatric Serous Otitis Media on Music Perception

Rabia KARA[2], Büşra GÖKÇE[2], Osman İlkay ÖZDAMAR[1], **Gül ACAR[1]**

[1]Ent, İstanbul Medeniyet Üniversitesi, Türkiye
[2]Audiology, Ankara Üniversitesi, Türkiye

Purpose of Study: Otitis media with effusion (OME) is a very common condition in early childhood. Exposure to inconsistent auditory stimulus may affect perception of sound while the auditory nervous system is developing in this period. It is also known that musical perception may be affected as well as auditory processing due to OME. The aim of our study is to evaluate the musical perception and auditory processing of children with normal hearing who have a history of OME in early childhood and to investigate the possible correlation between the tests.
The Methods Used: Normal hearing children with (n=20) and without (n=22) the history of OME in early childhood between the ages of 8 and 13, who were determined to have normal hearing by medical examination and audiological tests were included. Montreal Battery of Evaluation of Music Abilities (MBEMA) was used to assess the music perception of the children included in the study; for the evaluation of temporal skills Frequency Pattern Test (FPT), Duration Pattern Test (DPT) and Adaptive Test of Temporal Resolution (ATTR) were applied. Turkish version of the Children's Auditory Performance Scale (CHAPS) was used for subjective evaluations.
A Summary of The Results: A statistically significant difference was found between the scores of the MBEMA Melody (p=0.028) subtest. Significant differences were observed between the groups in FPT (p=0.007) and DPT (p=0.038). There was a significant difference between the groups in the assessment of CHAPS scores (p=0.028). However, there was no statistically significant difference between the ATTR values (p>0.05). There was a positive moderate (0.324) correlation between the melody test and FPT. In addition, a positive moderate (0.316) correlation was found between FPT and CHAPS results.
The Conclusion: Otitis media, which is common in early childhood, may negatively affect music perception and auditory processing skills.

Keywords : Pediatric otitis media, Music perception, Auditory temporal processing

Music Perception & QOL

PP 230

Subjective and objective assessment of the music perception ability in early implanted, Mandarin-speaking, prelingually deaf adolescent and young adult cochlear implant users in Taiwan

Bang-Yan ZHANG[1,3], **Che-Ming WU[1,2,3]**

[1]Department of Otorhinolaryngology & Head and Neck Surgery, New Taipei Municipal Tucheng Hospital (built and Operated By Chang Gung Medical Foundation), Taiwan
[2]Department of Otorhinolaryngology & Head and Neck Surgery, Chang Gung Memorial Hospital—linkou, Taiwan
[3]School of Medicine, Chang Gung University, Taiwan

Background: Cochlear implant (CI) users had limited music perception ability compared to normal listeners. However, music enjoyment and engagement of these subjects and the relation between subjective and objective perception remained unclear. This study aims to measure rhythm, melody sensation, and a questionnaire to understand basic music perception ability and engagement of early implanted, Mandarin-speaking, prelingually deaf adolescent and young adult cochlear implant users in Taiwan.
Method: Primary Measures of Music Audiation (PMMA) and a self-compiled questionnaire modified from a music engagement questionnaire.
Result: Fifty-seven patients (implanted age 2.9±0.9 years) received PMMA and had a correction rate of 67.9% for melody and 68.6% for rhythm. Sixty-six patients (implanted age 4.1±2 years) finished the questionnaire, and most patients were active CI users. Above two-thirds of patients reported they like music and more than three-quarters of patients felt relaxed or pleasant when listening to music. The music preference in different environments was also investigated. However, only 37.9% of patients like their music activities in school classes. There was no association between PMMA score and music enjoyment.
Conclusion: Though those patients had limited objective perception accuracy of music, most of them claim music is important in their lives and would like to keep engaging in some music. Adjusting music activities in class may help improve music enjoyment in school.

Keywords : Music engagement, Primary measures of music audiation, Questionnaire

Music Perception & QOL

PP 231

Quality of life improvement in adults with bilateral severe to profound sensorineural hearing loss who have received a cochlear implant. A systematic literature review.

Shallu SHARMA[1], Matthias BRUNNER[1], Dell KINGSFORD SMITH[2]

[1]Market Access and Government Affairs, Cochlear Asia Pacific, Australia
[2]Medical Affairs, Market Access and Government Affairs, Cochlear Asia Pacific, Australia

Objective:
Untreated hearing loss can have a profound impact on quality of life (QoL). A systematic literature review was conducted to identify recent comparative studies reporting health-related QoL outcomes (utilities) in adults (≥18 years of age) with bilateral severe to profound sensorineural hearing loss (SNHL). The review focused on unilateral cochlear implantation (UCI) as the primary intervention versus non-surgical management.

Data Sources and Methods:
PubMed database, reference lists and grey literature sources were searched up to 30 March 2023. Studies published since 2012 and in English were included. Two reviewers independently scrutinised the publications for inclusion. If required, discrepancies were resolved through discussion with a third reviewer. The PICOS framework for systematic literature reviews was applied. Components considered were Population (bilateral SNHL, so single sided deafness was excluded), Intervention (UCI), Comparator (no intervention, conventional hearing aids), Outcome (Utilities) and Study Design (observational studies, economic evaluations and randomised clinical trials).

Results:
The search yielded 499 publications from which 11 studies met the inclusion criteria. The majority of studies were conducted in developed countries. Observational studies followed by economic evaluations were the most common study designs. All studies assessed multi-attribute utility instruments and all primarily used the Health Utilities Index Mark 3 (HUI3). Two studies also reported Euro-QoL 5-Dimension utility weights. All studies showed an improvement in QoL after cochlear implantation. Compared to pre-operative QoL, the mean improvement in HUI3 ranged from 0.089 to 0.3 one-year post implantation. The majority of identified studies reported a mean utility gain of >0.2, demonstrating significant and clinically meaningful improvements in QoL.

Conclusion:
This systematic literature review demonstrated that cochlear implantation in adults with severe to profound SNHL significantly improves QoL, and the HUI3 was the predominant tool used to measure improvements in QoL.

Keywords : Systematic literature review, Health-related quality of life, Cochlear implant

Music Perception & QOL

PP 232

Voice Quality Improvement in Children with Cochlear Implants/Hearing Aids after Musical Training Program

Son A CHANG[1], Sujin SHIN[2], Aeri WON[1], Sol YOON[1], Young-Myoung CHEN[1]

[1]Soree Rehabilitation Center, Soree Ear Clinic, Korea
[2]Communication Sciences and Disorders, University of Redlands, USA

Introduction
In children, music perception and production are important as there are numerous benefits in many areas such as language and cognitive development. In previous research, music perception skills after cochlear implantation (CI) have been reported improved compared to pre-implantation even though CI signal processing is limited to carry musical signals (McDermott, 2004). When it comes to music production, only few studies suggested limited musical production skills after CI (Nakata et al., 2006; Mao et al., 2013). To better understand how to facilitate music skills, more research is needed, especially focusing on the benefit of music training programs. In this study, we preliminarily investigated the benefits of musical performance program in children with CIs/HAs by comparing vocal performances before and after the music program.

Methods
Participants were 14 children who enrolled in 7-week classical music program. 11 participants were using bilateral CI and 3 participants were using acoustic stimulation via hearing aid variation with CI. Participants were between four to ten years old and evenly distributed in their gender (7 girls, 7 boys). Participants' voice parameters were collected before and after program using Praat software program and statistically analyzed using JASP. The vocal parameters were average pitch and loudness, jitter, shimmer, and NHR (Noise to Harmonic Ratio).

Results
As results, post-program improvement was found in intensity $t(5)=5.014$, $p<0.01$, and shimmer $t(5)=5.029$, $p<0.01$ compared to pre-test. There were no significant pre-post changes in other parameters, including average pitch, jitter, and NHR.

Keywords : Voice Parameters, Music Training Program, Cochlear Implants

Music Perception & QOL

PP 233

Music perception performance of Cochlear Implant recipients

Yen Jung PAN[1], Mei Ju HUANG[1,2], Chi Ching LIN[2], Kuan Ju CHEN[2], Kuan Hua CHEN[1,2], **Kuang Chao CHEN[1,2]**

[1]Otolaryngology Department, China Medical University Hospital Taipei Branch, Taiwan
[2]Holistic Hearing Health Center, China Medical University Hospital, Taiwan

Background and Aim:
Music perception ability in cochlear implant subjects has been evaluated by different levels, also developed some music therapy models. However, the rhythm and timbre of popular music are mostly different from traditional music structure. The aim of this study is to explore the comparison of the recognition of popular songs familiar to oneself, the habit of listening to music, and the results of other subjective and objective audiological examinations in different cases
Method:
15 subjects were included, aged from 11 to 35 years old, and gender were chosen randomly. All the subjects have the habit of listening to music before and after cochlear implant surgery. This test was performed after the first activation more than 6 months ago. First was audiology evaluation, which included impedance check, fine-tuning, pure-tone audiometry, sound field audiometry, speech perception tests, questionnaire, and audibility assessment. Second, we will ask the subjects to prepare 10 familiar songs. Recording the correct recognition rate of different music clips, singer gender, and instrument switching.
Results:
The coding strategy, manufacture, sound field threshold, and word recognition scores in quiet and noisy environments showed no significant difference. Most of the subjects increased their listening time after cochlear implant surgery, and part of them can correctly identify the song through beats. Six of the subjects can recognize songs with lyrics. Those who had longer listening time after the cochlear implant activation can result in better song identification.

Keywords : Popular music, Music perception, Cochlear implant

Music Perception & QOL

PP 234

Investigation of perception of melody conformity in post-lingual cochlear implant users

Sayaka OHGANE[1], Masae SHIROMA[1], Yuki SATO[1], Chie OBUCHI[1], Tetsuya TONO[2], Tuneo HARASHIMA[3]

[1]*Department of Speech and Hearing Sciences, International University of Health and Welfare, Japan*
[2]*Otorhinolaryngology, International University of Health and Welfare Hospital, Japan*
[3]*Faculty of Human Sciences Division of Disability Sciences, University of Tsukuba, Japan*

Purpose
The purpose of this study was to investigate how post lingual Adult cochlear implant (CI) users judge the musical conformity of a piece of music by experimentally manipulating the pitch, lyric, and rhythmic information of known melodies.
Materials and Methods
Three CIs and eight normal-hearing adults (NH) participated in this experiment.Three familiar melodies to all participants were selected, and eight artificially edited melody patterns for each original melody under the following three-condition were presented ; 1) two sound source conditions of piano sound with Lyrics and piano sound only, 2) two rhythm conditions of with and without rhythm cues, 3) two scale conditions of normal scale and single-note scale. As for a total of 24 melody patterns, the participants were asked to rate how well those melodies matched to their memories subjectively on a five-point scale (1: not at all fit to 5: very fit) as well as their rationale.
Results and Discussion
NH individuals tended to judge a rating of 4 or higher if the rhythm and scale were the same as the original melodies On the other hand, CI users were inclined to identify the melody as a known one when the lyric was presented even if the rhythm or the scale was monotonous. Some CI users commented that they felt the notes were rising or falling though the scale was monotonous. And some others could not identify piano melodies as known ones, even when the song title was presented in advance, and they claimed that they were either uncomfortable or difficult to match. The experiments revealed that lyric seemed to be the most important clue for CI users to determine even in familiar melodies, at least at present. Further investigation is needed.

Keywords : Music, Memory, Cognitive

Music Perception & QOL

PP 236

Comparison of the quality-of-life benefit received from cochlear implants and hearing aids among hearing-impaired adults

Punam KUMARI[1], **Sumit MRIG**[1], Yashu GOSWAMI[1], Samriddhi NIJHAWAN[1]

[1]Dept of Ent, Audiology & Cochlear Implant, Max Smart Super Speciality Hospital & Sankalp Ent & Cochlear Implant Center, India

Both hearing aids and cochlear implants help people with hearing loss to communicate better. Auditory rehabilitation can reverse the adverse affects of and dysfunction from hearing loss. Hearing aids can improve the overall quality of life (QOL) in hearingimpaired adults. For patients who receive no benefit from hearing aids (HAs), cochlear implants (CIs) provide improved audiologic performance and improvements in QOL. By evaluating the QOL benefit from CIs with that of HAs in hearing-impaired adults, the impact of auditory intervention on the functional gap between CI and HA candidates is assessed. The highest rated subdomain for the CI group was speech production, followed by social interaction, activity limitation, basic sound perception, self-esteem, and advanced sound perception respectively. The majority of CI recipients reported that the CI had met their needs and expectations, and that they were satisfied with their CI. In addition, all but one would recommend a CI to others if they were in a similar circumstance. For the HA group, QOL ratings were highest for the speech production category, followed by self-esteem, activity limitations, social interaction, advanced sound perception, and lastly basic sound perception. HA participants excepted their lives to become easier following implantation and hoped that the CI would enable them to be more sociable, as well as to decrease the stress in their own life. Results showed that CIs had a positive impact on the QOL of CI recipients, where changes occurred in the subdomains of basic and advanced sound perception, speech production, selfesteem, activity limitations, and social interaction. It was also found that the CI recipients' ratings were significantly better, than those on the HA for a CI. In particular, positive effects on QOL provided by the CI were evident where recipients reported improved family life, interconnectedness, communication, and independence.

Keywords : Quality of life, Cochlear implant, Hearing aids

Music Perception & QOL

PP 237

Music Activities and Workshops for Cochlear Implant Users ~ Music activity reports and current music training methods for 22 years ~

Yuji MATSUMOTO[1], Noriko MARUYAMA[2]

[1]Musician, Music Institute For Hearing Impaired, Japan
[2]University Instructor, Showa University, Japan

Our research team has been researching how to enhance music listening skills for cochlear implant users since 2001.
Based on these results, we are conducting musical activities for cochlear implant users. It is called "therapeutic music activities."
I would like to give a presentation on my musical activities.
I will also talk about music training methods which I am currently working on.
The target age of this music activities are infants, elementary school students, junior high school students, high school students, and adults.
The purpose of the music activities is giving cochlear implant users a rich emotional life and improving their quality of life through sound and music.
The methods are conducting therapeutic music activities, which cochlear implant users listen to music and have an experience with playing acoustic instruments. Through this musical activity, the participants can hear music and feel musical satisfactions with the stimulation of sounds.
Even if people have a difficulty hearing sounds, they can bring out their potential "sensitivity to music."
Now, I am currently working on two things. First, practice rhythms with percussion instruments and recognize musical frameworks. Second, practice "humming" as a training for pitch recognition and master the relationship between the sensation that resonates in the body and the pitch.
This music training is also available online.
If my participant frequently continue to work on the training, she will voluntarily do the training and it will lead an improvement in the willingness to identify and hear the sounds.
In addition, one of the participants of this training has perfect pitch. She is a cochlear implant user. I will report on the "tendency of pitch deviation" with the sounds through the cochlear implant.

Keywords : Music activity, Music training, Music

Music Perception & QOL

PP 238

Response shift of subjective hearing related quality of life in cochlear implant patients

Ioana Tereza BRILL[1], Lillian WIGERS[4], Thomas STARK[2], Stefan Michael BRILL[3]

[1]Ent, University Clinic Bochum, Germany
[2]Ent, Helios Munich West, Germany
[3]Germany, Med-el, Germany
[4]Soziales Und Gesundheit, Hochschule Kempten, Germany

Introduction:
Quality of life often improves substantially after cochlear implantation in functional deaf persons. After major changes in life, such as diseases or surgical interventions, the retrospective subjective view on the earlier situation is changing, possibly due to adaptation, changes in internal standards or re-evaluation of priorities. This change is called response shift and has been observed in organisational change, education, various medical fields such as cancer, chronic illness, moderate hearing loss. Whether response shift also occurs in cochlear implantation has not been investigated so far.

Material and methods
Seventeen participants were tested with the Nijmegen Cochlear-Implant Questionnaire preoperatively (timepoint t0) and postoperatively (t1). At t1, additionally a retrospective questioning regarding the preoperative state pre-t1, i.e. a then-test, was conducted. We calculated observed change (post t1 minus pre t0), then-test change (post t1 minus pre-t1) and response shift (pre-t1 minus pre-t0).

Results:
The NCIQ total score was 52.32 ±18.69 for t0, 59.29±14.06 for the retrospective pre-t1 and 67.65±26.02 for post-t1 questioning. The observed change was statistically significant in the general score and all subscores but speech production. The response shift was positive and statistical significant (p>0.5%) in the total score and in the social and psychological domains. In this categories its effect size was moderate (>0.5) and thus clinically significant.

Conclusion:
Resonse shift in cochlear implant adults with severe to profound hearing loss undergoing cochlear implantation does exist and is of clinical significance in the general score and social and psychological domains.

Keywords : Response shift, Cochlear implant, Quality of life

Other Implantable Hearing Devices

PP 239

Hearing performance, safety, and quality of life outcomes of the Baha Attract System in a Chinese cohort with conductive or mixed hearing loss

Ting YE[2], Yun LI[1], Zhaoyan WANG[1], Zhihua ZHANG[1], Cuicui GUO[2], Yin XIA[2], **Hao WU**[1]

[1]Department of Otolaryngology-head and Neck Surgery, Shanghai Ninth People's Hospital, Shanghai Jiaotong University School of Medicine, China
[2]Department of Otolaryngology-head and Neck Surgery, Beijing Tiantan Hospital, Capital Medical University, China

Purpose of study
The Baha Attract System, consisting of an implant plus sound processor coupled via transcutaneous magnets, is designed to provide an aesthetic non-skin penetrating bone conduction hearing implant with minimal aftercare requirements. This study aimed to assess hearing performance, quality of life, and safety of the Baha Attract System, among Chinese recipients with conductive or mixed hearing loss.

