12th International Conference on Cochlear Implants and Other Implantable Auditory Technologies

Thursday, May 3, 2012

Scientific Session I Oral Abstracts

10:30 AM – 12:00 PM

Thursday (10:30 AM - 12:00 PM) Marriott Grand 1 - 5 — Presentation 1

Topic: Basic Science I

Title: An Introduction to Ion Channel Biology of the Inner Ear

Author(s): Paul Fuchs

Presenter: Paul Fuchs

Abstract: Signaling in the inner ear, as throughout the nervous system, involves bio-electricity. Neurons and other cells make bio-electric signals by the specialized movements of ions found in body fluids, principally, sodium, potassium, calcium and chloride. These ions obey simple physical rules: move down the concentration gradient, and move toward opposite charge. Neurons use these rules to generate ionic currents through selective channels that then change the membrane potential of the cell. The resulting transient signals are called 'action potentials', 'synaptic potentials', and 'receptor potentials', and they occur on top of steady-state 'resting potentials'. For example, the action potential results from the sequential flux of sodium, then potassium ions. These ionic currents flow through selective pores: sodium channels and potassium channels, distinct proteins encoded by independent families of genes. For an acoustic, or vestibular, input to reach the brain, the stimulus energy must be transduced into a receptor potential in sensory hair cells. Voltage-gated calcium channels drive the release of glutamate from the hair cell onto an associated afferent neuron. If large enough, resulting synaptic potential can trigger an action potential that carries information to the brain. This introductory talk will review this sequence of steps, explain the basic mechanisms and point out some of the beautiful but challenging specializations of ion channel expression in the inner ear.

Learning Objective: Recognize the basics of bio-electricity.

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 1 - 5 — Presentation 2

Topic: Basic Science I

Title: The Sound Sensation of Apical Electric Stimulation in Cochlear Implant Recipients with Contralateral Residual Hearing

Author(s): Diane S. Lazard, Jeremy Marozeau, Hugh McDermott

Presenter: Diane S. Lazard

Abstract: Background: Studies using vocoders as acoustic simulators of cochlear implants have generally focused on simulation of speech understanding, gender recognition, or music appreciation. The aim of the present experiment was to study the auditory sensation perceived by cochlear implant (CI) recipients with steady electrical stimulation on the most-apical electrode. Methodology/Principal Findings: Five unilateral CI users with contralateral residual hearing were asked to vary the parameters of an acoustic signal played to the non-implanted ear, in order to match its sensation to that of the electric stimulus. They also provided a rating of similarity between each acoustic sound they selected and the electric stimulus. On average across subjects, the sound rated as most similar was a complex signal, inharmonic in 3 out of 5 subjects.Conclusions/Significance: For these subjects, the sound sensation created by steady electric stimulation on the most-apical electrode was neither a white noise nor a pure tone. It was a complex sound with a concentration of energy around 523 Hz, and in 3 out of 5 cases with a moderate, progressive increase in the spacing between the frequency components.Auditory samples will be provided.

Learning Objective: Recognize the psychoacoustic properties of the sound sensation of a pulse train

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 1 - 5 — Presentation 3

Topic: Basic Science I

Title: Experimental study of the 1D array beam type piezoelectric artificial basilar membrane

Author(s): Sangwon Kim, Won Joon Song, Hongsoo Choi

Presenter: Sangwon Kim

Abstract: In this work, an experimental study on 1D array beam type artificial basilar membrane (ABM) is conducted to mimic the passive hearing mechanism of human. Piezoelectric thin-film structures have found a wide variety of applications in emerging MEMS technologies. For electro-mechanical applications in micro scale, piezoelectric thin-film is commonly used as the actuating or sensing component in these structures. We fabricated 1D array type piezoelectric thin-film beam structures with different lengths and widths using MEMS technology. For each array a constant width was used as 100, 200, 300 and 400 µm. The lengths were varied from 300 µm ~ 3300 µm. The variation of the beam length is required to make each beam has different resonance frequency, so that each beam will response at different incoming sound frequencies. Mechanical responses of the beam array were measured using laser Doppler scanning vibrometer (LDSV). The transfer function defined as the ratio between the displacement and the input voltage was mainly investigated for consistent comparison among the responses. Tracking the beam of maximum response at each frequency showed that the ABM has frequency separation capability in the range of 2-14 kHz. Mechanical resonance characteristic of the beam array also provided a strong support to the capability of the ABM. 1D array type piezoelectric thin-film beam structures have been fabricated and the characteristics of the devices are under investigation. The possible areas that need to be investigated further to improve the frequency separation capability of the ABM will be also discussed in this presentation. The ultimate goal is using the developed ABM for the next generation of artificial cochlea.

