SELECTED ABSTRACTS

ORAL PRESENTATIONS

IN ORDER OF PRESENTATION

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Microneedle Mediated Delivery of siRNA-Lipofectamine is Safe for Inner Ear Gene Therapy

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Elizabeth S. Olson, PhD; Jeffrey W. Kysar, PhD; Anil K. Lalwani, MD

Hypothesis: Microneedle mediated intracochlear injection of siRNA-Lipofectamine through the round window membrane (RWM) can be used to safely and effectively transfect cells within the cochlea.

Background: Vectors used in siRNA-based gene therapy to hair cells are limited, and common transfection reagents, including Lipofectamine, have known cellular toxicity. Our lab has optimized the use of 100μm diameter hollow microneedles for intracochlear injection through the guinea pig RWM. In this study, we test the feasibility of microneedle-mediated injection of siRNA-Lipofectamine through the RWM for cochlear transfection.

Methods: Fluorescently-labeled scramble siRNA (Invitrogen BLOCK-iT™ Alexa Fluor™) was diluted into Lipofectamine RNAiMax (Invitrogen) and OptiMEM (Gibco). 1.0μl of siRNA was injected through the RWM of Hartley guinea pigs at a rate of 1 μl/min (n=8). Distortion product otoacoustic emissions (DPOAE) and compound action potential (CAP) hearing tests were performed prior to and 48 hours after injection. Afterwards, animals were euthanized and cochlea were fixed and decalcified for hair cell analysis. Control cochlea were processed in parallel from untreated guinea pigs.

Results: Fluorescence, indicating successful transfection, was observed within the basal and middle turns of the cochlea with limited distribution in the apex. Signal was most intense in the organ of Corti, spiral ligament, and spiral ganglion cells. No significant changes in DPOAE and CAP were noted post-perforation, suggesting that siRNA-Lipofectamine at low doses does not cause cochlear toxicity.

Conclusions: Small volumes of siRNA and Lipofectamine can be safely delivered to cochlear structures using microneedles, paving the way for atraumatic cochlear gene therapy.

Professional Practice Gap & Educational Need: There is no clinically available method to directly access the inner ear for both diagnostic perilymph aspiration and therapeutic drug delivery. Hollow microneedles may be used to perforate the RWM without causing physiologic or anatomic harm. Further development of microneedle technology will fill this practice gap and pave the way for inner ear gene therapy.

Learning Objective: To understand safety and distribution of siRNA-Lipofectamine in the cochlea using microneedle technology and how it improves upon current technology for inner ear drug delivery.

Desired Result: Further development of tools for facilitating inner ear diagnosis and therapy.

Level of Evidence – N/A

Indicate IRB or IACUC: Columbia University Irving Medical Center – IAACUC No. AC-AABR7603
(Approved 4/1/2022, Modification Approved 8/5/2022)

Microbiome of the Ear: A Descriptive Comparison of the External and Middle Ear in the Healthy and Diseased States

Samantha Frank, MD; Ruwaa Samarrai, MD; Nehal Navali, BS
Dong-binh Tran PhD; George M. Weinstock, PhD
Daniel S. Roberts, MD, PhD

Objective: To define predominant taxa in the healthy human outer and middle ear as well as those with bacterial/fungal otitis externa and chronic otitis media (COM) with and without cholesteatoma.

Study Design: Case-control study

Setting: Tertiary Care Center

Subjects: 31 adult subjects: 13 outer ear subjects (7 normal, 5 bacterial otitis externa, 1 fungal otitis externa); 18 middle ear subjects (3 normal, 13 COM, 2 COM with cholesteatoma).

Interventions: Swabs of the outer ear were obtained in clinic and swabs of the middle ear were obtained in the operating room and placed in SCF-1 buffer. Samples underwent 16S rRNA sequencing.

Main Outcome Measures: Abundance of bacterial phyla and genera as well as intra and inter sample diversity.

Results: Corynebacterium, Propionibacterium, and Staphylococcus were commonly isolated in the outer ear and middle ear. Turicella was also commonly isolated in the middle ear. Propionibacterium was significantly more prevalent within the normal outer ear. Corynebacterium and Propionibacterium were prevalent in subjects with dry canal wall down mastoidectomy bowls. In an actively wet ear, one organism predominated without appreciable diversity of the microbiome.

Conclusions: Corynebacterium and Propionibacterium are common skin bacteria and were found to predominate in the healthy outer ear as well as dry diseased mastoidectomy bowls with prior canal wall down. When active disease was present, one organism was exclusively identified without presence of microbiologic diversity. The microbiome of the outer and middle ears were found to cluster, which suggests communication between the healthy outer and middle ear.

Professional Practice Gap & Educational Need: There is very limited understanding of the microbiome of the human adult outer ear and middle ear despite the potential for therapeutic intervention. The microbiome of the healthy middle ear is debated with some sources reporting sterility and others reporting high diversity of organisms with decreased diversity in the setting of COM. Further, pathogenic middle ear organisms have been isolated in the healthy outer ear, suggesting a possible connection between these sites.