Methods
A prospective, two-centre, repeated measures study of participants, aged ≥8 years, unilaterally implanted with the Baha Attract System (N=24). Audiological thresholds using 4-frequency pure tone average (PTA4 at 500, 1000, 2000 and 4000 Hz), and subjective assessments using Speech, Spatial and Qualities (SSQ) and Health Utility Index (HUI3) questionnaires, were conducted at pre- and 3 months post-fitting. Safety parameters were also collected.

Results
Study participants had a mean age of 21.7 years (±13.94), mixed (57%) or conductive hearing loss (43%) and the majority were male (83%).
The primary endpoint of free-field PTA4 hearing threshold after 3 months of Baha Attract System use decreased significantly vs. pre-operative threshold, resulting in a mean hearing threshold gain of 23.07 dB (95% CI: -27.81, -18.34; p-value: <0.0001).
These improvements in hearing thresholds led to improvements in SSQ domain scores by a mean of 3.82 (95% CI: 2.84, 4.80; p-value: <0.0001); 2.78 (95% CI: 1.71, 3.86; p-value: <.0001); and 3.18 (95% CI: 2.14, 4.22; p-value: <.0001), respectively, from pre-op to 3-months post Baha Attract System fitting. Mean HUI3 utility scores also significantly improved: 0.209 (95% CI: 0.131, 0.288; p-value: <0.0001). Incidence and grading of skin irritation was low (n=3); and no serious adverse event related to the device or procedure was reported.

Conclusion
These study results support the clinical safety, hearing performance and patient-related benefits of the Baha Attract System in Chinese patients with conductive or mixed hearing loss

Keywords : Baha, Unilateral, Hearing loss

Other Implantable Hearing Devices

PP 240

Retrosigmoid sinus approach in Bonebridge implantation

Sung Il CHO[1], Gi-Sung NAM[1]

[1]*Department of Otolaryngology - Head and Neck Surgery, Chosun University, Korea*

Bonebridge is a treatment option for conductive hearing loss, mixed hearing loss, and single-sided deafness. Bonebridge implantation is usually performed on a planned site of the mastoid bone with the guidance of a preoperative CT scan. However, the conventional transmastoid approach cannot be performed for patients with canal wall down mastoidectomy. Retrosigmoid implantation is useful in patients with canal wall down mastoidectomy, mastoid pathologies, and congenital deformities. We present a retrosigmoid approach using common surgical landmarks of the occipital bone as a reliable and effective method for hearing improvement by bonebrige implantation.

Keywords : Bone conduction, Implants, Surgery

Other Implantable Hearing Devices

PP 241

Comparison between non-surgical adhesive bone conduction device and surgical active bone conductive implant.

Mario Emilio ZERNOTTI[1], Carolina DER MUSSA[2], Sofia BRAVO-TORRES[2], Maria Fernanda DI GREGORIO[1]

[1]*Otorhinolaryngology, Sanatorium Allende, Argentina*
[2]*Otorhinolaryngology, Luis Calvo Mackenna Hospital, Chile*

INTRODUCTION:
Congenital Aural Atresia (CAA) affects 1-2 in every 10,000 live births, with higher prevalence in Latin America at 5 to 21 of every 10,000 newborns. Conductive hearing loss is the most important aspect. There are surgical and non-surgical alternatives like spectacle frames and rigid and softband to improve it. Active transcutaneous bone conduction implants (BCI) achieve good sound transmission and stimulate the bone directly.
OBJETIVE: to assess the audiological performance and subjective satisfaction of children implanted with an active transcutaneous BCI over one year and to compare the outcomes with a non-surgical adhesive bone conduction device (aBCD) in the same users.
METHODS: Prospective, multicentric study. Audiological performances were evaluated at 1-, 6- and 12-months post-activation, and after a 1-month trial with the non-surgical device.
RESULTS: 10 patients completed all tests. The average PTA4 in the unaided condition was 65 dB HL and improved significantly to 20 dB HL after using the BCI for 12 months. The speech recognition in quiet in the unaided condition was on average 33 %, which improved significantly of 99 % with the BCI and 91 % with the adhesive BCD could be achieved.
CONCLUSIONS: The adhesive BCD demonstrated sufficient hearing improvement and subjective satisfaction, thus is a good solution for hearing rehabilitation if surgery is not desired or not possible. If surgery is an option, the bone conduction implant is the superior device in terms of hearing outcomes, particularly in background noise and subjective satisfaction.
Key words: aural atresia, bone conduction device, conductive hearing loss

Keywords : Aural atresia, Bone conduction device, Conductive hearing loss

Other Implantable Hearing Devices

PP 242

Speech Performance and Subjective Satisfaction of Active Middle Ear Implant in Congenital Aural Atresia

Farid ALZHRANI

King Abdullah Ear Specialist Center (kaesc), King Saud University, Saudi Arabia

Objectives: To evaluate the safety, speech performance in noise, and subjective satisfaction of patients with congenital aural atresia (CAA) implanted with the active middle ear implant.

Methods: A retrospective study includes 13 patients (15 ears) implanted with middle ear implants with different methods of floating mass transducer attachment. In 6 ears, the FMT was coupled with the short process of incus; in 8 ears, the clip coupler was used; and in one ear, the round window coupler was used. Patients were assessed preoperatively, and at one, three, and six months postoperatively. The assessment includes Pure Tone Average (PTA4), Speech Reception Threshold (SRT), and Speech Discrimination Score (SDS). The Speech Spatial and Qualities of Hearing scale (SSQ12) was also used to evaluate the satisfaction levels

Results: The mean aided PTA4 using Vibrant Sound Bridge (VSB) was 26.44 ±4.03 dB HL compared to 61.88 ±1.53 dB HL unaided. The SDS in quiet improved significantly (p=0.002) from 51% (±19.17%) to 94.60% (±4.43%). Furthermore, there was a significant improvement in SDS in noise (p=0.008), and SSQ12 responses (p <0.0001).

Conclusions: Patients with hearing loss due to CAA can substantially benefit from VSB, with highly satisfactory subjective results and a negligible rate of complications.

Keywords : Active Middle Ear Implant, Congenital Aural Atresia, Vibrant Sound Bridge

Other Implantable Hearing Devices

PP 243

The Bonebridge BCI 602 Active Transcutaneous Bone Conduction Implant in Children: Objective and Subjective Benefits

Piotr Henryk SKARZYNSKI[1,2,3,4], Katarzyna Beata CYWKA[1], Bartlomiej KROL[1], Henryk SKARZYNSKI[1]

[1]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[2]Heart Failure and Cardiac Rehabilitation Department, Faculty of Dental Medicine, Medical University of Warsaw, Poland
[3]Institute of Sensory Organs, Institute of Sensory Organs, Poland
[4]University of Maria Curie Sklodowska, University of Maria Curie Sklodowska, Poland

The Bonebridge hearing implant is an active transcutaneous bone conduction implant suitable for various types of hearing loss. It was launched in 2012 as the BCI 601. With new size and shape, the BCI 602 can be used in patients previously excluded due to insufficient anatomical conditions. The purpose of this study is to evaluate the objective and subjective benefits of the new BCI 602 in children who have conductive or mixed hearing loss.
The study group included 22 children aged 8-18 years (mean age 14.7 years) who had conductive or mixed hearing loss. All patients were implanted unilaterally with the BCI 602. PTA, speech recognition tests (in quiet and noise), and free-field audiometry were performed before and after implantation. Word recognition scores were evaluated using the Demenko and Pruszewicz Polish Monosyllabic Word Test, and speech reception thresholds in noise were assessed using the Polish Sentence Matrix Test.
The subjective assessment of benefits was carried with the Abbreviated Profile of Hearing Aid Benefit (ABHAB) questionnaire.
After BCI 602 implantation all patients showed statistically significant improvement in hearing and speech understanding. The mean word recognition score (WRS) changed from 12.1% before implantation to 87.3% after 6 months. Mean speech reception threshold (SRT) before implantation was +4.79 dB SNR and improved to -1.29 dB SNR after 6 months. All patients showed stable postoperative results. The APHAB questionnaire showed that difficulties in hearing decreased after implantation. Preoperative scores (M = 35.7) were significantly worse than postoperative scores at 6 months (M = 25.7).
The study confirms that the BCI 602 is an innovative and effective solution especially for patients with conductive and mixed hearing loss due resulting from anatomical ear defects. The BCI 602 system provides valuable and stable audiological and surgical benefits. Subjective assessment also confirms the effectiveness of the BCI 602.

Keywords : Bone conduction, Children, Conductive and mixed hearing loss

Other Implantable Hearing Devices

PP 244

Implantation of two generations of Bonebridge in children and after mastoid obliteration with bioactive glass S53P4

Piotr Henryk SKARZYNSKI[1,2,3,4], Katarzyna Beata CYWKA[1], Bartlomiej KROL[1], Andrzej PASTUSZAK[1], Marek POROWSKI[1], Henryk SKARZYNSKI[1]

[1]*World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland*
[2]*Heart Failure and Cardiac Rehabilitation, Faculty of Dental Medicine, Medical University of Warsaw, Poland*
[3]*Institute of Sensory Organs, Institute of Sensory Organs, Poland*
[4]*University of Maria Curie Sklodowska, University of Maria Curie Sklodowska, Poland*

After radical surgery for chronic cholesteatoma (CWD mastoidectomy), patients have the option to have the posterior wall of their external auditory canal surgically reconstructed with S53P4 bioactive glass. The procedure eliminates some of the restrictions related to having a postoperative cavity and extends the options for a hearing prosthesis. If classic reconstruction is not possible and a hearing aid is not used, we suggest use of a Bonebridge implant.
This study describes, over 18 months of follow-up, 16 patients after a two-stage surgical procedure: first obliteration of the mastoid cavity with bioactive glass and then Bonebridge implantation. There were 7 patients who received the first generation of implant (BCI 601) and 9 who used the second (BCI 602).
During the observation period, no serious complications were found. The study demonstrated the safety and validity of the procedures, and confirmed the safety of using S53P$ bioactive glass in otosurgery (antibacterial effect, nonrecurrence of cholesteatoma, no effect on the inner ear). The audiological benefits expected from using the Bonebridge implant processor were also confirmed.
It is concluded that, after reconstructing the posterior wall of the external auditory canal with bioactive glass, two-stage implantation of a Bonebridge implant in a typical site is a safe solution for patients who have difficult anatomical conditions following their CWD mastoidectomy.

Keywords : Bioactive glass, Mastoid obliteration, Bonebridge

Other Implantable Hearing Devices

PP 245

Effectiveness and stability of audiological, functional and surgical outcomes after implantation of an active bone conduction device

Katarzyna Beata CYWKA[1], **Piotr Henryk SKARZYNSKI**[1,2,3], Bartlomiej KROL[1], Stavros HATZOPOULOS[4], Henryk SKARZYNSKI[1]

[1]*World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland*
[2]*Heart Failure and Cardiac Rehabilitation, Faculty of Dental Medicine, Medical University of Warsaw, Poland*
[3]*Institute of Sensory Organs, Institute of Sensory Organs, Poland*
[4]*Audiology and Ent, University of Ferrara, Italy*

Purpose: to assess the effectiveness and safety of a bone-conduction implant, the Bonebridge BCI 602, in adults with conductive or mixed hearing loss.
Methods: the study group included 42 adults who had either conductive or mixed hearing loss. All patients underwent Bonebridge BCI 602 implant surgery. Before and after implantation, pure-tone audiometry, speech recognition tests (in quiet and noise), and free-field audiometry were performed. Word recognition scores were evaluated using the Polish Monosyllabic Word Test. Speech reception thresholds in noise were assessed using the Polish Sentence Matrix Test. Subjective assessment of benefits was done using the APHAB (Abbreviated Profile of Hearing Aid Benefit) questionnaire.
Results: the APHAB questionnaire showed that difficulties in hearing decreased after BCI 602 implantation. Both word recognition in quiet and speech reception threshold in noise were significantly better after BCI 602 implantation and remained stable for at least 12 months. A significant advantage of the device is a reduced time for surgery while maintaining safety. In this study, the mean time for BCI 602 implantation was 28.3 min ± 9.4.
Conclusions: Bonebridge BCI 602 implant is an effective hearing rehabilitation device for patients with conductive or mixed hearing loss. Patient satisfaction and audiological results confirm its efficacy and safety. Its new shape and dimensions allow it to be used in patients previously excluded due to insufficient or difficult anatomical conditions.
Keywords: Bone conduction; Bone conduction implant; Bonebridge; Hearing loss; Partial deafness treatment; Quality of life; Transcutaneous hearing implant.

Keywords : Bone conduction implantoutcomes, Active, Outcomes

Other Implantable Hearing Devices

PP 246

Self-Rated Benefits of Auditory Performance after Bonebridge Implantation in Patients with Conductive or Mixed Hearing Loss, or Single-Sided Deafness

Anna RATUSZNIAK[1], **Piotr Henryk SKARZYNSKI**[1,2,3], Elzbieta GOS[1], Katarzyna Beata CYWKA[1], Henryk SKARZYNSKI[1]

[1]World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland
[2]Heart Failure and Cardiac Rehabilitation, Faculty of Dental Medicine, Medical University of Warsaw, Poland
[3]Institute of Sensory Organs, Institute of Sensory Organs, Poland

The Bonebridge implant can be a satisfactory solution for patients with conductive or mixed hearing loss (CHL or MHL), or with single-sided deafness (SSD). The aim of the study was to assess patients' self-reported benefits with the Bonebridge and characterize the relationships between pre-implantation audiometric data, auditory functioning, and satisfaction after implantation. A focus was to see whether different types of hearing loss were associated with particular benefits. The study sample consisted of 81 patients. Procedures comprised pure tone audiometry before implantation, the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire, and a structured interview asking about satisfaction. Statistically significant improvements after implantation were found in all groups (CHL, MHL, SSD) on the APHAB questionnaire. In the structured interview, patients with SSD were the least satisfied. No significant correlation was found between pre-operative air-bone gap and bone conduction thresholds or with APHAB score. Bonebridge implantation is beneficial to patients with CHL or MHL, or with SSD. Assessment of patients for Bonebridge implantation is complex, and audiometric data should be complemented by patient-reported outcomes to provide deeper insight into their individual needs and attitudes.

Keywords : Bone conduction, Hearing implant, Self-related benefits

Other Implantable Hearing Devices

PP 247

Speech perception and hearing effort using the new SAMBA 2 active middle ear implant audio processor

Torsten RAHNE[1], Laura FRÖHLICH[2], Luise WAGNER[1], Miram WILLHAUS[3], Alexander MÜLLER[4]

[1]Department of Otorhinolaryngology, Head and Neck Surgery, University Hospital Halle (saale), Germany
[2]Department of Otorhinolaryngology, University Hospital Bonn, Germany
[3]Med-el Germany, Med-el Gmbh, Germany
[4]Orl Department Friedrichshain Clinic, Vivantes Hearing Center Berlin, Germany

Purpose: The Vibrant Soundbridge (VSB) was introduced in 1996, and the fourth generation of the audio processor recently released. This clinical study evaluates the audiological performance and subjective satisfaction of the new SAMBA 2 audio processor compared to its predecessor, SAMBA.
Method: Fifteen VSB users tested both audio processors for approximately 3 weeks. Air conduction and bone conduction thresholds and unaided and aided sound field thresholds were measured with both devices. Speech performance in quiet (Freiburg monosyllables) and noise (OLSA) was evaluated as well as subjective listening effort (ACALES) and questionnaire outcomes (SSQ12 and APSQ). In addition, data from 16 subjects with normal hearing were gathered on sound field tests and ACALES.
Results: Both audio processors showed substantial improvement compared to the unaided condition. The SAMBA and SAMBA 2 had comparable performance in sound filed thresholds, while the SAMBA 2 was significantly better in speech in quiet, speech in noise, reduced listening effort, and improved subjective satisfaction compared with the SAMBA.
Conclusion: The SAMBA 2 audio processor, compared to its predecessor SAMBA, offers improved performance throughout the parameters investigated in this study. Patients with a VSB implant would benefit from an upgrade to SAMBA 2.

Keywords : SAMBA 2, Soundbridge, Speech Perception

Other Implantable Hearing Devices

PP 248

Performance with a new bone conduction implant audio processor in patients with single-sided deafness

Wilhelm WIMMER[1,3], Tom GAWLICZEK[1], Alexander HUBER[2], Marco CAVERSACCIO[1], Martin KOMPIS[1]

[1]Department of Ent, Head and Neck Surgery, Bern University Hospital, University of Bern, Switzerland
[2]Department of Otorhinolaryngology, Head and Neck Surgery, University Hospital Zurich, Switzerland
[3]Klinikum Rechts Der Isar, Department of Otorhinolaryngology, Technical University of Munich, Germany

The SAMBA 2 BB is a new audio processor for the Bonebridge® implant. It features automatic listening environment detection, which reduces interfering speech and background noise and focuses on target speech. This study aimed to evaluate the audiological benefits of the SAMBA 2 BB (AP2) and compare them with its predecessor, the SAMBA BB (AP1), for single-sided sensorineural deafness (SSD) patients.