Learning Objective: Identify numerical analysis for piezoelectric artificial basilar membrane determination of the geometry of the micro scale ABMdesign of a total implantable 1D array beam type ABM

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 1 - 5 — Presentation 4

Topic: Basic Science I

Title: Optical coherence tomography (OCT) sensor guided cochlear implant electrode insertion

Author(s): Wade Chien, John Niparko, Iulian Iordachita, Russell Taylor, Jin Kang

Presenter: Wade Chien

Abstract: Objective: The primary objectives of cochlear implant electrode insertion are: 1) to ensure proper positioning of electrode array in the scala tympani; and 2) to avoid trauma to the cochlear neurosensory epithelium. It has been shown that careful, atraumatic electrode insertion can improve hearing outcome. However, currently all cochlear implant electrodes are inserted into the cochlea blindly. In this study, we incorporate a single fiber optical coherence tomography (OCT) probe within the cochlear implant electrode array and investigate its use during the electrode insertion process. Study Design: Cochlear implant electrode insertion is tested both in plastic models of the cochlea as well as in human cadaveric temporal bones. The electrode being inserted is coupled to a single fiber OCT probe, which will provide anatomical feedback within the cochlea during the electrode insertion.Results: When the OCT-coupled cochlear implant electrode is inserted into both the plastic models of the cochlea as well as the human cadaveric temporal bones, the OCT is able to accurately detect the cochlear sidewalls before the electrode makes contact with them. This allows for the identification of the optimal location for stylet withdrawal if a stylet is being used.Conclusion: Optical coherence tomography offers an exciting way of visualizing the cochlea during cochlear implant electrode insertion. This could potentially allow surgeons to more accurately navigate around the cochlea and minimize insertion trauma, resulting in better hearing outcomes.

Learning Objective: Identify the challenges of cochlear implant electrode insertion.

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 1 - 5 Presentation 5

Topic: Basic Science I

Title: Application of triphasic pulses with adjustable phase amplituderatio (PAR) for cochlear ECAP recording: Amplitude growth and recovery functions.

Author(s): Andreas Bahmer

Presenter: Andreas Bahmer

Abstract: Triphasic electrical stimulation pulses with an adjustable phase amplitude ratio (PAR)can reduce stimulus artifacts in electrically evoked compound actions potential recording (ECAPs) in the cochlea. An elaborate systematic evaluation of PAR for artifact reduction has not yet been conducted. In the present paper, the effect of PAR variation on human ECAP recordingand the feasibility of amplitude growth and recovery function. Measurements were accomplished in five subjects (S1-S5), whereby more detailed test series were carried out in one subject (S1) (Devices from MED-EL, Innsbruck). A comparison of PAR optimized triphasic pulses was carried out against two other measurement techniques (biphasic alternating polarity stimulation and stimulation according to Miller). ECAP recording with triphasic pulses showed drawbacks: additional artifacts depending on stimulation and/or recording parameters are introduced, the ratio between the additional artifact and improved detectability of neural responses is dependent on PAR, and response thresholds obtained with triphasic pulses are in most cases substantially higher compared to thresholds measured with the Miller method. Higher thresholds most probably occur because the triphasic pulse patterns seem to less effectively stimulate neural structures compared to biphasic pulses. For certain electrode groups threshold profiles obtained with triphasic pulses were found to be similar compared to stimulation with biphasic pulses.Results in recording recovery functions were compared with data applying artifact cancellation strategy for biphasic pulses according to Miller (Miller et al., 2000). Measurements collected in subject S1 showed similar parameter profiles on basal electrode contacts, whereas apical/middle electrode contacts differed in part largely. Compared to Miller's artifact cancellation method estimated asymptote levels were lower with triphasic stimulation; the estimated absolute refractory period and time constants were estimated higher on apical electrodes. In S2-S5 congruencies in estimated asymptote levels and time constants were found when triphasic stimulation and biphasic stimulation according to Miller were compared.

Learning Objective: Summarize the implementation of triphasic pulse patterns designed for the recording of ECAP with a cochlear implant stimulator allows measurements of amplitude growth functions.

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 1 - 5 Presentation 6

Topic: Basic Science I

Title: Robot-assisted, sensor-guided cochlear implant electrode insertion

Author(s): John Niparko, Wade Chien, Iulian Iordachita, Jin Kang, Russell Taylor

Presenter: Wade Chien

Abstract: Objective: The primary objectives of cochlear implant electrode insertion are: 1) to ensure proper positioning of electrode array in the scala tympani; and 2) to avoid trauma to the cochlear neurosensory epithelium. Although it has been shown that careful, atraumatic electrode insertion can improve hearing outcome, several factors (including hand tremor and lack of feedback on the electrode-to-cochlear relationship during the insertion process) can limit surgeons' ability to achieve this. Our goal is to develop a system addressing human sensory-motor limitations in cochlear implant surgery.Study Design: The key components of our approach include a cooperatively controlled "steady hand" robot, OCT and other imaging subsystems, and human-machine interfaces. In our approach, the robot senses forces exerted by the surgeon on the tool and moves accordingly, but with extreme precision and without tremor. OCT or other imaging may be used to sense the cochlear geometry relative to the robot and electrode array, and a variety of "virtual fixtures" and other modes for assisting the surgeon can be implemented. Results: In preliminary experiments, we have demonstrated using a 0.5 mm optical bore scope to provide visual guidance into the cochlea of a human cadaveric temporal bone. We have also demonstrated insertion of an electrode array into a cochlear phantom. In related experiments, we have explored replacing the stylet in an electrode array with a forward-looking OCT optical fiber in order to sense the proximity of the electrode array to the first turn of the cochlea. Finally, we have begun conceptual design of custom tooling for robotic manipulation of electrode arrays and stylets. Further experiments and integration of a complete system are planned.Conclusion: A systems approach combining robotics, OCT and other imaging subsystems, and cooperative human-machine interfaces offers significant potential to assist surgeons in achieving atraumatic insertion of electrode arrays into the cochlea.