Learning Objective: An understanding of common microbiologic sampling methods demonstrating variations in the microbiome of the healthy and diseased middle and outer ear.

Desired Result: Physicians will develop a further understanding of the microbiome of the middle and outer ears, particularly the differences in healthy and diseased states.

Level of Evidence – Level III

Indicate IRB or IACUC: IRB 21-072J-2, University of Connecticut Health Center, Initial approval 02/09/2021

Topical Stimulation Induces Progenitor Cell Proliferation in the Tympanic Membrane

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Hypothesis: Mechanical stimulation is sufficient to induce a proliferative response in the progenitor cells of the mammalian tympanic membrane (TM).

Background: Previous clinical studies of the application of topical growth factors to chronic TM perforations have reported high rates of closure. In one trial, a high rate of closure was observed when either growth factor or placebo was applied. This raises the possibility that manipulation of the TM may be sufficient to induce a regenerative response in the progenitor cells of the TM. Furthermore, the mechanisms by which the epithelial migration of TM keratinocytes responds to foreign material is unknown.

Methods: Topical agents including saline, corn oil, gelfoam, and small solids were applied to mouse TMs. TMs were then harvested and whole mount immunofluorescence imaging performed.

Results: Application either liquid or solid agents on top of the TM without perforation was sufficient to induce a robust proliferative response within the keratinocytes of the TM within 24 hours of application. Concomitant with the induction of proliferation, markers of keratinocyte progenitor activation were induced.

Conclusions: Mechanical stimulation of the tympanic membrane is sufficient to induce progenitor cell activation and proliferation in the tympanic membrane. This may provide a cleaning mechanism by which keratinocyte migration is induced in response to foreign material on the TM. This may also suggest techniques for inducing closure of chronic TM perforations by mechanical manipulation of the TM.

Professional Practice Gap & Educational Need: The mechanisms by which the tympanic membrane clears debris and how the tympanic membrane can close chronic perforations are not well understood. A better understanding of these mechanisms may predict improved methods of closing chronic perforations.

Learning Objective: - Describe the response to the tympanic membrane to mechanical stimulation
- Understand the role of tympanic membrane progenitor cells in epithelial migration.

Desired Result: - Consider utilizing mechanical stimulation of the TM to promote healing of chronic TM perforations.

Level of Evidence – N/A – animal study

Indicate IRB or IACUC : UCSF IACUC **AN165495-03**

Cost-effectiveness of DW-MRI versus Second Look Surgery in Treating Cholesteatoma: A Modeling Study

Daniel D. Bu, MPP, MBA; Zachary G. Schwam, MD
Enrique Perez, MD; Maura K. Cosetti, MD

Objective: To evaluate whether tympanomastoidectomy with DW-MRI is a cost-effective method of treating cholesteatoma compared to tympanomastoidectomy with second-look surgery.

Design and Setting: Cost-effectiveness analysis was conducted using a Markov state-transition model. The simulation model adhered to the Panel Recommendations on Cost-Effectiveness in Health and Medicine established by the US Public Health Service (USPHS). One-way and Monte Carlo probability sensitivity analysis were conducted for validation.

Interventions: Tympanomastoidectomy with DW-MRI versus tympanomastoidectomy with second-look surgery.

Main Outcome Measures: Effectiveness and health utility were measured using quality-adjusted life years (QALYs). Costs were derived from Medicare reimbursement using the perspective of the payer. Probabilities for outcomes and complications were taken from existing literature. Cost-effectiveness was assessed using the incremental cost-effectiveness ratio (ICER).

Results: With base case analysis assuming a 40-year-old patient, the total cost was $15,410 when treated with tympanomastoidectomy and second-look surgery versus $12,241 when treated with tympanomastoidectomy and DW-MRI. The second-look treatment pathway yielded 17.05 QALYs, while the DW-MRI pathway yielded 16.91 QALYs in terms of health benefit accrued across the lifetime of the patient. The cost-effectiveness ICER was $22,635/QALY. Using the conventional $50,000 willingness-to-pay threshold, second-look surgery was the more cost-effective approach 62.2% of the time by simulation.

Conclusions: Both treatment pathways were found to be cost-effective, with second-look surgery incrementally cost-effective 62.2% of the time. Assumptions were validated by one-way and Monte Carlo probability sensitivity analysis.

Professional Practice Gap & Educational Need: There is ample variation in treatment pathways regarding usage of DW-MRI and second-look surgery for cholesteatoma.

Learning Objective: To evaluate the cost-effectiveness of DW-MRI and second-look surgery approaches, accounting for health-related quality-of-life outcomes and costs for the duration of the patient lifetimes.

Desired Result: To inform the discussion on the treatment for cholesteatoma given emergent non-invasive technologies.

Level of Evidence: Level III

Indicate IRB or IACUC: Exempt

Conductive Hearing Loss Associates with Dementia, Neuropsychiatric, and Incident Adverse Life Events and Middle Ear Reconstruction Improves Outcomes – A Multi-National Database Study

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Thomas L. Haupt, BS; Thomas O. Wilcox, MD
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Objective: Test the hypothesis that conductive hearing loss (CHL) is associated with dementia, neuropsychiatric, and incident adverse life event (ALEs) versus normal hearing controls and that middle ear reconstruction (MER) associates with improved outcomes for these measures in a multi-national electronic health records database.