Seven participants with SSD wore each device for two weeks, and aided sound field hearing thresholds, speech understanding in quiet and noise, and subjective evaluations were conducted. The study found that the AP2 provided improved speech understanding in quiet, with an average increase of 17% compared to the AP 1 aided condition ($p = 0.007$). Additionally, in both complex noise scenarios (speech from the front or from the ipsilateral side of the implanted ear), the AP2 led to improved speech reception thresholds by 1.2 dB (S0NMIX, $p = 0.032$) and 2.1 dB (SIPSINMIX, $p = 0.048$) compared to the AP1. The subjective evaluations, which included the SSQ12, APSQ, and BBSS questionnaires, did not reveal statistically significant differences, except for an improved APSQ usability score with the AP2.

Our findings suggest that clinicians can expect SSD patients to benefit from the AP2 in both quiet and complex noise scenarios when compared to the older AP1. The study highlights the importance of automatic listening environment detection for improving speech understanding in challenging environments.

Keywords : SAMBA 2, Bonebridge, Unilateral deafnes

Other Implantable Hearing Devices

PP 249

Comparison of efficacy of Transcutaneous active and passive Bone Conduction Hearing Devices

Himanshu SWAMI

Ent Department, Army Hospital Research and Referral, India

Bone Anchored Hearing Devices (BAHD) are primarily indicated in conductive hearing loss. Over a period of time the indications have expanded to include more challenging mixed hearing loss and single sided deafness.

The percutaneous devices had played important role in auditory rehabilitation in set of patients where conventional hearing aid cannot be used. However, there are significant issues of fixture failure and skin complications associated with abutment in percutaneous devices. Transcutaneous BAHD offers less skin complications and better cosmetic results in comparison with percutaneous BAHD. In view of this, all suitable patients prefer transcutaneous BAHD over percutaneous BAHD if they meet the audiometry criteria.

There are three commercially available transcutaneous devices in India. The passive transcutaneous BAHD Attract (AT, Cochlear, Sydney, Australia) and two active transcutaneous BAHD namely Bonebridge (BB, MedEl, Innsbruck, Austria) and the recently introduced, Cochlear Osia (Cochlear, Mölnlycke, Sweden).

In our study we accrued 10 patients who underwent passive BAHD (AT) and another set of 10 patients active BAHD (BB).

The outcomes were measured in remains of functional gain in lower ie 0.5 KHz, 1 KHz and 2 Khz and higher frequencies ie 4 KHz, 6KHz and 8KHz and two groups were compared. The quality of hearing was measured using Speech, Spatial & Quality of hearing scale and by Hearing Implant Sound Quality Index.

The results implied better Audiological outcomes both in lower and higher frequencies which could be attributed to soft tissue attenuation in AT. There was also significant improvement in quality of hearing using BB.

Keywords : Bone Anchored Hearing Devices, BAHA Attract, Bone Bridge

Other Implantable Hearing Devices

PP 250

Early Clinical Experience with the OSIA Bone Conduction Implant System in Australia

Jay LEE

Attune Hearing Implant Centre, Attune Hearing, Australia

Purpose: OSIA is the most recent bone conduction implant device available in Australia for hard-of-hearing people. with conductive or mixed hearing loss or SSD.
Attune Hearing Implant Centre is one of the leading private hearing implant programs in Queensland. In this presentation, the indications for using this implant, the clinical experience, and patients' outcomes and feedback will be shared.

Method: A retrospective analysis was carried out of 15 OSIA recipients with conductive, mixed, or unilateral hearing loss (SSD). The outcome was measured in various formats including pure tone and aided speech testing, International Outcome Inventory (IOI), and NAL Client Oriented Scale of Improvement goals (COSI).

Result: All recipients except one recipient reported a significant improvement in their hearing and life quality. The degree of reported improvement varied from slightly to extremely. Outcome measures were consistent with the reported benefits.

Conclusion: Early clinical experience with the OSIA bone conduction implant device has been positive. Uptake and satisfaction were high in recipients. OSIA is a great addition and option for hard-of-hearing people with conductive, mixed, and SSD.

Keywords : OSIA, Bone conduction implant, Clinical experience

Other Implantable Hearing Devices

PP 251

Hearing Habilitation with a Cochlear Implant and an Auditory Brainstem Implant in a Child with Bilateral Cochlear Nerve Aplasia

Pei Shan LEEM[1], Kaijun TAY[1], Mandy PHUA[1], Vanessa TAN[1]

[1]Department of Otolaryngology, Singapore General Hospital, Singapore

Objectives: To report on the outcomes of hearing habilitation through combination of auditory brainstem implantation (ABI) and cochlear implantation (CI) in a child with bilateral cochlear nerve aplasia
Study design: Case study

Patient: X was a 7 month old child referred to our clinic for hearing loss. After extensive investigation including Magnetic resonance Imaging and transtympanic electrical auditory brainstem response, he was diagnosed with cochlear nerve aplasia.

Intervention: X was implanted first with an ABI at 16 months old and subsequently with a CI at 5 years old for bilateral hearing

Main outcome measures: Aided sound field thresholds, Speech Perception test, Category of Auditory Performance (CAP) score

Results: At 10 years post ABI and 5 years post CI, X had aided sound field thresholds obtained between 20dB to 35dB on right (ABI side), and 20dB to 65dB on left (CI side). He had aided speech scores at 50dB using recorded Arthur Boothroyd (AB) words: Right 83%, Left 22% and binaural: 83%. 2/12 electrodes of his ABI do not have auditory stimulation. Main speech benefits were derived from his ABI side. He does not report non auditory stimulation using both current maps of ABI and CI.

He has a CAP score of 6 out of 7 whereby he understands conversation without lip reading. His Speech Intelligibility Rating (SIR) is 5 out of 5 whereby connected speech is intelligible to all listeners. X reported significant benefits with bilateral inputs and uses both his implants during all waking hours.

Conclusion: Bilateral hearing habilitation can be achieved using a CI and ABI concurrently. Cochlear nerve aplasia remains a challenging clinical problem. More data is required to clearly delineate the ideal treatment option. The outcomes of this patient provide further evidence for early Auditory Brainstem implantation and Cochlear implantation on contralateral ear.

Keywords : Auditory brainstem implant, Cochlear nerve aplasia, Cochlear implantation

Other Implantable Hearing Devices

PP 252

Vibrant Soundbridge Implantation prior to Auricular Reconstruction with Unilateral Microtia-Atresia

Hidekane YOSHIMURA[1], Masahiro TAKAHASHI[2], Satoshi IWASAKI[2], Jun SHINAGAWA[1], Yutaka TAKUMI[1], Ikkei TAKASHIMIZU[3], Fumio NAGAI[3], Takatoshi YOTSUYANAGI[4], **Shin-Ichi USAMI[5]**

[1]Department of Otorhinolaryngology - Head and Neck Surgery, Shinshu University School of Medicine, Japan
[2]Department of Otorhinolaryngology, International University of Health and Welfare Mita Hospital, Japan
[3]Department of Plastic and Reconstructive Surgery, Shinshu University School of Medicine, Japan
[4]Department of Plastic and Reconstructive Surgery,, Sapporo Medical University School of Medicine, Japan
[5]Department of Hearing Implant Sciences, Shinshu University School of Medicine, Japan

Unilateral congenital aural atresia (UCAA) is often associated with microtia. In such patients, the middle ear and ossicles are affected to varying degrees in patients with CAA, leading to conductive hearing loss. To address this, an active middle ear implant, known as a vibrant soundbridge (VSB), has been increasingly used to improve hearing ability. Most children with microtia require plastic reconstruction for cosmetic and functional benefits. However, auriculoplasty using a rib graft should be performed in patients older than 10 years as treatment at a younger age has unfavorable outcomes in terms of both the reconstructed ear and the donor-site thorax. Hence, for early hearing rehabilitation, VSB implantation should be performed in advance of the plastic reconstruction of the auricle, which is challenging. Here, we demonstrate a 9-year-old case of UCAA receiving VSB implantation prior to auricular reconstruction. In cooperation with the plastic surgeons, we performed VSB implantation so as not to interfere with the costal cartilage grafting associated with the auriculoplasty, leading to in significantly greater hearing ability without impairing auditory function. Subsequently, 17 and 24 months after VSB implantation, plastic reconstruction of the auricle was safely performed in two operative steps. Our findings suggested that these interventions can provide substantial hearing improvement in safe conditions and open new strategies for earlier hearing rehabilitation in UCAA children. To achieve a successful outcome, cooperation between otologists and plastic surgeons is essential.

Keywords : Congenital aural atresia, Middle ear implant, VSB

Other Implantable Hearing Devices

PP 253

The role of maximum output and necessary dynamic range in active middle ear implants

Hannes MAIER[1,2], Thomas LENARZ[1,2], Susan BUSCH[1,2]

[1]Otorhinolaryngology, Hannover Medical School, Germany
[2]Hearing4all, Cluster of Excellence, Germany

Introduction: The frequency specific maximum output (MO) of acoustic devices, such as bone conduction devices and active middle ear implants, is crucial for speech intelligibility and patient benefit. Technical limitations may prevent coverage of patients' entire residual input dynamic range due to low MO. Here, we determined individual MO from clinical routine data with the Vibrant Soundbridge (VSB) and an MO-based analysis of how much coverage of the dynamic range is required for sufficient speech intelligibility.
Methods: In retrospective 69 patients, implanted with the VSB at the round window (RW) at our center were analyzed. Individual MO was determined and the dynamic range (DR) was calculated for each patient and frequency. Finally the word recognition score (WRS) in quiet was correlated to the absolute and weighted DR across the frequencies 0.5, 1.0, 2.0 and 4.0 kHz.
Results: The MO was similar for different coupling types with a maximum at 1.5 kHz. The average MO over speech relevant frequencies (0.5, 1.0, 2.0, 4.0 kHz) was between 71.6 ± 13.8 dB HL to 82.6 ± 7.3 dB HL for different coupling modalities to the RW. Despite minor differences in avg. MO, the variability between coupling modalities was pronounced. Word recognition scores in quiet (n=67) improved with increasing dynamic range and were strongly correlated to DR (r = 0.962 - 0.964). Performance increased significantly above a DR of 20 dB with a mean WRS of ≥ 77.3% (± 16.1% standard deviation) compared to a mean WRS of ≤ 51.7% (± 29.6 dB standard deviation) below 20 dB DR.
Conclusion: The individual MO and DR can be successfully determined from patients' clinical data only, permitting an in-depth analysis of patient outcomes. Our approach allows the prediction of necessary dynamic range for the definition of evidence-based frequency-specific indication limits.

Keywords : Active middle ear implant, Vibrant Soundbridge, Dynamic range

Other Implantable Hearing Devices

PP 254

Can we compare outcomes between different hearing solutions for Unilateral Profound Sensorineural Hearing Loss?

Stephanie CARRICK[1], Karin CARVALHO[2], Ulrika PETERSSON[3], Helén LAGERKVIST[3]

[1]Audiology, Oticon Medical, Australia
[2]Clinical Affairs, Oticon Medical, Denmark
[3]Clinical Evidence, Oticon Medical, Sweden

Introduction: Different solutions are available for patients with conductive, mixed hearing losses and single-sided deafness (SSD). These include bone conduction devices, middle ear implants, middle ear surgery, air conduction hearing devices, CROS/Bi-CROS and cochlear implants for SSD patients. Is it possible to determine which solution yields the best outcome for that hearing loss configuration? Can the different hearing solutions be compared?

Aim: The aim of this presentation is to compare evidence for treatment options in terms of audiological outcomes and safety.

Methods: Literature searches were performed to identify state-of-the-art treatments and audiological and safety outcomes for patients with conductive, mixed hearing losses and SSD. Audiological parameters evaluated were: average functional and effective gain. Safety parameters were categorised as: major (life-threatening, causing permanent disability/damage or a hospitalization of significant duration (> 24 hours), requiring surgery (including implants loss for percutaneous implants) or minor (any complications not meeting the criteria of being major).

Results: The literature review showed that bone conduction devices were at least as successful as both middle ear surgery and middle ear implants, in giving hearing benefit to the patient. Audiological outcome data is lacking for the most common treatment: hearing aids and CROS aids. Furthermore, the safety profile of the different treatment options demonstrated that middle ear surgery and middle ear implants had a less favourable risk profile than bone conduction systems. The potential benefit of cochlear implants for SSD patients cannot be estimated using this method.

Conclusion: All treatment options described can give the patient hearing benefit, but to different degrees and with different safety risk profiles associated with the treatment. There are gaps in the audiological data for several solutions. This methodology works as a comparison for many treatment options for different hearing loss configurations. Detailed results will be given during the presentation.

Keywords : Single-sided deafness, Unilateral profound, Outcomes

Other Implantable Hearing Devices

PP 255

THE GREY ZONE BETWEEN COCHLEAR IMPLANTS AND AUDITORY BRAINSTEM IMPLANTS

Mohan KAMESWARAN

Ent, Madras Ent Research Foundation, Chennai, India

Objectives: Cochlear Implants (CI) are indicated in patients with severe - profound hearing loss unresponsive to amplification with hearing aids. Auditory brainstem implants (ABI) are indicated in Neurofibromatosis type II, cochlear and cochlear nerve aplasia, Michel aplasia, ossified cochlea, bilateral temporal bone fractures in which a cochlear implant cannot be used. However, situations are encountered where the decision to use a cochlear implant or an ABI is not clear cut.
Methods: This is a retrospective analysis of the author's experience of a spectrum of patients with hypoplasia of the cochlear nerve, narrow IAM, NF2 patients who underwent tumor removal with cochlear nerve preservation, bilateral severe labyrinthitis ossificans, dysplastic cochlea which were grey zones between cochlear and auditory brainstem implants, unlike conventional indications for CI or ABI.
Results: Advances in electrophysiological tools such as aided cortical auditory evoked potentials, transtympanic electrically evoked auditory brainstem responses and high resolution radioimaging have helped to evaluate such grey zones and have helped choose the appropriate management option - CI or ABI.
Conclusion: In difficult situations where there are no clear cut solutions, the surgeon has to take crucial decisions on whether a particular patient requires a cochlear implant or an auditory brainstem implant. Transtympanic electrically evoked auditory brainstem responses (TTEABR) has emerged as a useful investigation to decide on CI versus ABI.

Keywords : Cochlear Implant, Auditory Brainstem Implant, Grey Zone

Other Implantable Hearing Devices

PP 256

Baha implantation in patient with the external auditory canal obstruction due to calcium pyrophosphate deposition disease originating in the temporomandibular joint

Nao NOJIRI[1], Yusuke YAMADA[1], Yusuke MATSUDA[1], Tetsuya TONO[1]

[1]*Otorhinolaryngology, International University of Health and Welfare School of Medicine, Japan*

Calcium pyrophosphate deposition (CPPD) disease originated in temporomandibular join (TMJ) is very rare. The aim of this paper is to present our experience with Baha for the management of bilateral mixed hearing loss in a patient with CPPD involving the TMJ and the external auditory canal.
Case: A 71-year-old man had been followed by an oral surgeon under the tentative diagnosis of CPPD in the right TMJ since age 68. The patient was referred to our department because of bloody discharge from his right ear. The external auditory canal was found to be obstructed by the preauricular mass. CT showed that a high-density mass of 5 cm in diameter arose from the right TMJ and extended into the external auditory canal and the middle ear cavity. The middle ear on the left side appeared to be normal. The pure tone audiogram showed bilateral mixed hearing loss with the AC/BC thresholds, 82.5 dB/30 dB on the right and 70.0 dB/30.0 dB on the left. The monosyllable recognition score was 55% (right) and 30% (left) respectively. After partial resection of the CPPD mass from the external auditory canal, the tympanic and epitympanic cavities, a titanium implant was successfully placed posterior to the CPPD mass. Postoperative hearing results with Baha at one year were good with 27.5 dB in threshold and 70% in monosyllable score. Pathological examination revealed that the specimen was entirely composed of calcified material deposits, with some indistinct crystal structures. Thin film X-ray diffraction (XRD) analysis was performed to confirm the diagnosis, and calcium pyrophosphate (CPP) crystals were identified from the crystals.
Conclusion: The XRD analysis allowed us definitive diagnosis of CPPD in this patient. Due to the necessity of future MRI for coexisting CPPD, Baha was useful in the management of bilateral mixed hearing loss in this patient

Keywords : Baha, CPPD, X-ray diffraction

Other Implantable Hearing Devices

PP 257

PRE-SURGICAL PLANNING FOR BONEBRIDGE USING OTOPLAN FOR BETTER SURGICAL OUTCOMES

Sanjiv BADHWAR[1], **Sailaja TIMMARAJU**[2], Amit SAHGAL[3], Faizan RAHMANI[3]

[1]*Ent Services, Kokilaben Dhirubhai Ambani Hospital, India*
[2]*Education & Traiining, Med-el, India*
[3]*Ent Services, Kokilaben Dhirubhai Ambani Hospital, India*

INTRODUCTION:
BONEBRIDGE (BB) is an active transcutaneous bone conduction device, a surgical treatment option for individuals with conductive, mixed, and single sided deafness. Planning for BB surgery requires estimation of the temporal bone thickness as the bone conduction – floating mass transducer (BC-FMT) placement requires drilling of the temporal bone. Care must be taken to avoid the risk of injuring sigmoid sinus or the dura during the drilling of the temporal bone. CT Scan study can be used to understand the thickness of temporal bone at Sino-dural angle and Retrosigmoid position, common sites of placement of BC- FMT. However, only imaging is not sufficient to estimate the temporal bone thickness. A device specific software is extremely useful to provide the temporal bone thickness, and to simulate the position of the BC FMT for precision in surgery.
METHOD:
CT scans of the subjects that underwent BB surgery at our hospital were selected for this study. OTOPLAN, a radiological planning software, developed by Cascination AG and MED-EL, was utilized to analyse temporal bone thickness, for automatic 3D reconstruction and to identify placement site of BC-FMT in all 4 patients. Sigmoid sinus in temporal bone was also mapped to understand the proximity of this structure to the temporal bone surface. Simulation of the BC-FMT on the chosen site of placement and the points of cortical screws were marked as well.
RESULTS & CONCLUSION:
OTOPLAN is an effective tool in identifying the site of BC-FMT placement with precision. This has reduced the duration of surgery and has reduced risk of injury to the underlying critical structures. Further, simulation with the BC-FMT on the 3D reconstructed image with measurements from tip of mastoid and ear canal gave a clear understanding of the future site of pinna reconstruction in cases with external ear malformations.