Learning Objective: Recognize the challenges of cochlear implant electrode insertion

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 6 - 10 — Presentation 7

Topic: ABI

Title: Outcome of cochlear versus auditory brainstem implantation in 21 children with cochlear nerve absence

Author(s): Liliana Colletti, Marco Mandalà, Vittorio Colletti

Presenter: Vittorio Colletti

Abstract: Objectives: To compare outcomes obtained from 21 patients with cochlear nerve absence (CNA) receiving first a cochlear (CI) and subsequently an auditory brainstem implantation (ABI). Study Design: Individual retrospective cohort study from 2000 to 2011. Methods: Between 2000 and 2011, 21 children with profound hearing loss received a CI and subsequently, due to failure in making progress after explantation an ABI on the same side. The perceptual auditory abilities obtained after CI and ABI were investigated with the Category of Auditory Performance (CAP). Results: MRI identified bilateral CNA in 14 children before CI and in 7, after CI explantation, before ABI. Thirteen children had associated disabilities, 6 with also comorbidities. Seven children had associated intracranial abnormalities. Fourteen children had cochlear abnormalities. The vestibules were normal in 4 children and abnormal in 8. The cochlea and auditory canal were normal in 7 children. CAP scores with CI immediately before ABI showed in 11 patients CAP 0, in 7 CAP 1 and in 3 CAP 2. CAP scores with ABI at the last follow-up showed in 3 patients CAP 1, in 4 CAP 2, in 5 CAP 3, in 3 CAP 4, in 2 CAP 5 in 1 CAP 6 and in 3 CAP 7.Conclusions: In children with CNA CIs provides limited possibilities of developing auditory abilities while ABIs offer the opportunity for developing open set speech perception and acquiring speech with through restoration of audition. These findings have important implications in the decision making of selection the appropriate device for the rehabilitation of children with CNA.

Learning Objective: Recognize that children with CNA CIs provides limited possibilities of developing auditory abilities.

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 6 - 10 — Presentation 8

Topic: ABI

Title: Auditory brainstem implantation in neurofibromatosis type II patients

Author(s): Stefan Brill

Presenter: Stefan Brill

Abstract: Background: In neurofibromatosis type 2 (NF2) cases, the patients likely suffer from lesions at the acoustic nerve due to tumor growth. In such cases sometimes auditory brainstem implantation (ABI) can be a successful treatment.Methods: 32 patients received a Med-El Combi40+ or PulsarCI100 ABI and were enrolled post-surgically. Non-auditory side effects of individual electrode stimulation were evaluated at fitting, those electrodes were deactivated. Speech and environmental sound recognition performancewas determined using the Sounds Effects Recognition Test (SERT), Monosyllable Trochee Polysyllable (MTP) test and open set sentence test. Subjective benefits were determined by questionnaire.Results: SERT and MTP outcomes under auditory-only conditions improved significantly between first fitting and 12 months. Open set sentence recognition improved from 5% at first fitting to 34% after 12 months. The number of active electrodes as determined by the presence or absence of non-auditory side effects, had no significant effect onperformance. All questionnaire respondents where 'adequately to very' satisfied with their ABI.Conclusion: ABI is an effective treatment option in NF2 patients with the potential to provide open set speech recognition.

Learning Objective: Explain that a substantial percentage of NF2 patients treated with ABI achieves open set speech understanding.

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 6 - 10 — Presentation 9

Topic: ABI

Title: The Subjective Outcome of Auditory Brainstem Implantation

Author(s): Amanda McSorley, Jamie Motion, Deborah Mawman, Martin O'Driscoll, Simon R Freeman, Scott Rutherford, Andrew T King, Simon K Lloyd

Presenter: Amanda McSorley

Abstract: AIM:To assess subjective benefits of auditory brainstem implants (ABI) with particular reference to daily duration of use, auditory fatigue and differentiation between speech and environment and speech quality. This study also aimed to investigate the extent to which patients perceive the ABI to be a useful deviceMETHODS:Between 1994 and 2009 57 patients were fitted with an ABI. The aetiology of hearing loss was Neurofibromatosis Type 2 (54), otosclerosis (2) and unknown temporal bone inflammation (1). A total of 31 living patients who were using the device were sent an ABI questionnaire. Data were collected on the following areas:• Daily duration of use• Auditory fatigue• Differentiation between speech and environment• Differentiation between speech qualities• Subjective assessment of ABI usefulnessRESULTS:Of 31 eligible patients, 23 returned completed questionnaires. One form completed on a patient's behalf was excluded. Mean duration of usage per day was 12.62 hours (Range 8-16). Auditory fatigue was reported in 70% of patients and 71% turned the processor off at one or more points during the day. Differentiation between speech and environment was achieved in 95% and 70% were able to differentiate between speech qualities. The ABI was perceievd to be most beneficial when speaking to a familiar voice in a quiet place, with 15% patients rating it as very useful or better. When used in conjunction with lip-reading, this figure rose to 60%. CONCLUSIONS:Overall, the ABI provides a modest restoration in hearing and is generally well tolerated with over 50% patients able to use the device for extended periods each day. It enables differentiation between speech and environmental sounds as well as male, female, adult and child voices. The greatest subjective benefit perceived by patients is its usefulness in conjunction with lip-reading, with those who received lip-reading training reporting the most benefit.