Keywords : BONEBRIDGE, OTOPLAN, BONE CONDUCTION IMPLANT

Other Implantable Hearing Devices

PP 258

Hearing Rehabilitation with Osia®2 in patients who underwent failure with Bonebridge® in Unilateral Hearing Loss

Gerard Francia LAPINA[1], **In Seok MOON[1]**

[1]Otorhinolaryngology-head and Neck Surgery, Yonsei University College of Medicine, Korea

Introduction: Various types of bone conduction hearing aids have been widely used for hearing rehabilitation for the last 30 years. Among them, the recently launched Osia®2 system is a new active transcutaneous bone conduction implant system using piezoelectric effect. This can be expected to deliver more efficient sound transmission, overcome sound attenuation, and improve high-frequency hearing than conventional passive transcutaneous hearing aids, and is considered to be cosmetically superior to percutaneous hearing aids. Moreover, thick shield can prevent device failure. We analyzed the hearing outcome of Osia®2 and compared to the results of Bonebridge®.

Methods: We experienced four cases of Osia®2 implantation in patients who got device failure after Bonebridge® implantation. Device failure were happened from 30months to 49 months after Bonebridge implantation. Comparison of postoperative pure tone threshold and Korean Hearing in Noise Test (K-HINT) score after implantation. Operation time and perioperative pain measured using a visual analogue scale (VAS) were also compared.

Results: All of them had no complications after Osia®2 or Bonebridge® implantation. Patients showed similar improvement in pure tone threshold in both group. But better Korean Hearing in Noise Test (K-HINT) score was shown in Osia®2 group. Furthermore, Operation time is shorter and pain is less in Osia®2 implantation group.

Conclusion: Osia®2 can be better alternative than conventional bone conduction implant.

Keywords : Bone conduction, Hearing, Hearing loss

Other Implantable Hearing Devices

PP 259

Evaluating a new sound processor for a novel active transcutaneous system

Ann-Charlotte PERSSON[1], Åsa NILSSON[2], Karl-Johan FREDÉN JANSSON[3], Sabine REINFELDT[3], Tove ROSENBOM[2], **Marcus HOLMBERG[2]**, Bo HÅKANSSON[3]

[1]Habilitation & Health, Hearing Organization, Gothenburg, Sweden
[2]Clinical Affairs, Oticon Medical Ab, Sweden
[3]Signal Processing and Biomedical Engineering, Chalmers University of Technology, Sweden

The purpose of this study is to confirm the performance of the upcoming Sentio 1 Mini (Oticon Medical AB, Askim, Sweden) sound processor (test device) on users previously implanted with the Bone Conduction Implant (BCI) implant.

The study is a prospective, single-center, comparative investigation using within-subject control design. All subjects (16) previously implanted with the BCI implant were invited for participation within the study. They were previously implanted with the BCI implant between 2012 and 2016 (Reinfeldt et al., 2022). Outcomes measures include audiometry, sound field thresholds (unaided and aided), SSQ12 and preference between test device and previous sound processor. Any adverse events will be collected. The overall follow-up period is 12 months.

A total of 11 subjects were enrolled and fitted with the Sentio 1 Mini sound processor. Average age was 48 years (range: 27-72). Gender distribution was 7 females and 4 males. 6 subjects had conductive and 5 subjects mixed loss on the implanted ear. No adverse events have been reported so far within the clinical investigation. Preliminary 1 month data shows functional improvement with the test device of 32.5 dB. (defined as aided differed from unaided sound field threshold, averaged over 500, 1000, 2000 and 4000 Hz (PTA4)). Effective gain (aided threshold compared to BC thresholds) was 11.9 dB.

In addition, the SSQ12 self-reported data indicate good performance of the Sentio 1 sound processor. A systematic preference scheme showed that a majority of the subjects preferred the test device.

We conclude that the preliminary data show good performance on the Sentio 1 Mini sound processor on subjects previously implanted with the BCI implant. The sound processor is safe to use and there was a preference for using Sentio 1 over their previous sound processor.

Keywords : Bone conduction, Active transcutaneous, Conductive hearing loss

Other Implantable Hearing Devices

PP 260

First Clinical Experience from a Novel Active Transcutaneous Bone Conduction Implant System

Myrthe K.s. HOL[1,2], Emmanuel A.m. MYLANUS[2], Susan ARNDT[3], Peter MONKSFIELD[4], Thomas LENARZ[5], James TYSOME[6], **Marcus HOLMBERG[7]**

[1]Department of Otorhinolaryngology/head and Neck Surgery, University Medical Center Groningen, The Netherlands
[2]Department of Otorhinolaryngology, Radboud University Medical Centre, The Netherlands
[3]Department of Otorhinolaryngology, Head and Neck Surgery, University Medical Center Freiburg, Germany
[4]University Hospitals Birmingham Nhs Foundation Trust, Queen Elizabeth Hospital Birmingham, UK
[5]Department of Otorhinolaryngology, Hannover Medical School, Germany
[6]Department of Otolaryngology — Head and Neck Surgery, Cambridge University Hospitals Nhs Foundation Trust, UK
[7]Clinical Affairs, Oticon Medical Ab, Sweden

Objectives
The objective is to share the first clinical experience from a novel active transcutaneous bone conduction implant system in users with mixed/conductive hearing losses and single sided deafness.
Methods
A multi-center, single-arm, prospective, clinical investigation on the novel active transcutaneous bone conduction implant system (Sentio, Oticon Medical AB, Sweden) is ongoing. So far, 41 out of 50 planned patients have been implanted in all 6 participating clinics (clinicaltrials.gov identifier NCT05166265). This report includes the first observations and clinical reflections on the surgical installation and clinical follow-up for these patients.
Results
The first implanted 20 patients had a mean age of 47 years and with the type of hearing loss being either conductive (n = 14), mixed (n = 4), or single sided deafness (n = 2) on the implanted side. Surgery duration from incision to last suture varied between 45 and 85 minutes, also indicating a surgical learning curve. Implant installations could be done without any specific preoperative planning. Implant performance outcomes and safety profile follow expected patterns after the initial observed follow-up period of 12 months, currently. The poster will include experiences from the 41 implanted patients over a follow-up up to 20 months.
Conclusion
These initial clinical observations indicate that the implant is small and with limited invasiveness to install. Clinical outcomes are promising, without safety-related concerns. More complete conclusions will be available at the time of the conference.

Keywords : Active transcutaneous, Bone conduction, Conductive hearing loss

Public Awareness / Public Health

PP 261

Association between Hearing Loss and the Incidence of Ischemic Stroke: A Nationwide Population-based Study

Subin KIM[1], Eun-Ju JEON[1], Seong-Su LEE[2], Young-Hoon JOO[1], Kyung-Do HAN[3], **Kyoung Ho PARK[1]**

[1]Otolaryngology-head and Neck Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea, Korea
[2]Division of Endocrinology and Metabolism, Department of Internal Medicine, College of Medicine, The Catholic University of Korea, Seoul, Korea, Korea
[3]Biostatistics, College of Medicine, The Catholic University of Korea, Seoul, Korea, Korea

Purpose: This study investigates the statistical relationship between hearing loss and ischemic stroke in South Korea using data from the Korean National Health Insurance Service (KNHIS) database for 2009–2017.

Materials and Methods: A total of 6,438,405 participants who completed the questionnaire of KNHIS were eligible for this study. Physical examinations, laboratory tests, and auditory function was evaluated using pure-tone audiometric testing. The demographic variables included age, gender, obesity, economic status, alcohol consumption, smoking history, and underlying diseases such as diabetes, hypertension, dyslipidemia, and chronic kidney disease.

Results: The participants with hearing loss had significantly higher percentage of diabetes, hypertension, dyslipidemia, and waist circumferences. Hearing loss was remarkable risk factor for ischemic stroke (HR: 1.095; 95% CI: 1.072-1.118). The risk factors for ischemic stroke stratified with demographic factors revealed that the risk of ischemic stroke increased when hearing loss was present irrespective of age, hypertension, and dyslipidemia. Furthermore, hearing loss patients with current smoking history, heavy alcohol consumption and diabetes were more vulnerable to ischemic stroke compared to the subjects with normal hearings.

Conclusion: Hearing loss patients are more likely to be exposed to ischemic stroke compared to normal hearing listeners. Therefore, patients with hearing loss should be aware of ischemic stroke and require education on preventing caridiovascular diseases.

Keywords : Hearing impairment, Ischemic stroke, Myocardial infarction

Public Awareness / Public Health

PP 262

Improving awareness towards paediatric hearing loss in primary care services

Khairunnisak MISRON[1],
Tengku Mohamed Izam TENGKU KAMALDEN[1],
Lukmanul Hakim MISRON[2]

[1]Otorhinolaryngology, Hospital Sultan Ismail, Malaysia
[2]Nuclear Medicine, Advanced Medical and Dental Institute, Malaysia

Introduction: Primary care serves as the first line of defence for many health conditions. The understanding on the importance of early detection of hearing loss among paediatric population is crucial as it might result in delayed speech and language acquisitions with great impact on academic achievement.

Objectives: This study aimed to determine the awareness towards paediatric hearing loss among primary care professionals (PCPs).

Methodology: This was a cross sectional survey among primary care physicians and medical officers in Johor state from October 2021 till April 2022. The QR codes containing self-reported questionnaires were sent to all primary care facilities. The questionnaires comprised of knowledge and current practices in managing hearing loss among paediatric patients in primary care settings.

Results: 505 questionnaires were distributed and the response rate was 23.76%. Although 90.83% of the PCPs agreed that newborn hearing screening (NHS) is very important, approximately one-third of them never received NHS results. Only 12.50% of the PCPs were very confident in explaining the NHS results to the parents while 35.83% had lack of confidence. Most of the PCPs (76.67%) reported that they were not adequately trained in managing hearing loss among paediatric population. The PCPs had shown satisfactory understanding on the necessity of training with regards to permanent hearing loss in children. Finally, PCPs had recommended the mode of spreading the information that can be used in educating the public mainly by means of online courses, laminated cards, website and brochures.

Conclusion: PCPs showed acceptable awareness towards hearing loss among paediatric group. However, there are some rooms for improvement need to be undertaken such as strengthening the knowledge among PCPs as well as empowering the resources to the primary care facilities. In future, PCPS might be responsible in screening, detecting and treating children with hearing loss at primary care settings.

Keywords : Hearing loss, Primary care, Awareness

Public Awareness / Public Health

PP 263

Comparison of the Cochlear Osia Bone Conduction Implant System with the Baha Attract System for conductive and mixed hearing loss: a cost-utility analysis from a Korean public health perspective.

Matthias BRUNNER[1], Shallu SHARMA[1], So Hyun MIN[2],
Dell KINGSFORD SMITH[3]

[1]Market Access and Government Affairs, Cochlear Asia Pacific, Australia
[2]Quality Assurance, Regulatory Affairs and Reimbursement, Cochlear Korea, Korea
[3]Medical Affairs, Market Access and Government Affairs, Cochlear Asia Pacific, Australia

Objective:
Bone conduction implants (BCI) are important surgical solutions for patients with conductive and mixed hearing loss where conventional hearing aids no longer provide benefit. The Osia System is an active transcutaneous osseointegrated BCI utilising piezoelectric transducer technology with a fitting range of ≤55dB sensorineural hearing level. This study evaluated the cost-utility of the Osia System versus the passive transcutaneous Baha Attract System from a South Korean public health perspective.

Methods:
In the absence of adequate direct comparative studies of the Osia and Baha Attract Systems, an indirect treatment comparison (ITC) of the clinical effectiveness and utility gains was required to inform an economic evaluation. The ITC was based on three well-conducted studies identified through a systematic literature review: two Osia System studies (Mylanus 2020, Briggs 2022) and one Baha Attract System study (den Besten 2019 and Kruyt 2020).
A Markov economic model was developed to estimate the cost-utility of the Osia System compared to the Baha Attract System, considering relevant Korean public health system costs. The incremental cost-effectiveness ratio (ICER) was calculated in KRW/quality adjusted life years (QALYs) over a 10-year time horizon.

Results:
The Osia System was found to be consistently clinically superior to the Baha Attract System across all objective audiological outcomes (pure tone average, hearing in quiet and noise), and associated with a clinically meaningful utility gain of 0.03 measured by the Health Utility Index (Drummond 2001). The Markov model demonstrated that the Osia System is cost-effective, under a gross domestic product (GDP) per capita willingness to pay threshold, with an ICER of 28M KRW/QALY gained.

Conclusion:
An ITC showed that the Osia System is more effective than the Baha Attract System, providing better hearing and health utility outcomes. The economic evaluation demonstrated the Osia System to be cost-effective use of Korean public healthcare expenditure.

Keywords : Osia System, Cost-effectiveness analysis, Indirect treatment comparison

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The Demography of Hearing Loss in Indonesia

Eka Kurnia HIKMAT[1], Rika FITRIYANA[2], Sulistiyorini SULISTIYORINI[3]

[1]*Rehabilitation, Rumah Siput Indonesia Hearing Rehabilitation and Training Center, Indonesia*
[2]*Faculty of Psychology, Universitas Bhayangkara Jakarta Raya, Indonesia*
[3]*Faculty of Psychology, Universitas Persada Indonesia Yai, Indonesia*

Purpose:
In 1994, The Joint Committee on Infant Hearing recommended that hearing loss should be identified before 3 months of age and intervened by 6 months. In 2019, the Hearing First's Mission Probable Whitepaper summarized landmark research studies suggesting that the outcomes are optimized if children with mild-to-moderate hearing loss start to wear hearing aids by 3-6 months of age and if children with severe-to-profound hearing loss start to wear cochlear implants by 6-9 months. This study aims to discover the demography of hearing loss in Indonesia and compare it with the recommended best practices mentioned above.

Method:
The study uses descriptive retrospective cross-sectional method. An online survey was administered from September 17 to October 19, 2022. 155 surveys were submitted from 19 out of 38 provinces that Indonesia has.

Results:
53% of the research subjects are female and 47% are male, all have hearing loss. The median age of the research subjects is 7 years. Only 4% of the research subjects were diagnosed before the age of 3 months, the median age at diagnosis is 2 years. 82% of the research subjects have bilateral profound hearing loss, the rest have other combinations of hearing loss. Only 20% of the research subjects wear appropriate hearing technology, none of them started to use the technology at the recommended age. The median age for the start of hearing aid use is 3 years and for the start of cochlear implant use is 4 years. The top three etiologies found are Rubella (38%), Unknown (30%) and Cytomegalovirus (9%).18% of the research subjects have additional needs and the top three of them are related to vision (12%), attention (12%) and Global Development Delay (10%).

Conclusion:
There is a tendency that the demography of hearing loss in Indonesia has not met the recommended best practices.

Keywords : Demography, Hearing Loss, Indonesia

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Hearing benefit after cochlear implantation during Covid-19 pandemic

Artur LORENS[1], Kornelia ZAWISTOWSKA[1], Anita OBRYCKA[1], Piotr Henryk SKARZYNSKI[1], Henryk SKARZYNSKI[1]

[1]*World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland*

Background and Aim: Due to the coronavirus pandemic numerous restrictions that affected communication of hearing impaired patients were introduced. In particular protective masks and barriers, as well as the requirement to increase the distance during the conversation could significantly hindered communication for people with hearing loss. The aim of this study was to verify whether the changes in everyday live due to restrictions related to the coronavirus pandemic affected hearing benefit of cochlear implant users.
Method: 189 adult cochlear implanted patients were evaluated with Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire during Covid-19 pandemic (between June 2020 and March 2022). All participants were using their cochlear implants for at least 14 months. The results of study group were compared with the outcomes of 189 adult cochlear implant users, with the same experience with the device, tested before Covid-19 pandemic (November 2016 – February 2020).
Results: We observed slight, but significant difference between the groups in APHAB Global Score and Ease of Communication subscale. Patients with CI, tested before Covid-19 reported lower frequency of problems than patients tested during pandemic.
Conclusions: Only small differences in hearing benefit between CI patients tested during Covid-19 pandemic compared to those evaluated before pandemic was observed. This suggests that cochlear implant is an effective hearing prosthetic device also in situations where the sound is muffled or when it is presented from a greater distance.

Keywords : Cochlear implant, APHAB questionnaire, Subjective assessment

Public Awareness / Public Health

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Perception of social support by adults scheduled for cochlear implantation

Anita OBRYCKA[1], Justyna WITKOWSKA[1], Artur LORENS[1], Malgorzata FLUDRA[1], Piotr Henryk SKARZYNSKI[1], Henryk SKARZYNSKI[1]

[1]*World Hearing Center, Institute of Physiology and Pathology of Hearing, Poland*

Background and Aim: People with hearing loss experience restrictions in activity and participation in social and occupational life. They often require support from both specialists and social environment to cope with those limitations. The purpose of this study is to examine how adults who decided to have a cochlear implant surgery perceive social support. The relationship between perceived support and sociodemographic variables such as gender, age, education, marital status (partner), job performance, place of residence, and type of hearing loss has been determined.
Method: The study included 541 patients scheduled for cochlear implant surgery at the Institute of Hearing Physiology and Pathology. Women constituted 50.6% and men 49.4% of the study group. The age of the patients on the day of examination ranged from 18 to 87 years. The assessment tool was the Multidimensional Scale of Perceived Social Support – the questionnaire designed to assess perceptions of social support from three sources: Family, Friends and, Significant Other.
Results: The results indicate a high level of perceived social support among patients with hearing loss (mean score of 5.80 on a scale of 1 to 7). The overall score of perceived social support was significantly lower in patients who were not in martial/partner relationship. In addition, analyses showed that patients living in rural areas perceived greater support than those living in urban areas.
Conclusions: The study showed that individuals with profound hearing loss, undergoing CI surgery report high level of perceived social support. This indicates that the patients have a coping resource they can use in a difficult process of adaptation to new hearing with cochlear implant.

Keywords : Social support, Cochlear implant, Hearing loss

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Awareness Analysis of the National Support Policy for Newborns and Infants With Hearing Loss Who Performed National Infant Health Checkup

Seok Hyun PARK[1], Jeongho LEE[2], Ky Young CHO[1], Hakyoung KIM[1], Kyu Young CHO[1], Su-Kyoung PARK[1], **Jiwon CHANG**[1]

[1]*Department Or Otolaryngology Head and Neck Surgery, Hallym University Kangnam Sacred Heart Hospital, Korea*
[2]*Department of Pediatrics, Soon Chun Hyang University Hospital, Korea*

Background and Objectives:
It is well recognized that early detection and intervention are most important for the prevention of neonatal hearing loss. The national support policy in Korea for newborn hearing screening has been changed since October 2018; however, parent awareness of the change still needs to be increased. This study investigated how well parents, who have underwent national infant checkups of their children, were aware of the Korean national policy for neonatal and infant hearing loss in parents.

Subjects and Method
A survey of neonatal hearing tests and national support policies conducted for 353 parents was analyzed. The survey included questions about parent awareness of the neonatal hearing screening test period, confirmatory test period, national support for these expenses, and hearing aid support. Also evaluated were the necessity of national guidance and management system for neonatal hearing.

Results
The test time of neonatal hearing screening was correctly recognized by 82.2% of the parents. The percentage increased after the national insurance coverage started in October 2018 in Korea, and the rate was higher for parents who visited an otolaryngology clinic rather than a pediatric clinic. The test time of the confirmatory test was correctly recognized only by 20.4%. National support policy for neonatal hearing screening tests, confirmatory hearing tests, and hearing aids were acknowledged by 50.7%, 43.1%, and 56.1% of the parents, respectively.

Conclusion These results indicate the necessity of efforts to increase the awareness of neonatal hearing tests and relevant support policies in Korea to ultimately achieve early hearing
detection and intervention of neonates and infants in Kore

Keywords : Awareness, Hearing, Neonatal Screening

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Parental Awareness of the National Support Policy for Outpatient Clinic Newborn Hearing Screening in South Korea

Jisu KIM[1], Su-Kyoung PARK[1], Kyu Young CHOI[1], **Jiwon CHANG[1]**

[1]Department of Otolaryngology Head and Neck Surgery, Hallym University Kangnam Sacred Heart Hospital, Korea

Background and Objectives
Newborn hearing screening (NHS) is recommended for babies before reaching the age of one month; however, the awareness of the policy in parents is reported to be insufficient in South Korea. The understanding that NHS is covered by the national insurance is also low possibly due to the lack of both advertisement and national policies for hearing loss. In this study, parental awareness of NHS and related national support policies were investigated by surveying parents who visited the Otolaryngology clinic for NHS for their children.

Subjects and Method
Parental awareness was evaluated by a survey of 99 parents for the suitable period for NHS and hearing evaluation for their children. Also, we investigated the awareness of national support policies for NHS and hearing aids, along with other opinions regarding the national support system.

Results The recommended initial NHS timing was acknowledged by 84.7% of the parents; however, the recommended confirmatory hearing test timing was recognized only by 17.2%. The awareness of national support policies for hearing aids, support policies for inpatient and outpatient NHS was noted in 37.4%, 46.5%, and 37.4%, respectively. The necessity for national guidance and a national management system for neonatal hearing loss was supported by 92.9% and 97% of the parents, respectively.

Conclusion Most parents visiting the Otolaryngology clinic were unaware of the time point for the confirmatory hearing test and of the national support policies for infantile hearing loss. A national infantile hearing management system is required to meet the 1-3-6 guidelines for infantile hearing loss.

Keywords : Awareness, Hearing, Neonatal screening

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Status of the Newborn Hearing Screening in the 4-Months Age National Infant Health Checkup in Korea: A Nationwide PopulationBased Study

Jiwon CHANG[1], Su-Kyoung PARK[1], Gi Jung IM[2], Joong Ho AHN[3], Jun Ho LEE[4], Kyoungdo HAN[5], Jong Woo CHUNG[3], Jin-Sook KIM[6], Hyunsook JANG[6], Seung Hwan LEE[7]

[1]Department of Otolaryngology Head and Neck Surgery, Hallym University Kangnam Sacred Heart Hospital, Korea
[2]Department of Otolaryngology Head and Neck Surgery, Korea University College of Medicine, Korea
[3]Department of Otolaryngology Head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea
[4]Epartment of Otolaryngology Head and Neck Surgery, Seoul National University College of Medicine, Korea
[5]Department of Statistics and Actuarial Science,, Soongsil University, Korea
[6]Division of Speech Pathology and Audiology, Hallym University College of Natural Sciences, Korea
[7]Department of Otolaryngology Head and Neck Surgery, School of Medicine, Hanyang University, Korea

The aims of this study are to review data on 4-months age National Health Screening Program for Infants and Children (NHSPIC) using a National Health Insurance Service (NHIS) database, and to analyze the newborn hearing screening (NHS) results and related characteristics of the 4-months NHSPIC for 7 years in South Korea.

Among 3,128,924 of total eligible infants in Korea between the year 2010 and 2016, 69.2% (2,164,621 infants) conducted 4-months age NHSPIC, and 94.4% (2,042,577 infants) of which performed hearing questionnaires regarding NHS. Among the total hearing examinees, premature infants accounted for 3.6%, infants who were hospitalized in the neonatal intensive care unit (NICU) for more than 5 days accounted for 5.6%, and infants with head and neck abnormalities were 0.6%. The NHS performing rate was 79.1% for total hearing examinees in 2010, but gradually increased to 88.9% in 2016. The NHS performing rate in 2016 was 93.4% for premature infants, 91.7% for NICU hospitalized babies. The mean referral rate was 0.6% for total hearing examinees, 1.4% for premature infants, and 2.3% for NICU hospitalized babies. When we analyzed the NHS performing rate and the referral rate according to the household income level, the NHS performing rate of infants in Medical Aid programs was the lowest as 65.6% (other five levels between 85.1% to 86.0%). The referral rate of infants in the Medical Aid program (3.8%) was significantly higher other classes (1.10–1.25%).

The estimated overall NHS performing rate in Korea gradually increased and was 88.9% in 2016. The overall referral rate was low as 0.6%, and it was significantly different depending on the infant's health condition and household income levels. We assume that our finding would help to establish policies managing hearing impaired children, and to develop the customized hearing care service programs considering the household economic levels.

Keywords : Population Surveillance, Newborn Hearing Screening, Infant

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Challenges for and benefits of early hearing detection and intervention information system (EHDI-IS) implementation.

Jason HOLLOWELL

Hearing and Language Center, Shizuoka General Hospital, Japan

Purpose: To design, develop, trial and pilot an early hearing detection and intervention information system (EHDI-IS). Goals for the system were (a) to facilitate early identification and intervention for children with hearing impairment (b) to improve the efficiency and accuracy of data management and tracking (c) to better coordinate care and communication among the multiple stakeholders involved (d) to enable timely and effective program evaluation and monitoring and (e) to inform research and policymakers.

Methods: Plans for an EHDI-IS, that adheres to the EHDI-IS Functional Standards put forth by the Centers for Disease Control in the United States, were drafted. The draft design for the EHDI-IS was fine-tuned via consultation with private OBGYN birthing clinics, hospitals, governmental and public health offices. A one-month initial pilot of the system, using pseudo data, was conducted during which additional feedback was provided by two participating institutions. A formal trial of the system, using live birth data, was begun on September 1st 2022.

Results: Between September 1, 2022 and May 31, 2023, the results for screenings administered to 1,130 newborns have been entered into the system. The automatically calculated referral rate as of 5/31/23 was 1.77% and the positive predictive value was 5.0% with one diagnosis of hearing impairment representing an occurrence frequency of .09%. Of the 19 referrals recorded at the time of writing, 2 (10.53%) were lost to follow-up and the average amount of time required for first follow-up visit for the remaining 17 children was 20.14 days with a range of 3 to 77 days.

Conclusions: The EHDI-IS is effectively empowering EHDI program stakeholders to work toward the accelerated 1-2-3 goals set forth by the JCIH. Further data accumulation in the system will provide a resource for investigating the efficacy of intervention methodologies.

Keywords : Hearing screening, EHDI, Intervention

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Exploring the Current State of Adult Cochlear Implant Surgery for Individuals with Hearing Disabilities in South Korea: A nationwide population-based study

Hee Won SEO[1], Jae Yeong JEONG[1], Haewon CHOI[1], Soorack RYU[2], Hayoung BYUN[1], Seung Hwan LEE[1], **Jae Ho CHUNG[1]**

[1]Department of Otolaryngology-head and Neck Surgery, College of Medicine, Hanyang University, Korea
[2]Biostatistical Consulting and Research Lab, Medical Research Collaborating Center, Hanyang University, Korea

Objective
This study aimed to investigate the trends in cochlear implantation among patients registered with hearing disabilities in South Korea using a nationwide population cohort.
Methods
Subjects with newly-registered hearing disabilities were examined using the Korean National Health Insurance Service (KNHIS) data from January 1988 to December 2020. A total of 525,559 individuals were registered with hearing disability during the period under study. Cochlear implantation surgeries were identified using procedure codes in the insurance claims data, resulting in a subset of 8,149 patients. The patients were further stratified into age groups at 10-year intervals, from their 20s to 90s, to evaluate the trends in cochlear implantation surgeries across different age groups and years.
Results
The first cochlear implantation surgery in South Korea was performed in 2002. After the introduction of national health insurance coverage for the procedure in 2005, there was a significant increase in the number of surgeries performed, leading an upward trend in the total number of cochlear implantations. From 2005 to 2020, patients in their 50s and 60s accounted for the majority of all cochlear implantation surgeries, representing 44.4% of the total. In 2007, the first cochlear implantation surgery was reported in a patient over 80, and since then, the number of surgeries performed in the elderly population has showed a gradual increase each year. In comparison, the annual number of surgeries among patients in their 20s to 50s remained relatively consistent throughout the years.
Conclusion
The present study showed an increasing awareness and acceptance of cochlear implantation in South Korea, particularly among the elderly population. Active health policies and patient education are necessary to optimize hearing health outcomes.

Keywords : Cochlear implantation, Hearing disabilities, National health insurance

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Auditory processing, cognitive and hearing abilities in community-dwelling elderly in Hong Kong

Anna KAM[1,2]

[1]*Department of Special Education and Counselling, The Education University of Hong Kong, Hong Kong SAR*
[2]*Integrated Centre of Wellbeing (i-well), The Education University of Hong Kong, Hong Kong SAR*

Purpose:
This study investigated the relationship between auditory processing, cognitive and hearing abilities in adults over 65.

Methods
This prospective cross-sectional study recruited 125 subjects of ages ranging from 65 to 96 (average 77) from the community. The hearing was measured by a tablet-based automated pure-tone test. Auditory processing abilities were assessed by the speech-in-noise and dichotic listening tests. Cognitive abilities were assessed by the Montreal Cognitive Assessment (MoCA). Correlational analyses were used to determine the relationship between auditory processing abilities (speech recognition threshold and dichotic listening percent correct) and cognitive abilities. Regression analyses were used to test auditory processing abilities to predict MoCA scores after accounting for the effects of age and hearing level.

Results and Discussion
Significant correlations were observed between auditory processing abilities and cognitive abilities. The MoCA score was more significantly correlated with the dichotic listening performance than with speech recognition in noise performance. After controlling for age and hearing level, both auditory processing abilities measured were found to be predictors for the cognitive test score.

Conclusions
Results suggested the possible application of the auditory processing tests in screening for cognitive impairment in older adults.

Keywords : Auditory processing, Hearing, Cognition

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The Current Status of Universal Newborn Hearing Screening Served by Audiologist in Medical Center in Central Taiwan.

Ying-Chih TSAI[1], Yi-Yung CHEN[1], Pei-Hsin KUO[1], Pei-Chi CHAN[1], Yi-Ting LIU[1], Wen-Jie HUANG[1], Jun-Yang FAN[1], **Ching-Hui HSU[1]**

[1]*Department of Otorhinolaryngology, Head and Neck Surgery, Changhua Christian Hospital, Taiwan*

Universal Newborn hearing screening has been funded by Taiwan government since 2011; however, there are limited numbers of medical institutions that execute newborn hearing screening by audiologists. This study aims to present the model and the outcomes of newborn hearing screening and follow-up executed by audiologists at a medical center in central Taiwan. In this research we analyze the results of newborn hearing screening and follow-up in 2022 by descriptive statistics.

This study shows that the screening rate is 98.9%, refer rate of screening is 1.5%, and return rate of outpatient department (OPD) referral is 98.1% in our hospital.The statistics show that newborn hearing screening performed by audiologists in our hospital not only stand out but also adhere to the standards set by the American Speech-Language-Hearing Association (ASHA).

Consequently, the implementation of a comprehensive one-stop service, encompassing newborn hearing screening, re-screening, hearing diagnosis, and behavioral audiometry, all executed by audiologists, exhibits the potential to elevate both the screening and diagnosis rates. Moreover, this model has the capacity to streamline the scheduling of hearing tests and expedite the fitting of hearing aids and be a reference for the hearing diagnosis hospitals.

Keywords : Newborn hearing screening, Early detection and intervention, Audiologist

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Individualized Cochlear Implant Performance Prediction

Andreas BUECHNER[1], Alexey DEMYANCHUCK[1], Thomas LENARZ[1]

[1]Dept. of Otolaryngology, Hannover Medical School, Germany

Introduction
Cochlear implantation is a promising solution to restore hearing ability, but predicting its efficacy for individual patients is challenging. To address this, we developed a machine learning system using a large dataset of approximately 3000 adult patients who had post-lingual onset of hearing loss and underwent cochlear implantation. The dataset included epidemiological factors and clinical information, such as age and deafness duration at the time of implantation, preoperative pure tone audiometry results and word recognition scores. The target variable to predict was the average postoperative monosyllabic score at the 1 year after operation timeframe.

Methods
Our system involved iterative stages, starting with exploratory data analysis to select appropriate features, build a data pre-processing pipeline, and train and evaluate decision tree models using k-fold cross-validation. The best-performing models were finally tested on a hold-out dataset, resulting in a mean absolute error of 20.5% with a standard deviation of 15.6%. The decision tree visualization graphs provided interpretable paths for the predictions, aiding clinicians in understanding the rationale and potential error of a prediction.

Results
Our system's predictive capabilities were evaluated on the recent implantation data from 2020-2021 period, resulting in a mean absolute error of 18% with a standard deviation of 13.1%. The results demonstrate the potential of machine learning methods in predicting cochlear implant outcomes and improving patient care. Further research is needed to investigate the generalizability of our system and the effect of additional clinical and demographic factors on prediction performance.

Conclusion
In summary, our machine learning system for predicting postoperative performance of cochlear implantation utilized a large dataset and involved exploratory data analysis, data pre-processing, decision tree models, and decision tree visualization graphs. The system achieved a mean absolute error of 18% with a standard deviation of 13.1%, demonstrating promising potential for improving patient care.