Learning Objective: Assess the extent to which patients perceive the ABI to be a useful device

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 6 - 10 — Presentation 10

Topic: ABI

Title: Outcome of cochlear implantation in patients with vestibular schwannoma

Author(s): Luis Lassaletta, Rosa Perez-Mora, Isabel Sanchez-Cuadrado, Marta Bastarrica, Javier Gavilan

Presenter: Luis Lassaletta

Abstract: ObjectivesIn recent years, some cases of cochlear implantation in patients with VS have been reported. The main issue is how to know if the cochlear nerve will be able to carry the electrical stimulus to the brainstem. The precise effect of radiotherapy on the outcome is still unknown. The aim of this study is to present our experience with cochlear implants in patients with VS, including decision issues, surgical aspects, and outcome.Study DesignRetrospective study of all patients with VS undergoing cochlear implantation in La Paz University Hospital, Madrid. Five patients were included, 3 of them implanted in the same side of the tumor. A case note review was undertaken and data collected on preoperative and postoperative speech perception testing.ResultsPatients with implantation contralateral to the tumor achieved excellent open-set speech recognition. Patients with ipsilateral implantation had no postoperative complications. The audiological outcome was variable, all of them being users initially. In one patient, who had implantation in a previously radiated tumor, the performance decreased 1 year following surgery and the implant was removed. The other 2 patients are current users. Both had a translabyrinthine approach with preservation of the cochlear nerve. One is a NF2 patient with previous radiation. She uses the implant daily although she obtains only improved access to environmental sound and lip-reading skills. The other patient achieved open-set speech recognition and is also a daily user. ConclusionOur study confirms that cochlear implantation may offer at least the same results as ABI with much less morbidity. Open-set speech communication is possible in certain cases. Variability in auditory performance depends on the status of the cochlear nerve. Early surgical intervention in NF2 patients when the cochlear nerve can be spared is an important consideration to allow for possible cochlear implantation.

Learning Objective: Manage patients with NF2 or vestibular schwannomain the only hearing ear from an audiological perspective.

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Thursday (10:30 AM - 12:00 PM) Marriott Grand 6 - 10 — Presentation 11

Topic: ABI

Title: Cochlear Implantation in single side deafness after translabyrinthine removal of acoustic neuromas

Author(s): Thomas Klenzner, Marcel Weller, Wiebke van Treeck, Ines Blümel, Maika Frommelt, Albert Thauer, Jörg Schipper

Presenter: Thomas Klenzner

Abstract: Background:Translabyrinthine resection of tumors of the inner ear canal and cerebellopontine angle (CPA) leads to deafness on the surgical treated ear. As restoration of hearing in cases of single side deafness appears more and more in the focus of cochlear implantation, the rehabilitation of hearing of the same ear seems to be possible in certain circumstances for patients with acoustic neuromas. Methods:We report about our concept and results in three patients, treated in tertial reffering setting, who underwent translabyrinthine resection of an acoustic neuroma and consecutive cochlear implantation on the same ear. The removal of the tumor was complete in all mentioned cases and the cochlear nerve could be preserved. In two cases the CI was implanted sequential in one case simultaneously. No other severe complications occurred so far.Results:As the patient with the simultaneously implantation is waiting for the first fitting, the two other patients received an open speech understanding on the implanted ear (80% monosyllables at 65 dB) after 6 months of use. The personal feedback with regard to the hearing impression in daily life situations is very positive.Conclusion:In our opinion under specific conditions cochlear implantation gives the possibility to restore hearing after translabyrinthine resection of tumors of the inner ear canal and CPA.

Learning Objective: Recognize the possibility to provide patients with a cochlear implant who underwent translabyrinthine resection of acoustic neuromas.

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Thursday (10:30 AM - 12:00 PM) Four Seasons Grand Ballroom — Presentation 12

Topic: Imaging

Title: Can preoperative temporal bone CT scan predict the operative difficulties to access the round window membrane for atraumatic cochlear implantation?

Author(s): Alexandre Karkas, Nicolas Menjot De Champfleur, Jean-Luc Puel, Frédéric Venail

Presenter: Frédéric Venail

Abstract: Objectives: To search for a correlation between radiological and anatomical measurements of round window (RW) region and try to predict on CT the degree of exposure and difficulties to access the RW membrane (RWM) for atraumatic insertion of electrode arrays (EAs), i.e. without crossing the basilar membrane.Study design: Ten cadaveric temporal bones (TBs) were CT scanned then underwent facial recess approach (FRA); radiological and anatomical measurements were thus performed. CT scans of 126 normal TBs from living subjects were analyzed and compared with cadaveric TBs. Thereafter, the degree of exposure “H” of RWM through the earcanal and a theoretical FRA was calculated on CT of the 126 TBs. To confirm these results, the degree H was calculated on CT of another 7 cadaveric TBs and EAs of various apical diameters (0.25-0.5mm) were tested in situ on them after performing FRA.Results: There was no statistically significant difference (SSD) between radiological and anatomical measurements of the 10 cadaveric TBs and no SSD between radiological measurements of the 10 cadaveric TBs and 126 control TBs (p>5%). All measurement values will be provided. The degree H was much greater through FRA than through the earcanal and access to RWM was feasible in most cases of FRA. Access to RWM through the earcanal was difficult and cochleostomy was needed in most cases. As for the 7 newly tested TBs, there was a good correlation between radiological and in situ trials. The basilar membrane remained intact in all 7 cases. Conclusion: Our work is unique in that it compares on the same TBs anatomical and radiological measurements of landmarks for RW surgery. By analyzing CT scan, we were able to predict the degree of exposure of RWM. FRA provides an excellent access to RWM and is very appropriate for atraumatic RWM insertion of EAs.