Keywords : Outcome prediction, Outcome variability, Public Awareness

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Long-term outcomes of Chinese Nurotron Cochlear Implant Recipients: an analysis of a large sample

Jianan LI[1,2], Yipeng LIN[3], Tianyi LIU[3], Shanxian GAO[3], **Li YIN**[3]

[1]Senior Department of Otolaryngology-head & Neck Surgery, The Sixth Medical Center of Pla General Hospital, China
[2]National Clinical Research Center For Otolaryngologic Diseases, Chinese People's Liberation Army General Hospital, China
[3]Institute of Audiology、speech and Medicine, Nurotron Biotechnology Inc., China

Introduction: Cochlear implantation (CI) has garnered widespread acclaim for its efficacy and safety, evidenced by over one million implants and four decades of clinical implementation. However, the Nurotron CI, a relatively novel entrant, remains less comprehensively understood within the field. To elucidate its attributes, we undertook a comprehensive data analysis aimed at enhancing professionals' comprehension of this specific CI brand and potentially extending implant options for hearing-impaired patients.

Materials and methods: Between January 2010 and May 2023, a total of 12,636 subjects underwent Nurotron CI surgery at various centers across China. Implant effectiveness was evaluated using diverse metrics, including Categories of Auditory Performance (CAP) and Speech Intelligibility Ratings (SIR) scores. Demographic and clinical data were gleaned via interview surveys administered by the clinical support team of Nurotron Biotechnology Inc.

Result: Approximately 74% of implant recipients were below 18 years of age. Notably, around 54.6% experienced auditory deprivation for under three years. Leading the causes of hearing loss was congenital deafness, accounting for approximately 62.4%. Among recipients, 69% opted for unilateral right-side implantation, while 4% chose bilateral implants. CAP scores evidenced a marked rise from one month (2.4±1.2) to five years (5.4±1.1) post-activation (P=0.005), followed by sustained stability. Similarly, SIR scores displayed a significant upward trajectory from one month (2.3±1.6) to four years (3.6±1.1) post-activation (P<0.001).

Discussion: The CAP and SIR scores exhibit consistent growth for a duration of four to five years after activation, ultimately reaching a high level that substantiates the efficacy of Nurotron CI. At present, a majority of Nurotron implant recipients are children undergoing unilateral implantation. The projected rise in implant recipients, including the elderly and those opting for bilateral implants, can be attributed to advancing economic conditions and improved living standards.

Conclusion: The Nurotron CI System can significantly enhance speech assistance for individuals with hearing impairments.

Keywords : Cochlear implantation, Auditory performance, Speech perception

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Association between socioeconomic characteristics, health conditions and usability of hearing device based on a 10-year outcome in South Korea

Eun Bit BAE[1,2]

[1]Neurology, Seoul National University Hospital, Korea
[2]Korea University Research Institute For Medical Bigdata Science, Korea

Introduction
Hearing is an important ability affected highly to work performance with social communication, especially in adults. This study's aim is to explore and evaluate affected sociological and economic factors for hearing device users.

Methods
Among 96,372 individuals' collected data, 2009 through 2018, from the Korea National Health and Nutrition Examination Survey, a total of 41,029 individuals' data answered otorhinolaryngologic questions were included to evaluate the socioeconomic and health condition of hearing device users. Mainly the chi-square analysis was conducted on 7,972 individuals' data excluding normal hearing (main analysis) and subgroup analyses were conducted on 1,700 individuals having significant complaints of hearing. The chi-square analyses were conducted between hearing device usability (use, hardly use, and no-use) and 47 variables of socio-economic and health related factors.

Results
Among 1,700 individuals with significant complaints of hearing, non-users of hearing devices, such as hearing aid and cochlear implants, were 1,292 (76% of 1,700) and 6,124 individuals (97.8% of 6,262) having little complaint of hearing were showed as non-user of hearing devices. Among 47 socio-economic and health-related factors, both main and subgroup analyses showed significant differences ($p < .05$) in gender, attendance in the workplace, education level, occupation classification, and employment type. Interestingly, only those who had severe hearing loss showed significance in subjective general health conditions, $X2$ (8, $N = 1509$) = 25.385, $p = .001$, indisposed feeling recent in 2 weeks, $X2$ (2, $N = 1507$) = 8.160, $p = .017$, and suicidal ideation in a year, $X2$ (2, $N = 1006$) = 9.168, $p = .01$.

Discussion
This study results showed that still non-users of hearing devices in severe hearing loss are 76% in South Korea and non-users are significantly affected in their physical and mental health condition. It is suggested to replicate the results through further study.

Keywords : Health condition, Hearing aid, Cochlear implant

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How's going on the national support project for cochlear implants in South Korea: Example of Gyeonggi-do, 2018 – 2022.

Eun Bit BAE[1,2]

[1]Neurology, Seoul National University Hospital, Korea
[2]Korea University Research Institute For Medical Bigdata Science, Korea

Introduction
Gyeonggi-do is the region with the largest number of residents among the eight provinces in Korea (20% of the national population). South Korea's national support project for cochlear implant (CI) surgery and rehabilitation has been operating extensively throughout the country. In particular, Gyeonggi Province was operated openly and actively. This study was conducted to determine the status of cochlear implant support projects based on Gyeonggi-do data.

Methods
To measure the financial support trend, the study used the recent five years from 2018 to 2022 of national statistical data for the Cochlear implant (CI) surgery and rehabilitation financial support project in the hearing impaired, and statements of budget and expenditure of Gyeonggi-do.

Results
The recent five years of trend for CI surgery support budget showed consistency from 2018 to 2021 and a decrease in 2022. The trend for CI rehabilitation support budget showed consistency except in 2019. Following the trend of the CI support budget, the number of recipients ($M = 15.2$, $SD = 4.21$) and expenditure ($M = 79,677,114$ won, $SD = 27,142,241.5$) for CI surgery support is showing a decreasing trend from 2020 to 2022. The CI rehabilitation support trend is considered increased (recipients' number, $M = 34.2$, $SD = 4.38$; expenditure, $M = 85,506,840$ won, $SD = 9,125,601.7$). The total amount of expenditure for CI support was considerably lower than the support for other events and festivals, supporting organizations, support for the operation of institutions, and the rights of disabled persons.

Discussion
This study shows that the decreasing trend of CI support and CI support budget and amount of expenditure were considerably lowered than other supports for social events and social communities.

Keywords : Gyeonggi-do, Cochlear implant support project, Rehabilitation

Miscellaneous

PP 278

Word fluency Performance in Swedish Adults with Congenital Cytomegalovirus Infection: A Long-term Follow-up study

Karolina FALKENIUS SCHMIDT[1,2], Anastasia NYSTRÖM[2], Eva KARLTORP[3,4], Måns MAGNUSSON[1,2], Ulrika LÖFKVIST[4,5]

[1]Department of Otorhinolaryngology and Head and Neck Surgery, Skåne University Hospital, Lund, Sweden
[2]Department of Clinical Sciences, Lund University, Sweden
[3]Department of E N T, Karolinska University Hospital, Stockholm, Sweden
[4]Department of Clinical Science, Intervention and Technology, Karolinska Institute, Stockholm, Sweden
[5]Department of Public Health and Caring Sciences, Uppsala University, Sweden

Congenital Cytomegalovirus (cCMV) is the most common prenatal infection, the main infectious cause of sensorineural hearing loss in developed countries. The knowledge of how cCMV infection affects individuals on population level over time is limited. This is the first study that presents linguistic follow-up data performed on adults who were infected in utero. The aims were to investigate word fluency performance and retrieval strategies in a group of adults with cCMV infection and compare with age-matched uninfected controls.

METHOD: All individuals from a universal CMV screening study in Sweden sampled 1977-85 and their controls were invited to participate in a follow-up study. Participants were between 34-43 years. 34/ 71 persons with cCMV and 22/50 controls were enrolled. Participants were evaluated with two different word fluency tasks (FAS letter fluency, Verb fluency). A qualitative analysis was performed to evaluate which word retrieval strategies were used.

RESULTS: Education level was the most important factor for word fluency ability in both groups. There was a greater variation in word fluency ability in the cCMV group, even in absence of hearing loss. Only 43 % of participants with cCMV infection, but without symptoms of the infection at birth, had adequate results on both FAS and Verb fluency tasks, while most of the controls, 86%, performed typically on both tasks compared to Swedish norm data.

CONCLUSION: Higher education level had a positive effect on outcome. Adults with cCMV infection with higher education level used less effective retrieval strategies on FAS letter fluency which may indicate poorer executive functioning. These findings show it is important to identify all individuals with cCMV infection. Only then is it possible to evaluate their language development and support those who demonstrate atypical abilities from early childhood onwards, and if needed also individualize the rehabilitation of those who receive cochlear implants.

Keywords : Congenital Cytomegalovirus infection, Adults, Word fluency

Miscellaneous

PP 279

The Impact of Cochlear Implantation on the Quality of Life of Adult Patients: A State-of-the-Art Review

Wan Nur Hanim MOHD YUSOFF[1], Mohd Fadzil Nor RASHID[2], Nur 'izzati MD. YUSOFF[1], Fatimah SAZARI[3]

[1]Center For Rehabilitation & Special Needs Studies, Faculty of Health Sciences,, Universiti Kebangsaan Malaysia, Malaysia
[2]School of Health Sciences, Health Campus,, Universiti Sains Malaysia, Malaysia
[3]Department of Medical Rehabilitation Services, Hospital Canselor Tunku Mukhriz, Malaysia

Objectives: Cochlear implantation is a highly effective intervention for adults with severe to profound hearing loss. However, the impact of cochlear implantation on the quality of life (QoL) of adult patients remains an important topic of investigation. In this state-of-the-art review, we aim to synthesize and examine the existing information on QoL in cochlear implant recipients.

Method: A comprehensive search was conducted using multiple databases, including Scopus, PubMed, and Cochrane Library, to identify studies published between 2019 and 2023 that investigated the impact of cochlear implantation on the QoL of adult patients. The inclusion criteria were studies done in any country or region, articles written in English, and characterized in terms of participants, intervention(s), outcomes, and study design. A total of 10 studies were included in this review.

Results: The majority of the studies included in this review utilized the Speech, Spatial and Qualities of Hearing Scale and Nijmegen Cochlear Implant Questionnaire as measures to assess the impact of cochlear implantation. The results indicated a significant improvement in the QoL of adult cochlear implant patients across various domains such as social interactions, emotional well-being, and functional status. Several studies also reported that the level of improvement in QoL was positively associated with age of implantation and the length of device use.

Conclusions: The majority of cochlear implant patients show significant improvements in their QoL after the procedure, as evidenced by patient-reported outcome measures. This knowledge empowers healthcare professionals to provide valuable insights and guidance to their patients when making informed decisions about treatment options and managing their expectations regarding the benefits of the intervention. However, further research is needed to better understand the factors that influence the degree of improvement in QoL following cochlear implantation and to address potential barriers to accessing this intervention.

Keywords : Cochlear implant, Quality of life, Adult

Miscellaneous

PP 280

PATTERNS OF DEVICE FAILURE AMONG DIFFERENT TYPES OF HEARING AIDS

Jeong Heon KIM[1], **Joong Ho AHN[1]**, Woo Seok KANG[1], Hong Ju PARK[1], Jong Woo CHUNG[1]

[1]Otolaryngology, Asan Medical Center, University of Ulsan College of Medicine, Korea

Objective: The purpose of this study is to investigate the proportion of device failure of hearing aids, especially within one year of use, and differentiate the pattern among various types of hearing aids.
Method: We retrospectively reviewed medical data of patients from January 2019 to December 2021 who experienced device failure within 1 year of commencing the use of hearing aids. Patients were divided according to type of hearing aids (Receiver in Canal; RIC, Completely in Canal; CIC, Behind the Ear; BTE), onset of device failure (<6months, ≥6months), and reason for failure. Data were statistically analyzed using Pearson's Chi square test and Fisher's exact test.
Results: A total of 2157 patients prescribed with hearing aids (1899 RIC, 161 CIC, 97 BTE) were enrolled in this study. Of these patients, 167 patients experienced device failure within one year (113 RIC, 33 CIC, 21 BTE). The incidence of device failure within one year differed significantly between RIC and CIC (6.0% vs 20.5%; p<0.001), RIC and BTE (6.0% vs 21.6%; p<0.001). Within 6 months, failure rate of RIC and CIC, RIC and BTE still remained statistically different (2.4% vs 14.9%, vs 9.3%; both p<0.001), while between 6 months and 1 year, only RIC and BTE differed significantly (3.7% vs 13.6%; p<0.001). Regarding proportion of patient negligence, patients with RIC, CIC, BTE hearing aids did not exhibit any significant difference (69.9%, 69.7%, and 71.4%, p=0.989).
Conclusion: All 3 types of hearing aids showed similar proportions of patient negligence. However, we may conclude from the higher overall failure rate in CIC and BTE that patient education may hold an important role in sustaining device integrity in these types.

Keywords : Hearing aid, Device, Failure

Miscellaneous

PP 281

Effects of Renal Function on Recovery of Hearing in Sudden Sensorineural Hearing Loss

Yeung-Jun PARK[1], **Moo-Jin BAEK[1]**, Hyeonwoo AHN[1]

[1]Otolaryngology, Inje Univerrsity, Haeundae Paik Hospital, Busan, Korea

Objectives: Recent studies have indicated that patients with chronic kidney disease (CKD) are at a higher risk of developing sudden sensorineural hearing loss (SSNHL). However, studies focusing on the prognosis of SSNHL in patients with CKD are lacking. Therefore, the present study aimed to investigate whether renal function is associated with SSNHL prognosis.
Methods: I retrospectively reviewed the medical records of patients diagnosed with SSNHL at the Haeundae-Paik Hospital between March 2010 and February 2022. Patient demographics, audiometric data, treatment modality, audio-vestibular symptoms, estimated glomerular filtration rate (eGFR), and treatment outcomes (based on Siegel's criteria) were evaluated. The patients were divided into subgroups according to eGFR at diagnosis, and clinical factors were compared. Logistic regression analysis was used to investigate factors associated with SSNHL recovery at 2 and 4 weeks after treatment.
Results: During the study period, 1,678 patients were diagnosed with unilateral SSNHL. After exclusion, 631 patients were included for analysis (mean age 54.0±14.2, male:female= 306:325). There were 544 (86.2%) patients in the normal renal function group, 61(9.6%) in the CKD group, and 26 (4.1%) in the dialysis group. Recovery rates were 55.7%, 32.8%, and 15.4% in the normal, CKD, and dialysis groups, respectively. Multivariate logistic regression analysis showed that dialysis group was significantly associated with SSNHL recovery at 2 weeks and 4 weeks after treatment.
Conclusions: CKD group and dialysis group showed a significantly lower rate of recovery of SSNHL. In addition, dialysis group was associated with a poor prognosis of SSNHL.

Keywords : Sudden hearing loss, prognosis, renal function,, Chronic kidney disease, end stage renal disease, dialysis

Miscellaneous

PP 282

Social competence in CI children and HA children

Chia-Ying CHU[1], Feng-Yi CHIU[2]

[1]*Speech and Hearing Science Research Institute, Children's Hearing Foundation, Taiwan*
[2]*Teaching and Research Department, Children's Hearing Foundation, Taiwan*

Social competence as the ability to interact effectively with others, which impacts academic performance, work, and life quality. Research shows that hard-of-hearing preschoolers tend to demonstrate weaker social competence when compared to their hearing peers. However, due to the severe to profound hearing loss and poorer language abilities of hard-of-hearing preschoolers who have cochlear implants (CI), it is unclear whether they display different levels of social competence compared to those who use hearing aids (HA). Therefore, this study aims to explore the social competence of preschoolers with HA and CI.

In this study, 33 Chinese-speaking preschoolers with HA and 14 with CI, all of whom used oral communication, participated. Using the Social Behavior Assessment System for Preschool (SBASP) to measure social competence, one-sample t-tests revealed that both preschoolers with HA and CI scored significantly lower on the total score of the social competence scale compared to the norm (HA: $t=-3.57$, $p<.01$; CI: $t=-2.55$, $p<.05$), but not the total score of the problem behavior scale in both groups (HA: $t=-.03$, $p>.05$; CI: $t=.99$, $p>.05$). Independent t-tests showed no significant differences in SBASP in both social competence ($t=.49$, $p>.05$) and problem behavior ($t=-.72$, $p>.05$) between the two groups. The study also assessed language ability using the Revised Preschooler Language Assessment (RPLA) and found that preschoolers with HA performed significantly better than those with CI ($t=2.474$, $p<.05$).

In conclusion, the study suggests that preschoolers with HA and CI both exhibit delayed social competence compared to their normally hearing peers. Although children with CI exhibit weaker language ability, they do not perform worse than preschoolers with HA in terms of social competence. The findings highlight the importance of considering the impact of different degrees of hearing loss on the social competence of hard-of-hearing preschoolers.

Keywords : Social competence, Preschoolers, Language ability

Miscellaneous

PP 283

Outcomes of 1100 Cochlear Implants in Govt. Program in India

Rohit MEHROTRA

Otorhinolaryngology, Mehrotra Ent Hospital, Kanpur, India

Introduction: This retrospective study is based on assessment of outcome of cochlear implantation at Late Dr. Shiv Nath Mehrotra Charitable ENT foundation between 2016 to march 2023 under ADIP(assistance to disable persons) scheme by taking into account various scoring systems like category of auditory performance (CAP), Speech intelligibility rating (SIR) and Glasgow children benefit inventory (GCBI).