Learning Objective: Recognize anatomical landmarks with respect to the round window region.

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Thursday (10:30 AM - 12:00 PM) Four Seasons Grand Ballroom — Presentation 13

Topic: Imaging

Title: Use of Cone Beam imaging to determine intra-cochlear electrode position in human temporal bones

Author(s): Shakeel Saeed, David Selvadurai, Nigel Biggs

Presenter: David Selvadurai

Abstract: Objectives: To determine the validity of cone beam CT imaging as a method of accurately determining intra-cochlear electrode position in human temporal bones. Cone beam CT offers several advantages over traditional high resolution CT imaging including:• Lower radiation dose (50 – 650 µSv) • Reduced flaring from electrode artefacts• Lower cost Study Design: A double-blind study design using fresh-frozen cadaveric temporal bones was under taken. Two experienced cochlear implant surgeons implanted eight (8) human temporal bones with a variety of cochlear implant electrodes using both round window and cochleostomy approaches. Electrodes were fixed in position and all 8 temporal bones were then scanned using cone beam CT. All 8 bones were then sent to a third party for histological analysis. The electrode position was verified for each specimen by an independent reviewer. The cone beam CT images were sent to three independent reviewers to estimate the intra-scalar electrode position within each bone. At the conclusion of the study results were unblinded and a comparison made between the estimated intra scalar-electrode positions based on cone beam imaging and those from the histology. Results: The correlation results showed a high level of agreement between to the two techniques in relation to estimation of intra-scalar location of the cochlear implant electrode.Conclusion: Cone beam CT imaging is potentially a valid technique for estimating intra cochlear electrode positioning in cochlear implant recipients. It offers a number of advantages as a low cost, safe and highly accurate imaging technique.

Learning Objective: identify that Cone Beam CT is a lower radiation modality that can be used in Temporal Bone imaging

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Thursday (10:30 AM - 12:00 PM) Four Seasons Grand Ballroom — Presentation 14

Topic: Imaging

Title: Role of Cone-beam-CT in imaging of cochlea implants

Author(s): Christian Güldner, Rainer Weiß, Isabell Diogo, Jochen A. Werner, Afshin Teymoortash

Presenter: Christian Güldner

Abstract: Objectives: Controversy discussions about the postoperative radiological control after cochlea implantation exist. Weather to do it, and when yes, what kind is the question. One upcoming dose-saving technique with high a high resolution is the cone-beam-computed tomography (CBCT). Aim of the current study was to evaluate its limits in daily routine and to determine rates of artifact after cochlea implantation.Study Design: Data of CBCT of 182 implanted ears were analyzed regarding the possibility of determination of the intracochlear position of the electrode. Furthermore, in 3 cadaveric heads a deep insertion was performed. Data sets were analyzed for radiological diameters of the electrode, cable and cochlear under different tube adjustments.Results: All three cadaveric heads could be fully implanted with a standard electrode by MedEl. In basal and apical part of the cochlea an artifact rate of about 50% was measured. Regarding the diameter of the cochlea (basal: 1.8mm; apical: 1.2mm), the radiological diameter of the electrode (basal: 1.2mm; apical: 1.0mm) and the true diameter (basal: 0.6mm, apical: 0.5mm) it is not possible to determine the exact position of the intracochlear position of the electrode in medial and apical turn. In data set of daily routine (182 ears) in 95% of the cases it was possible to get a safe or relative safe statement about the intracochlear position of the electrode. In 1% it was unsafe and in 4% impossible. In case of deep insertion (39 ears) in none case a safe evaluation was possible. A relative safe one was reached in 33%, an unsafe in 44% and in 23% no statement was possible. Conclusion: CBCT is a usefull tool in evaluation of intracochlear position of CI-electrodes. Due to artifacts, which are less than in CT, a safe evaluation is only possible in basal turn of the cochlea.

Learning Objective: Identify that CBCT has dose advantages in comparison to conventional CT.

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Thursday (10:30 AM - 12:00 PM) Four Seasons Grand Ballroom — Presentation 15

Topic: Imaging

Title: Potential structural neuroimaging biomarkers for pediatric cochlear-implantation outcomes

Author(s): Daniel J. Tward, Scott K. Holland, Jianqiao Feng, Kristen Smith, Mekibib Altaye, Ellis Arjmand, Marguerite M Care, Jannel M. Phillips, Sara Robertson, Charlotte Ruder, J Tilak Ratnanather