Materials and methods: 1100 children who were implanted between 2016 to march 2023 at Late. Dr. Shiv Nath Mehrotra Charitable ENT Foundation were included in the study. The results were analyzed using the above scoring system to assess the performance level and quality of life of each implanted children taking into consideration practical issues in Indian set up.

Results: 90% of total children implanted showed significant improved hearing, 80% with significant speech benefit and 90% with improved quality of life.

Conclusion: Outcome in terms of quality of life, auditory perception and rehabilitation was very good. The ADIP (assistance to disabled persons) scheme of central government has been a blessings for lower socio economic status children. Considerable improvement in hearing, speech and overall quality of life in almost 80% of children.

Keywords : Category of auditory performance, Speech intelligibility rating, Glasgow children benefit inventory

Miscellaneous

PP 284

Visualize the limitations of hearing and the benefits of cochlear implantation: Audiogram of Chinese Sounds

Yu-Chen HUNG[1,2], Yen Ming CHANG[3,4]

[1]Speech and Hearing Research Institute, Children's Hearing Foundation, Taiwan
[2]Special Education, Chung Yuan Christian University, Taiwan
[3]Audiology Department, Children's Hearing Foundation, Taiwan
[4]Department of Speech-Language Pathology and Audiology, National Taipei University of Nursing and Health Sciences, Taiwan

Purpose: In aural rehabilitation, it's typical to use a speech sound audiogram (also known as a "speech banana") to assist in counseling individuals and determining their hearing capabilities for various speech sounds. To cater to Chinese-speaking population, we developed a speech banana that reflects the distribution of Chinese speech sounds on an audiogram more accurately.
Methods We defined the coordination of each phoneme on the audiogram by taking into account their frequency and intensity. The sensitivity and specificity of the newly developed Chinese speech banana were evaluated to determine its effectiveness.
Results The results showed that the specificity rates were high at 94.2% for frequencies below 8000 Hz, while the sensitivity was high at 96.8% for frequencies above 8000 Hz.
Conclusion The utilization of a more precise audiogram of Chinese sounds as a counseling aid could be beneficial for Chinese-speaking individuals undergoing aural rehabilitation, including those with cochlear implants, as it has the potential to identify auditory access gaps and low-perceptual quality sounds, leading to improved rehabilitation outcomes.

Keywords : Speech Banana, Audiogram of Chinese Sounds, Speech perception

Miscellaneous

PP 285

Comparison of the results between the first steroid treatment group and the retreatment group with idiopathic sudden sensorineural hearing loss

Jae Hwan KWON

Otolaryngology, Kosin University, Korea

Background and Objectives
Sudden sensorineural hearing loss(SSNHL) is a non-specific caution of hearing loss. It is an otological emergency disease. If there is no improvement or the degree of hearing loss is severe, the patients are referred to other medical institution. Many papers have been published regarding the treatment results of SSNHL, however most of them didn't mention that the patients were referred from other clinic after steroid treatment. The author would like to compare the treatment results between patients group referred after steroid treatment and first steroid treatment group.

Subjects and Method
From January 2015 to August 2017, we retrospectively analyzed 127 patients. Patients who received steroid treatment for the first time were classified as Group 1, patients who received steroid treatment in another hospital and patients who were re-treated were classified as Group 2. And, the treatment results of each group were evaluated.

Results
According to the results of this study, the recovery rate in Group 1 was 66.7% and the recovery rate in Group 2 treatment group was 31.4%.

Conclusion
Most of the previous studies on the treatment results of sudden hearing loss were performed in tertiary medical institutions. It is likely that the treatment results of patients recovered after treatment in primary and secondary medical institutions are likely to be missed, which means that the results of steroid therapy may be better than those reported previously.

Keywords : Sudden sensorineural hearing loss, Steroid, Primary health clinic

Miscellaneous

PP 286

Are Mandarin-speaking prelingually deafened adults can benefits from cochlear implant?

Hung-Ching LIN[1,2], Pei-Hsuan HO[1,2]

[1]*Otolaryngology and Head Neck Surgery, Mackay Memorial Hospital, Taiwan*
[2]*Audiology and Speech Language Pathology, Mackay Medical College, Taiwan*

Objectives: With advances in cochlear implant (CI) technology, pre-lingual deaf adults may experience improved speech perception and quality of life (QoL). Most people in Taiwan speak Mandarin Chinese. However, Mandarin is a tonal language, which has 4 unique tone (high flat tone, rising tone, low tone, and falling tone).
As a result of CI is limited by the technology and sound-processing strategies have been designed based on intonation language, there were poor resolution on fundamental frequency and harmonics. Western language is an intonation language and different from tonal language in that tones convey the lexical meaning, so it is hard to lip-reading and tone recognition for tonal language CI users. This study was aimed to evaluate the long-term post-CI outcomes in pre-lingual deaf Mandarin-speaking adults and the difference between them and post-lingual deaf adults.

Methods: Fifty-five adult implanted ears were included. Post-CI long-term outcomes were using vowels, consonants, disyllabic words, Mandarin monosyllable words, categories of audiology performance, speech intelligibility rating, psychosocial scale questionnaires.

Results: Post-CI auditory performance and speech intelligibility of pre-lingual deafness adults was significantly inferior to that of those with post-lingual deafness. However, both groups presented improved QoL, with no significant difference between the groups. In addition, no significant difference between pre-lingual deafness and post-lingual deafness was identified in auditory performance between the matching groups in terms of deafness duration.

Conclusions: Despite inferior auditory performance and speech intelligibility in pre-lingual deaf adults compared to post-lingual deaf adults, the former can also benefit from social-emotional life function regardless of auditory performance after CI. With careful counseling and the establishment of reasonable expectations before implantation, we can encourage pre-lingual deaf adult patients with oral-verbal communication that may have continued to improve post-CI performance.

Keywords : Cochlear implant, Pre-lingual deafness adult, Long-term outcomes

Miscellaneous

PP 287

Work life questionnaires for cochlear implanted patients.

Alicia HUARTE[1], Raquel MANRIQUE[1], Beatriz PEREZ[1], David CALAVIA[1], Manuel MANRIQUE[1]

[1]*Otorhinolaryngology, Clinica Universidad De Navarra, Spain*

Introduction: The aim of this study is to determine the impact that the cochlear implant (CI) had in the working life of the individuals implanted, using the first version of a questionnaire developed in the cochlear implant program at the University Clinic of Navarra.

Purpose of the study:
To demonstrate that the cochlear implant significantly affected the working lives of this patients.

Material and methods: This is a retrospection study on a population of 60 patients (mean age, 48 years old) with bilateral profound neurosensorial hearing loss treated with a CI and to whom a questionnaire on working life satisfaction was given.

Results: Of the patients completing the questionnaire, 94.23% were currently satisfied at work. Almost all of them (93.05%) were more motivated to go to work after the implantation. The majority (79.31%) considered themselves more competent after surgery and device activation. Social relations at work were considered to have improved after cochlear implantation by 67.23% of patients.

Conclusions: The CI provided positive support in the professional sphere as well as in social abilities by improving communication skills of implanted patients. The development of tools to assess the degree of job satisfaction of patients treated with a CI is of great interest.

Keywords : Cochlear Implant, Questionnaire, Work life

Miscellaneous

PP 288

Self-esteem in Hearing Impaired Individuals Before and After Cochlear Implantation

Yun Ji LEE[1], Yeon Ju CHOI[1], Jee Yeon LEE[1], Woo Seok KANG[1], Joong Ho AHN[1], Hong Ju PARK[1], **Jong Woo CHUNG[1]**, Yeonjoo CHOI[1]

[1]otorhinolaryngology-head and Neck Surgery, Asan Medical Center, University of Ulsan College of Medicine, Korea

Objectives: This study aimed to evaluate the self-esteem of cochlear implant (CI) recipients and identify factors influencing their scores. Hearing-impaired individuals often face communication challenges leading to lower self-esteem, which can be improved by CI enhancing speech outcomes.

Methods: This prospective cohort study enrolled patients who consented to participate from May 2017 to Dec 2020. We recruited patients who were either planning to undergo CI or had previously received CI and visited the hospital for mapping. We used the Rosenberg Self-Esteem Scale (RSES) and Coopersmith Self-Esteem Inventory (SEI), which consists of 10 and 25 statements respectively, to which the subject responds on a four-grade scale from 1 to 4. The overall score, reflecting the total points, correlates with higher global self-esteem.

Results: A pre-operative questionnaire was performed to 21 patients scheduled for CI. The mean age was 57.6 years and all patients were postlingual deaf adults. There were statistically significant differences according to the social status (RESE; employed 32.78 ± 2.39, unemployed 25.64 ± 3.35, p<0.0001, SEI; employed 78.11 ± 8.99, unemployed 64.27 ± 12.09, p=0.01). A total of 73 patients were conducted post-operative questionnaire. Among them, 35 (48%) were prelingual and 38 (52%) were postlingual deaf. The survey was conducted at an average of 25 months after CI, and there were no significant differences based on gender, deaf type or social status (p=0.62, 0.22, 0.523). As the word recognition score (WRS) improves, there is a positive correlation with an increase in the RESE score. (r2=0.112, B=0.05, p=0.004)

Conclusion: In postlingually deaf adults, self-efficacy was higher in those who were employed. After the implementation of CI, self-efficacy increased with higher WRS It can be expected that auditory rehabilitation through CI may improve patients' self-efficacy.

Keywords : Self-esteem, Cochlear implantation, Social state

Miscellaneous

PP 289

Disaster Assistance for Hearing-Impaired people and associated issues: Drawing on the Experience of Flooding Caused by the 2019 Typhoon

Yutaka TAKUMI[1], Hidekane YOSHIMURA[1], Ayako GONDA[1]

[1]Department of Otorhinolaryngology, Shinshu University School of Medicine, Japan

"Better safe than sorry."

The Great East Japan Earthquake that occurred in 2011 and caused more than 20,000 deaths and missing persons is said to have caused extensive damage not only by the earthquake but also by the tsunami. It is also reported that the death rate of the disabled was twice as high (2%) as that of all residents, and that many hearing-impaired people in particular, died because they could not hear disaster prevention radio and did not know that a tsunami was on the way.

Nagano Prefecture is believed that the region has been unaware of flood damage because it is an area unrelated to tsunamis. However, in October 2019, Typhoon No. 19 approached Nagano Prefecture, causing frequent flooding in the Chikuma River basin, especially in the Nagano City, where the Chikuma River burst its banks and washed away many houses, causing extensive damage. The news that many trains were submerged in muddy water at the Hokuriku Shinkansen rail yard in the same area is still fresh in our memories. Fortunately, there were no hearing-impaired victims, but according to the Nagano Deaf Association, in many cases, evacuation decisions were delayed because they could not hear the disaster prevention radio and area mail sent to their cell phones. At evacuation centers, there were reports of problems such as confusion due to inability to understand voice instructions, inability to obtain sufficient information due to the time required for written communication, and inability to locate sign language interpreters and transcriptionists.

In the future emergency notification method would be to forcibly vibrate cell phones and send signals to hearing aids and cochlear implants. And in the future, evacuation centers should be required to transmit the location of sign language interpreters via the location feature of cell phones.

Keywords : Disaster, Flooding, Hearing-Impaired people

Miscellaneous

PP 290

Cochlear implant failures and Auditory performance after reimplantation: A single institution's experience

Yun Ji LEE[1], Joong Ho AHN[1], Hong Ju PARK[1], Jong Woo CHUNG[1], **Woo Seok KANG[1]**, Yeonjoo CHOI[1]

[1]Otorhinolaryngology-head and Neck Surgery, Asan Medical Center, Korea

Objectives: This study aimed to analyze the frequency and timing of device failure depending on the type of electrodes and patients' characteristics. Additionally, the performance of cochlear implants (CI) after reimplantation was compared.
Methods: A retrospective analysis was conducted on patients who underwent CI at our institution since 2000. Data on device type, timing, and frequency were collected and analyzed. The performance of CI after revision surgery was analyzed using speech perception assessments and word recognition scores (WRS) comparing the final follow-up after reimplantation to before device failure.
Results: CI device failure occurred in 30 patients, 32 ears including 25 children under the age of 18 (83.3%) and 5 adults (16.7%). A total of 15 patients (50%) had inner ear malformations. Device failure occurred most frequently within the first 3 years after implantation (19, 59.4%). There were two cases (6.3%) occurred after head trauma, while the remaining cases (30, 93.7%) were identified either due to sudden device malfunction reported by the patient, or abnormal findings during regular mapping. Depending on the manufacturers, there were 12 (37.5%) from A, 14 (43.8%) from B, and 6 (18.8%) from C. There were 15 (46.9%) with perimodiolar electrodes and 17 (53.1%) with straight electrodes. In prelingually deaf patients, a statistically significant improvement in CAP scores was observed (p=0.021). In both prelingual and postlingual patients, there was a tendency towards improved WRS (p=0.597 and p=0.768, respectively).
Conclusions: There was no significant difference according to electrode type, and it was noted that device failure occurred quite commonly in patients with inner ear malformations. After reimplantation, auditory performance remained well-preserved, and there was also a tendency towards improvement observed in the follow-up. Regular monitoring and prompt management of device failure can lead to better outcomes for those patients.

Keywords : Cochlear implant failure, Reimplantation, Auditory performance

Miscellaneous

PP 291

Coupling Varying Mass Loads to the Short Incus Process and the Effect on Middle Ear Transfer Function (METF)

Carmen MOLENDA[1], Ivo GRUENINGER[2], Veronika VOLGGER[1], Florian SIMON[1], Lisa LIPPL[3], Stefan BRILL[3], Felix GENNRICH[3], Joachim MÜLLER[1]

[1]Department of Otorhinolaryngology, Head & Neck Surgery (chairman: Univ.-prof. Dr. Med. Martin Canis), Lmu Klinikum, Munich University, Germany
[2]Department of Otorhinolaryngology, Helios Klinikum Berlin-buch, Germany
[3]Med-el, Med-el Medical Electronics Gmbh, Austria

Background
Modifications of the ossicular chain (OC), e.g. due to middle ear surgery, lead to changes of its dynamic behaviour and of the METF and the resulting sound transmission. The implantation of (active) middle ear implants (AMEI) regularly requires modifications to the OC. Using e.g. a floating mass transducer modifies the oscillating system by adding mass. While clinical results for different coupling techniques of an AMEI to the OC have been reported repeatedly, the effects of mass loads coupled to the OC on the middle ear dynamics are less well described. Previously published data including FE-analysis and experimental results using laser doppler vibrometry (LDV) after loading the OC at different sites, show a decrease of stapes foot plate (FP) displacement, especially for higher frequencies. To our best knowledge, experimental data regarding the effects of loading varying masses to the short incus process (SIP) are currently missing. Therefore we want to examine the effect of mass loading the SIP on the METF and the resulting motions at the SIP and the stapes FP. This data might help to further understand the effects of coupling implants at the SIP on sound transmission and might be useful for future generations of middle ear implants.

Material & methods:
LDV in eight human fresh frozen temporal bones and mass loads between 0 – 100 mg coupled to the short incus process. Movement was measured for frequencies between 100Hz and 8.5kHz at the stapes FP as well as at the SIP in the direction perpendicular to the axis through the incudomalleolar joint and the long incus process. Parametric function fitting was used to assess the effects on METF.

Results:
Our data shows a decrease of stapes and incus velocity especially for high frequencies and a shift of characteristic frequency towards lower frequencies with increasing mass loads.

Keywords : Laser doppler vibrometry, Mass load, Iddle Ear Transfer Function

Miscellaneous

PP 292

Hearing Restoration Centers Adaptive Performance through Emergencies & Pandemic Multi Centre Study

Mohamed ALSHEHABI[1], Fida ALMUHAWAS[2], Abdulrahman HAGR[2], Yaseen SAMAD[2], Ibrahim SHAMI[3], Nader ALDAJANI[3], Jad MOny[4], Fahad ALTAMIMI[5], Ahmad ALDHAFERI[6], Saeed ALGHAMDI[7], Musaad ALZAHRANI[8]

[1]Ent, Royal Medical Services, Bahrain
[2]Ent, King Abdullah Ear Specialist Centre Riyadh, Saudi Arabia
[3]Ent, King Fahad Medical City Riyadh, Saudi Arabia
[4]Ent, King Fahad General Hospital Jedda, Saudi Arabia
[5]Ent, King Saud Medical City Riyadh, Saudi Arabia
[6]Ent, Hafr Albaten Central Hospital, Saudi Arabia
[7]Ent, King Abdulaziz Medical City Makkah, Saudi Arabia
[8]Ent, King Fahad Specialist Hospital Dammam, Saudi Arabia

Objectives: This multicenter work aimed to study the impact of the COVID-19 pandemic on the services provided by Eight cochlear implants (CI) centers. Second, the study aimed to provide a suitable workflow for the CI centers in case of any further emergency situations.
Materials and Methods: This prospective multi-center study was conducted in eight CI centers. The impact of COVID-19 on the enrolled centers was studied on the following criteria: number of CI cases; age at implantation; the number of ENT follow-up visits; the number of programming visits; the number of rehabilitation visits; waiting lists; efficacy of remote clinical services such as programming sessions, rehabilitation session, and ENT clinics; how frequent is the CI committee; duration and setup of CI committee; the number of cases discussed in the committee; emergency cases numbers and how it managed; list of intra-op tests; number and attendees in OR; and operation time
Results: 1084 CI patients from eight CI centers were included and reported in the results of this study. The results of each section will be presented and discussed. Conclusion: In the era of the coronavirus disease 2019 pandemic, the available remote services can be a safe, feasible, and satisfactory alternative to classical activities. A few modifications to the CI workflow would be beneficial in maintaining the number of CI cases as well as the quality of service while assuring public health matters.

Keywords : Multi Centre, Cochlear, Pandemic

Miscellaneous

PP 293

Our Experience of 1100 Cochlear Implants in The State of U.P. in The Government Program

Rohit MEHROTRA

Otorhinolaryngology, Mehrotra Ent Hospital, Kanpur, India

Over the last few years cochlear implantation has become the most important treatment modality for children with severe to profound sensory neural hearing loss Earlier the implant age better the verbal language development. This retrospective study is based on assessment of outcome of cochlear implantation at Late Dr. S. N. Mehrotra Charitable ENT foundation between 2016 to March 2023 by taking into account various scoring systems like category of auditory performance (CAP), Speech intelligibility rating (SIR) and Glasgow children benefit inventory (GCBI). 1100 children with bilateral severe to profound sensory- neural hearing loss, hearing aid trial for minimum of 3 months, normal psychological assessment and normal cochlea on radiology, who were implanted between 2016 to March 2023 were included in our study. Malformed cochlea, multiple disabilities and any additional psychological issue in the child were excluded from the study. The results were analyzed using the above scoring system to assess the performance level and quality of life of each implanted children taking into consideration practical issues in Indian set up. The subjects were followed up for a maximum period of 5 years after implantation. 90% of total children implanted showed significant improved hearing, 80% with significant speech benefit and 90% with improved quality of life. Outcomes in terms of quality of life, auditory perception and rehabilitation was very good. Considerable improvement in hearing, speech and overall quality of life in almost 80% of children. Early age of implantation showed better hearing, better speech and better quality of life. Government program has a lot of challenges which have to be considered while evaluating the results.

Keywords : Category of auditory performance, Glasgow children benefit inventory, Speech intelligibility rating

Miscellaneous

PP 294

COCHLEAR IMPLANT IN A CASE OF PENDRED SYNDROME - BILATERAL SENSORNEURAL HEARING LOSS WITH HYPOTHYROIDISM AND GOITRE

Rohit MEHROTRA

Ent, Mehrotra Ent Hospital, Kanpur, India

We present a child of Indian origin with Pendred syndrome who underwent cochlear implant at Mehrotra ENT Hospital, Kanpur, India. Patients with Pendred syndrome represent challenging cochlear implant candidates, combining goitre, severe to profound hearing loss, and inner ear dysplasias. Cochlear implantation is the proper method for optimal hearing rehabilitation in patients with Pendred syndrome. The genetic background is a mutation of the SLC26A4 gene, coding for a transmembrane protein with anion transport function, called Pendrin. Child was implanted and rehabilitated at our center. Outcomes in terms of hearing, speech, and quality of life is comparable to cases with non-syndromic hearing loss.

Keywords : Goitre, Mutation, Pendrin

Miscellaneous

PP 295

Development of a Core Outcome Set to Evaluate Remote Technologies for Cochlear Implant Users

Cathy SUCHER[1,2], Emma LAIRD[3], David ALLEN[4,5], Hellen CULLINGTON[6], Isabelle BOISVERT[7], Rene GIFFORD[8], Melanie FERGUSON[1,9]

[1]Brain and Hearing, Ear Science Institute Australia, Australia
[2]Medical School, The University of Western Australia, Australia
[3]Melbourne Audiology and Speech Pathology Clinic, The University of Melbourne, Australia
[4]Incept Labs, Incept Labs, Australia
[5]Department of Linguistics, Faculty of Medicine, Health, and Human Sciences, Macquarie University, Australia
[6]University of Southampton Auditory Implant Service, University of Southampton, UK
[7]Faculty of Medicine and Health, University of Sydney, Australia
[8]Vanderbilt University Medical Center, Vanderbilt University, USA
[9]Curtin Medical School, Curtin University, Australia

Background: The use of telehealth for CI service provision has the potential to significantly improve the ability for CI services to provide efficient, effective, equitable services, and personalized care to CI users. It is essential to demonstrate that remote service provision provides at least equivalent care to face-to-face clinical care for regulatory purposes, as well as ensuring the trust and confidence of all stakeholders in the outcomes of the telehealth service. Using relevant and sensitive outcome measures to evaluate remote CI services is vital to facilitate evidence-based health care services.

We aimed to develop a Core Outcome Set to evaluate remote CI services to maximise the potential benefits of remote care, and ensure optimal and personalised care.

Methods: A systematic review of literature and online scoping workshops with key stakeholders (CI users, their partners, and CI professionals) were conducted to identify core elements and outcome domains to measure markers of service quality. These informed two parallel three-round Delphi reviews (CI users and CI professionals surveyed separately), to determine an ≥80% consensus of core outcome domains. Participants were recruited from Australia, the US and UK and included adult CI users (≥18 years old), and CI professionals. Round one is complete, with 119 participants (76 CI users, 43 CI professionals). The final round of surveys will be completed in August 2023.

Results:
The systematic review specified eight core elements (Physiological and Clinical; Physical Functioning; Cognitive Functioning; Emotional Functioning and Wellbeing; Delivery of care – device; Delivery of Care – service; Resource Use; Adverse Events). A total of 57 outcome domains were identified. The most relevant domains will be surveyed in Rounds 2 and 3 to obtain consensus.
Conclusion
This ongoing study will identify a minimum core set of outcomes to be used to assess benefits of remote technologies for CI users.

Keywords : Outcomes, Remote Care, Cochlear implants

Miscellaneous

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Assessment of Cognitive Function Changes Following Cochlear Implantation in Pre-School Children

Amit GOYAL[1], Dipika PRAKASH[1], Dolat Singh SHEKHAWAT[2], Tanu GUPTA[3], Vidhu SHARMA[1], Darwin KAUSHAL[4], Sourabha Kumar PATRO[5], Kapil SONI[1], Bikram CHOUDHURY[1], Daisy KHERA[2], Kuldeep SINGH[2]

[1]*Otorhinolaryngology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India*
[2]*Pediatrics, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India*
[3]*Psychiatry, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India*
[4]*Otorhinolaryngology, All India Institute of Medical Sciences, Bilaspur, Himachal Pradesh, India*
[5]*Otorhinolaryngology, Post Graduate Institute of Medical Education & Research, Chandigarh, India*

Objective: The study was aimed to assess the changes in cognitive function following cochlear implantation during a 6 month follow up in preschool children. We also evaluated various factors influencing the cognitive outcome post-implantation in these children.
Methodology: Bayley Scales of Infant Development (Edition III) was used to assess the cognitive function of 9 children of pre-school age-group with bilateral congenital profound hearing loss pre-operatively. Device was switched on postoperatively followed by a post-operative cognitive assessment at 6 months. A serial 3 monthly assessment of auditory improvement was done post operatively, using CAP score and IT-MAIS. Various factors influencing cognition were assessed. The data was analyzed for correlation.
Results: The age of the children varied from 1 year 9 months to 3 years 2 months; 77.78% were males. All nine candidates showed significant improvement in their cognitive scores at 6 months post operatively, with a median of 5.88% and inter-quartile range (IQR) of 5.55% to 24.26% (p-value = 0.012). There was a positive correlation between the improvement of cognition and the CAP scores as well as IT-MAIS scores at 3 monthly intervals post CI. However, it was not statistically significant.
The other factors assessed included the socio-economic status, pre-operative hearing aid usage, birth order, age at presentation and type of family.
Conclusion: At 6-month follow-up after switch-on, preschool children showed marked improvement in non-verbal cognitive functioning and working memory. The usage of age adjusted cognitive tool precludes the inclusion of a control group to draw a conclusion that, the improvement in cognition is due to auditory stimulation. Significant upgradation of the auditory function was noticed at 3- monthly follow up.

Keywords : Cochlear implantation, Cognitive function, Pre-school children

Miscellaneous

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Educating and Empowering Families of Cochlear Implant Users

Leena Rajesh VISHWAKARMA[1], Shabda Brahma AHMEDABAD[1]

[1]*Speech Hearing and Re Habilitation, Shabda Brahma, India*

Cochlear Implant is the best proven treatment for individuals with severe to profound hearing loss. However the outcomes varies from individual to individual, depending upon the various factors. We have realized that overall successful outcomes depends not only on its users but also upon the active involvement of the family members , extended family and support from professionals and society. And hence Educating and Empowering families of Cochlear Implant users become the essential part of the program for a long and successful run. In the present study we have analyzed the data of 1000 Cochlear Implant Users (both Children & Adults) at the Shabda-Brahma Cochlear Implant Centre - Ahmedabad. Based on our Experience with families of Cochlear Implant users and their overall performance in their Speech and Auditory Skills, we found out things which are needed to empower families of Cochlear Implant Users and identified the Barriers which hamper the overall performance and empowerment of families. Results of the present study indicated that involvement of family members, combating their psychological, comprehensive, financial and other issues becomes essential part to sustain proper balance between parents and professionals. And that is why Family Education and Empowerment should begin before Cochlear Implantation. The users whose family members were empowered prior to implantation and also during the journey of learning to hear and speak, performed significantly better.

Keywords : Children with Hearing Impairments, Early intervention Programs, Sensory Neural Hearing Loss, Cochlear Implants, Re-Habilitation program, Education and Empowerment of Families, Parental knowledge, Parental involvement, Parental support, Parental needs and mental stress, optimum expectation, Disability Certificate and concession, Mainstreaming, Education and Empowerment of Families

Miscellaneous

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Theory of mind in children with cochlear implants: comparison with age- and sex-matched children with normal hearing

Sung Wook JEONG[1], Young-Mi CHOI[1], Ji-Hye KIM[1], Lee-Suk KIM[1]

[1]*Department of Otolaryngology, College of Medicine, Dong-a University, Korea*

Objectives: Theory of mind (ToM) is a crucial ability for maintaining normal social interaction and is directly related to language ability. This study was performed to compare ToM between children with congenital hearing loss who have received cochlear implantation (CI) and those with normal hearing (NH).
Methods: One hundred children, aged 2–12 years, participated: 50 children who received CI before 36 months of age (CI group) and one-to-one age- and sex-matched children with normal hearing (NH group). All children underwent tests to examine receptive language ability and ToM. Receptive language was measured using the Receptive and Expressive Vocabulary Test, and ToM was measured using the Theory of Mind Task Battery (ToM-TB). The scores of the two tests were compared between the CI and NH groups.
Results: The ToM-TB score in the CI group correlated positively with age and receptive language score. ToM-TB scores did not differ significantly between children in the CI group who achieved normal receptive language and the NH group. However, these children in the CI group scored lower than those in the NH group on some advanced ToM tasks that require the ability to understand second-order emotion, message–desire discrepancy, or second-order false belief.
Conclusions: This case–control study found that children with CI who achieve normal receptive language ability have ToM that is similar to that in children with NH. However, these children exhibited weakness in advanced ToM skills. Interventions to facilitate the development of advanced ToM are needed for children with CI.

Keywords : Theory of Mind, Cochlear implant, Children

Miscellaneous

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Increased Risk of Dementia Following a Diagnosis of Hearing Impairment: A South Korean Nationwide Cohort Study

Minah PARK[1,2], Sung-In JANG[2,3], Kyungduk HURH[2,3], Eun-Cheol PARK[2,3], **Seung Hoon KIM[1,2]**

[1]*Institute of Health Services Research,, Yonsei University, Korea*
[2]*Department of Preventive Medicine, Eulji University College of Medicine, Korea*
[3]*Department of Preventive Medicine, Yonsei University College of Medicine, Korea*

Background: Among the elderly, hearing impairment is a common problem and may contribute to dementia.
Objective: Therfore, we aimed to examine the association between hearing impairment and the risk of dementia among older adults in South Korea.
Methods: Using the Korean National Health Insurance Service-Senior Cohort from 2005 to 2019, we collected data of 44,728 patients. Hearing impairment was determined using the national disability registry. Propensity score matching (1:1) was performed to match patients with and without hearing impairment (case: 22,364, control: 22,364). A Cox proportional hazards regression model was built to analyze the association between hearing impairment and dementia.
Results: Patients with hearing impairment had a higher risk of dementia than those without hearing impairment (hazard ratio [HR] = 1.28, 95% confidence interval [CI] = 1.23–1.34). Assessing the degree of disability, both severe (HR=1.25, 95% CI=1.16–1.35) and mild conditions (HR=1.29, 95% CI=1.23–1.35) had an increased risk of dementia, respectively.
Conclusion: Older patients with hearing impairment exhibit an increased risk of dementia, thereby warranting a new approach to dementia care among these patients regardless of the degree of hearing impairment.

Keywords : Hearing Impairment, Dementia, Hearing Loss

Miscellaneous

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SURGICAL & AUDIOLOGIC RESULT OF COMBINED AURICULO-MEATOPLASTY IN MICROTIA

Ho-Ki LEE[1], Jaiho CHUNG[2]

[1]Otology, Soree Ear Clinic, Korea
[2]Plastic Surgery, Profile Plastic Surgical Center, Korea

Purpose: The goal of microtia surgery is to create both good function and good appearance of the ear. There continues to be controversy over who should operate first, the plastic or the ear surgeon. There are advantages and disadvantages of each meatoplasty before, and after auriculoplasty. The purpose of this study is to review the surgical & audiologic result of combined auriculo-meatoplasty performed by plastic and ear surgeon together to overcome the disadvantages of each microtia surgery.
Material & Method: Forty patients (average age: 17 years old, ranging from 4 to 50) underwent the combined meatoplasty and auricular reconstruction with endoscope-assisted temporoparietal fascia flaps using Medpor since August 2018. Physical outcome of auricle and meatus (location, appearance, and complication rate) and hearing results were evaluated.
Results: Skin flap showed edematous state until postoperative 3 months. Two cases of exposed Medpor from auricle were noted. Five patients has lower lying auricle than we designed preoperatively. However, the position of auricle was corrected with an additional surgery. Postoperative average hearing gain was 33 dBHL when the tympano-ossiculoplasty was performed. A case with sensorineural hearing loss worse than 10 dBHL and two cases of high frequency hearing loss after surgery were identified. There were 11 cases that required the mold for prevention of postoperartive stenosis at meatal orifice.
Conclusion: Combined auriculo-meatoplasty performed by plastic and ear surgeon together has many advantages including fewer surgical stages, immediate ear projection, and early hearing restoration. However, a delicate intraoperative & postoperative care is mandatory to prevent complications.

Keywords : Microtia, Meatoplasty, Auriculoplasty

Miscellaneous

PP 301

Longitudinal Analysis of Cochlear Implant Outcomes and Associated Variables in Children with Additional Disabilities

Eung-Kyung CHO[1], **Sang-Yeon LEE[2]**, Myung-Whan SUH[3], Moo-Kyun PARK[3], Junho LEE[3], Seung-Ha OH[3]

[1]Speech & Hearing Center, Seoul National University Hospital, Korea
[2]Genomic Medicine, Precision Medicine & Rare Disease Center, Otorhinolaryngology-head and Neck Surgery, Seoul National University Hospital, Korea
[3]Otorhinolaryngology-head and Neck Surgery, Seoul National University Hospital, Korea

Objectives
The this study aims to examine the outcomes of cochlear implantation (CI) children with additional disabilities and identify associated variables.

Methods
In this study, we utilized a retrospective design and focused on 129 children who underwent CI within the Seoul National University Hospital, Korea, between March 2013 and February 2020. Auditory performance, language development, and communication skills were assessed longitudinally at 1, 2, and 3-year post-implantation. The Categories of Auditory Performance (CAP) score was used to quantify auditory perception abilities, and language development was assessed through Language Quotient scores. Communication skills were evaluated using a 9-point rating scale. Variables including age at implantation, CI use duration, molecular-genetic etiology, and disability type were analyzed.

Results
In this study, we analyzed data from 62 pediatric recipients for whom 3-year post-implantation outcomes were available. Our data revealed significant longitudinal improvements in auditory performance, language development, and communication skills for pediatric recipients with additional disabilities. Specifically, the CAP score improved from 0 pre-implantation to 5 at the 3-year post-implantation. Language Quotient scores showed an increase from 19.8 to 47.11. Interestingly, 84% of the subjects primarily employed behavior, gestures, or vocalization (scored 0 to 2) for communication, while half of the subjects transitioned to using oral language (scored 7 to 8) postoperatively. Nevertheless, the rate of improvement plateaued after the 2-year following implantation, which awaits further exploration. Among the variables analyzed herein, the type of disability was found to be significantly associated with the CI outcomes.

Conclusion
In pediatric CI recipients with additional disabilities, the auditory and language performance, as well as communication skills, demonstrate variability but generally exhibit improvement over time. The preoperative identification of the type of disability, coupled with specific molecular-genetic etiology, could serve as a predictive factor for CI outcomes, facilitating more precise, personalized guidelines for children with additional disabilities.

Keywords : Cochlear implant, Additional disabilities, Outcomes

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