Presenter: J Tilak Ratnanather

Abstract: Objectives: We aim to identify neuroimaging biomarkers (volume, thickness, surface area) of Heschl's gyrus (HG) in infants, which are predictive of hearing improvement 1 - 2 years post implantation. Such markers, in addition to data such as Cortical Auditory Evoked Potential, may impact clinical management of this population. Study Design: Computational anatomy methods were used to analyze MRI scans of hearing impaired (HI, n=11) infants (age 8-19 months) obtained by Smith et al. (Cereb. Cortex, 2011). Triangulated surfaces were extracted from white matter (WM) masks of HG which then yielded gray matter (GM) segmentations (Ratnanather et al., NeuroImage, 2003). Labeled Cortical Distance Maps (LCDMs) were computed from histograms of distances of GM voxels relative to the surface. Thickness and volume were obtained from LCDMs while surface area was obtained directly from the surface. Differences in pre- and post- implantation Multiple Frequency Averaged Thresholds were used as an audiological indicator, regressed with respect to structural and demographic variables.Results: Right HG anatomical markers may be predictive of threshold gain (thickness and volume: R2 = 0.54495, p = 0.04288). If we consider gender and its known effect on cortical thickness, a more meaningful prediction is obtained (R2= 0.7729, p = 0.038869).Conclusion: Right side anatomical markers show predictive value, with hearing improvement increasing with volume, and decreasing with thickness (particularly for males). While surface area is often an indicator of cortical function, thickness may play a role with respect to neuronal pruning at this stage of development. Our model may help predict post implantation outcome, and suggests that HI infants with thicker HG (especially males), or lower volume or surface area may benefit from a different rehabilitative strategy. Structural, in addition to functional biomarkers, should be considered in clinical management (Supported by NIH R01-DC07186 and P41- RR015241).

Learning Objective: Recognize that structural properties of Heschl's gyrus (volume, thickness, and surface area) can be identified from pediatric T1 MRI scans using tools from computational anatomy including Labeled Cortical Distance Maps.

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Thursday (10:30 AM - 12:00 PM) Four Seasons Grand Ballroom — Presentation 16

Topic: Imaging

Title: Auditory Functional MRI and Cochlear Implant Outcomes in Children

Author(s): Thomas J. Balkany

Presenter: Thomas J. Balkany

Abstract: Objective: Information regarding function of neural pathways from the cochlea through the auditory cortex may provide a method to predict outcomes and aid in side selection for cochlear implantation. The specific objectives of this study are to develop a pseudo-quantitative rank scale of afMRI in normal and hearing impaired children and to correlate preliminary CI outcomes with afMRI results. Study Design: Prospective evaluation of afMRI results in normal and hearing impaired children to develop a pseudo-quantitative rank scale (PQR). The PQR will be correlated with preliminary CI outcomes in 10 children. Results: The PQR is an effective instrument for scaling afMRI results in normal and hearing impaired children. Preliminary data comparing PQR with CI outcomes must be expanded, replicated and interpreted cautiously in predicting outcomes.Conclusion: afMRI may have clinical utility in predicting CI outcomes and side of implant selection.

Learning Objective: Describe the use of afMRI in evaluation of CI candidacy.

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Thursday (10:30 AM - 12:00 PM) Four Seasons Grand Ballroom — Presentation 17

Topic: Imaging

Title: MRT behavior of the Vibrant Soundbridge at 3 Tesla and 7 Tesla

Author(s): Ingo Todt, Arne Ernst

Presenter: Ingo Todt

Abstract: Objective: With the increasing expansion of MRI scanner of higher field strength (3T, 7T) the behavior of hearing implants in this scanner is of interest.The question of the MRI behavior of the Vibrant Soundbridge (VSB) is of high interest while beside the receiver, the magnetic floating mass transducer is attached to middle ear structures.It was the aim of this study to observe the behavior of the FMT in MRI scanner of higher field strength.Study design: Experimental.We performed laserdopplervibrometric (LDV) observations to evaluate the FMT function and temporal bone experiments to look at the attachment behavior of the FMT at the long process of the incus.Results: We observed no significant functional change of the FMT after 3 T and 7 T. At 3 T we found a removal or lose attachments of the FMT from the long process of the incus. Mechanical indications of an opening of the incustapedial joint or an opening of the footplate were not observed at 3 T under the performed experimental conditions.Conclusion: The MRI behavior of the VSB at higher field strength is of high importance. A direct sign of a structural damage under the performed experimental conditions were not observed.

Learning Objective: Recognize that FMT function is not significantly changed

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 18

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: Histological evaluation of soft tissue integration of experimental Baha abutments without soft tissue reduction

Author(s): Ulf Nannmark, Anna SA Larsson

Presenter: Anna SA Larsson

Abstract: Objectives: The protocol for Baha surgery involves reduction of soft tissue around the abutment in order to minimise the risk of skin-related complications. It is hypothesised that good soft tissue outcomes may be achieved without performing soft tissue reduction if improved abutment designs and/or materials are used that could provide better conditions for integration with surrounding soft tissue, thus reducing the risk of epidermal downgrowth and pocket formation, which cause adverse effects around percutaneous devices. The aim of the study was to investigate soft tissue integration of four different percutaneous abutment designs in an animal model. Study design: Thirty-six bone-anchored implants with 9mm percutaneous abutments were inserted in the skull of six skeletally mature sheep without performing soft tissue reduction. Four different abutment configurations were placed according to a pre-defined rotation scheme: (A) standard titanium Baha abutments, (B) standard titanium abutments coated with hydroxyapatite, (C) concave titanium abutments, and (D) concave titanium abutments coated with hydroxyapatite. The animals were euthanized after one, two or four weeks (two animals per time point). Implants and abutments with surrounding tissue were retrieved for descriptive histology and morphometric measurements of pocket depth. Wilcoxon signed-ranked test was used for statistical analysis.Results: Qualitative histological assessment showed healthy soft tissues around the abutments with limited or no signs of inflammation. Hydroxyapatite-coated abutments showed tight adherence with dermis and limited epidermal downgrowth and pocket formation. Weaker adherence between soft tissues and abutment surface, often associated with significant epidermal downgrowth and pocket formation, was noted for non-coated titanium abutments. The mean pocket depth for abutment types A, B, C and D was 1.38mm, 0.42mm, 1.51mm and 0.24mm, respectively. The difference between C and D was statistically significant ($p=0.031$). Conclusion: The results showed improved soft tissue adherence and reduced pocket formation to the hydroxyapatite surface compared to non-coated abutments.

Learning Objective: Identify that the results suggests that improved soft tissue outcomes with percutaneous Baha abutments without performing soft tissue reduction may be achieved if improved abutment designs and/or materials are used that can stabilise the soft tissue.

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 19

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: A Novel Bone Conduction Implant (BCI) Device

Author(s): Bo E. V. Hakansson, Hamidreza Taghavi, Måns Eeg-Olofsson, Sabine Reinfeldt, Carina B Johansson

Presenter: Bo E. V. Hakansson

Abstract: ObjectivesA novel Bone Conduction Implant (BCI) device that uses an implanted transducer and do not need a percutaneous implant has been developed and adapted for long-term implantation. One objective with the BCI implantation is that the surgical procedure should be similar or less invasive as compared with the bone anchored hearing aid (Baha) surgery. Another objective is that the BCI device should have similar current consumption and maximum power output as the ear level Baha.Study Design The BCI system consists of an external sound processor and an implanted unit called the BCI Bone Bridge. The BCI Bone Bridge comprises a passive implant and has an inductive link similar to those used in middle ear implant devices. In addition, the BCI transducer is implanted in the temporal bone and attached by a flat surface bone contact. The external sound processor has been implemented by a sophisticated digital signal processor (DSP) and a very efficient Application Specific Integrated Circuit (ASIC) for driving the inductive link. Measurements of the BCI system have been performed on a Skullsimulator, a dry skull, cadaver heads and in an animal (sheep) study.Results It was found that the BCI device has similar maximum power output at the cochlear level as the ear level Baha devices and the surgical procedure is regarded as minor invasive and safe for the patients. Also, the output was found to be robust for skin thicknesses range of 2 to 10 mm. Moreover, transmission and attachment properties of the BCI transducer to the bone were found to be efficient and long term stable in the sheep study. ConclusionThe BCI device is ready now for implantation in candidate patients. Regulatory work and patient recruitment are ongoing.

Learning Objective: Analyze basic principle of transcutaneous bone conduction devices

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 20

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: Transmission of bone conducted sound - correlation between hearing perception and cochlear vibration

Author(s): Måns Eeg-Olofsson, Stefan Stenfelt, Hamidreza Taghavi, Sabine Reinfeldt, Bo Håkansson, Caterina Finizia

Presenter: Måns Eeg-Olofsson

Abstract: Background:The vibration of the cochlea is assumed to be a good approximation of bone conducted (BC) sound perception. The excitation of the cochlear basilar membrane from BC stimulation is a complicated phenomenon where different pathways of BC sound contribute. There is also a possibility of different cochlear sensitivity depending on vibration direction. Research in the field of BC physiology has to a large extent been conducted on human cadavers and on dry skulls measured as acceleration or velocity of the otic capsule. To validate those results the vibration velocity of the otic capsule in live humans was measured, and was compared to BC hearing thresholds in the same individuals.Method:In 16 individuals with a common cavity in one ear, the vibration velocity of the otic capsule was measured with a laser Doppler vibrometer. The BC stimulation was applied at three ipsilateral positions and one contralateral position. Masked BC tone thresholds were measured from the same four stimulation positions.Results:The individual variation was large both for the vibration and the threshold measurements. The median velocity response difference between the positions was large in the low frequency range, but similar in the higher frequencies. For the BC tone audiometry there was a tendency of lower thresholds when the stimulation was closer to the cochlea. The relative median results showed similar trends for both vibration and threshold measurements. The correlation between the two methods at the individual level was low.Conclusion:The correlation between vibration velocity of the cochlea and hearing thresholds was low at the individual level. The median data support that vibration measurements in previous cadaver studies are valid, while dry skull results deviates from both cadaver and live human results.

Learning Objective: Identify that vibration measurement of the cochlea in previous cadaver studies is a valid estimation of BC sound perception.

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 21

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: Long-term results with soft tissue reduction in Baha surgery

Author(s): Anders Tjellström

Presenter: Anders Tjellström

Abstract: ObjectiveThe aim of the study was to find out if the soft tissue reduction we perform will last or if soft tissue will regenerate around the coupling as time goes by. Are there any differences between gender, age or BMIStudy designSixty-six patients coming for routine controls at our outpatient clinic were included in the study.At the visit to the clinic the thickness of the skin over the bone was measured with a rod-shaped device graded in mm. An evaluation of the skin status according to Holgers classification was also noted. The surgical technique was registered. Age at surgery and time after surgery was noted as well as gender and BMI. ResultsObservation time varied between 1 and 25 years with a mean of 10 years. The thickness of the skin varied between 0.5 mm and 5.5 mm with a mean value of 2.0 mm. There was no correlation between skin thickness and time after surgery. The age of the patient at surgery or gender was of no importance. The frequency of adverse skin reactions was as low as earlier reported.ConclusionSoft issue reduction will in most cases result in a stable situation and soft tissue proliferation rare even after many years. The frequency of soft tissue irritation was also found to be low.

Learning Objective: Assess a reaction free skin penetration around Baha coupling

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 22

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: Preliminary results from loading a Bone Anchored Hearing Aid (BAHA) Sound Processor at 2 weeks post surgery

Author(s): Rebecca Exley, Rachel Andrew, Iain Bruce, Kevin Green

Presenter: Rebecca Exley

Abstract: OBJECTIVESAdvances in Bone Anchored Hearing Aid (BAHA) design and surface structure have enabled development of more stable implant than the previous generation (Cochlear BAHA BI300, Sweden). Postoperative loading protocol from surgical implantation to mounting or 'loading' of the hearing aid is 3 months for adults and 6 months for children. Safe loading requires adequate integration of the implant with bone; a process termed osseointegration (1). Resonance Frequency analysis (RFA) is a validated non-invasive method of implant stability assessment (2). This is measured using an Osstell Probe Device (Osstell ISQ, Sweden) producing a numeric figure; the Implant Stability Quotient (ISQ). Our centre participated in a multi-centre investigation of the BI300,. Results showed higher stability of the new implant despite loading at 6 weeks compared to the previous design. The reported increase in primary and maintained high stability raised the clinical question of whether loading times could be safely reduced.STUDY DESIGNFifty four (n=54) adult patients with at least 4 mm of cortical bone were included. Twenty four (n=24) patients were loaded at the conventional 6 weeks and thirty (n=30) patients were loaded early at 2 weeks. RFA was used to obtain ISQ values, providing an objective measure of stability. Based on both ISQ values, and clinical evaluation of the implant site and soft tissues, implants were loaded at 2 or 6 weeks and monitored periodically thereafter. RESULTSInitial results demonstrate no difference in RFA values, soft tissue outcomes or implant failure rate between the 2 and 6 week loading groups.CONCLUSIONSLoading the BAHA at 2 weeks was found to be safe and effective. The improved surface topography of the implant confers sufficient stability to permit safe accelerated loading times. We will discuss the implications of the study on our BAHA practice and the increased patient satisfaction with early loading of the sound processor

Learning Objective: Recognize that following surgical placement of a BAHA sound processor, the device can be safely loaded earlier than conventional adult loading times of 3 months.

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 23

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: Use of the Skin Punch Technique for Bone Anchored Hearing System Placement

Author(s): Michael A Novak

Presenter: Michael A Novak

Abstract: Objectives: to evaluate a new technique for placing an osseointegrated bone conduction hearing aid fixture and pedestal.Study design: instead of creating a thin skin flap or using an incision with undermining, 4 millimeter or 6 mm skin punches were used to remove a core of soft tissue to bone or periosteum. Drilling and insertion otherwise proceeded in a standard fashion.Results: 32 procedures were performed on 30 adult and pediatric patients with 6-30 months follow-up. Two patients sustained spontaneous extrusions of the fixture. Both underwent successful replacement with no further problems for over 18 months. Otherwise there were no complications, and peri-pedestal skin irritation has been substantially reduced compared to standard techniques.Conclusions: with sufficient irrigation and longer pedestals, successful placement of an osseointegrated bone conduction fixture is possible using an easier, faster technique with fewer post-operative skin complications.

Learning Objective: Recognize that a new faster, easier technique with fewer skin complications for bone anchored hearing fixture placement is possible.

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Thursday (10:30 AM - 12:00 PM) Marriott Waterview Ballroom — Presentation 24

Topic: Bone Conduction and Middle Ear Implantable Devices I

Title: The Sophono Alpha, A Non-percutaneous Bone Conducting Hearing Implant: A multicentre report

Author(s): Deborah Sylvester, Robert Gardner, Peter Gerard Reilly, Kathryn Rankin, Christopher H Raine

Presenter: Deborah Sylvester

Abstract: Background;Percutaneous bone anchored hearing devices have become a standard of care for conductive, mixed, and single sided (SSD) hearing loss. A non-percutaneous bone conduction device has been developed based on the principle of acoustic transmission between implanted and external magnets. Objectives;Evaluation of selection criteria, surgical technique, audiological and quality of life outcomes for this novel deviceStudy design;Assessment of patient selection for implantation, surgical technique and evaluation of complications. Comparison of age appropriate pre- and post-implantation audiological tests including functional gain measurements via aided soundfield thresholds, speech recognition in noise (BKB-SIN) and patient perceptions through use of the Speech, Spatial and Qualities of Hearing (SSQ) questionnaire and measures of localization ability in patients with SSD. Outcomes;18 devices (15 adults, 2 children) were implanted in 16 patients since January 2011. Hearing loss included unilateral conductive (n=3) unilateral mixed (n=2), bilateral conductive (n=5) hearing loss, bilateral mixed (n=3) and SSD (n=3). The average BC thresholds on the implanted ear (s) ranged from 6-51dB Implants have been fixed either GA or LA without per-operative complications. 2 patients noted minor skin irritation. Patients with bilateral conductive loss gained significant benefit in detection (average 17dB, range 6-32dB) and speech perception in noise (3 dB, range 3) and reported benefits in all 3 domains of SSQ. Less benefit was gained in those with mixed bilateral loss. For patients with SSD, a significant improvement in speech perception in noise (1.7dB, range 0.5- -3.5dB) was detected.Conclusions;The surgical procedure requires no specialized equipment and can be performed as a day case. Data collected demonstrates good benefit and minimal complications for all patients studied thus far. This device complements treatment for patients requiring bone conduction aids and presents as an alternative to conventional percutaneous bone anchored implants.

Learning Objective: Assess that the Sophono device offers an alternative for patients requiring bone conduction aiding

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