Study Design: Retrospective cohort study with propensity-score matching (PSM).

Setting:
TriNetX is a research database representing about110-million patients from the United States, Brazil, and India.

Patients: Subjects with no HL, and any CHL (ICD-10:H90.0-2) over 50-years old. With and without any MER (CPT:1010174) of any age.

Main Outcome Measures: Odds-ratios with 95% confidence intervals (OR(95%CI)) for incident dementia (F01, F03, G30), neuropsychiatric diagnoses (F20.xx-F45.xx), and ALEs (Z55.xx-Z65.xx).

Results: Of 103,609 patients over 50-years old experiencing any CHL, 2.74% developed dementia compared to 1.22% of 38,216,019 patients with no HL (OR, 95%CI: 2.29, 2.20-2.37). Of patients experiencing CHL there were 39,850 who received MER. The average age was 31.3 years old, with 51% female patients. 343,876 control patients with CHL were identified. 39,900 patients remained in each cohort after 1:1 PSM for HL- and dementia-related risk factors. Matched risk for developing dementia among MER recipients was 0.33% compared to 0.58% in controls (OR: 0.58, 0.46-0.72), 10.32% compared to 13.87% for neuropsychiatric diagnosis (OR: 0.71, 0.68-0.75), and 3.34% compared to 4.02% for ALE (OR: 0.83, 0.77-0.89).

Conclusions: CHL increases the odds for dementia and MER improves dementia, neuropsychiatric, and social (incident ALEs) outcomes. This study represents the first population study on the topic of CHL and MER for these outcome measures.

Professional Practice Gap & Educational Need: Currently, no sufficiently powered studies have examined the association between CHL and dementia and how MER associates with cognitive outcomes. This study represents a population-level study on this under-reported topic and current best evidence that MER for CHL has similar cognitive, neuropsychiatric, and social outcomes compared to cochlear implant for sensorineural hearing loss. Better delineating these associations will improve patient consultation for middle-ear otologic intervention.

Learning Objectives: 1) Recognize the analogous association of CHL with incident dementia and that MER decreases the odds for dementia. 2) Appreciate the growing number of neuropsychiatric and social determinants of health outcomes (such as ALEs) improved by MER.

Desired Result: Encourage dementia, neuropsychiatric, and social outcomes as discussion points during middle-ear reconstruction consultation.

Level of Evidence – Level III

Indicate IRB or IACUC: Exempt

Influence of Cognitive Performance, Sociodemographic Factors, and Pure-Tone Audiometry on Speech Discrimination: A Prospective Population-Based Study of 1,061 Older Adults

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Ronald C. Petersen, MD, PhD; Maria Vassilaki, MD, PhD; Matthew L. Carlson, MD

Objective: The degree to which various patient factors influence speech discrimination is poorly characterized to date. The primary objective of the current work was to describe the influence of cognitive performance, sociodemographic factors, and pure-tone audiometry on speech discrimination in older adults.

Study Design: Prospective population-based study.

Setting: Olmsted County, Minnesota.

Patients: There were 1,061 study participants 50 years or older at enrollment in the Mayo Clinic Study of Aging between November 2004 and December 2019 who underwent formal audiometric and cognitive testing included in the current investigation.

Main Outcome Measures: The primary outcome measure was <100% word recognition scores (WRSs), with pure-tone averages (PTAs; 0.5, 1, 2, 3 kHz), age, sex, years of education, socioeconomic status assessed using state area deprivation index (ADI) quintiles, and global cognition z-scores as explanatory features.

Results: The mean (SD) age among the 1,061 participants was 76 (9) years with 528 (50%) males. Participant age [OR (95% CI) for a 10-year increase of 1.8 (1.4-2.3), $p<0.001$], male sex [OR 2.6 (1.9-3.7), $p<0.001$], and PTA [OR for a 10-dB hearing loss increase of 2.4 (2.1-2.8), $p<0.001$] were all significantly associated with <100% WRSs, with the greatest explanatory power attributable to the PTA. Years of education ($p=0.9$), state ADI quintile ($p=0.6$), and global cognitive performance ($p=0.2$) did not significantly influence WRSs.

Conclusions: Although PTA exhibits the greatest influence on speech discrimination, advancing age and male sex both independently increase the odds of having poorer speech discrimination among older adults, even after accounting for cognitive function, socioeconomic status, and years of education.

Professional Practice Gap & Educational Need: Adult-onset hearing loss is becoming increasingly recognized as a chronic disease state with important heath ramifications with projections suggesting the prevalence will increase significantly in coming years secondary to an aging demographic in the West. Delineation of modifiable and non-modifiable risk factors surrounding hearing loss is critical for the ongoing characterization of hearing loss as a chronic disease. Although ubiquitously used to assess hearing loss, little research to date has described the influence of various patient factors on speech discrimination. Especially since speech discrimination is often thought to require more central processing than pure-tone thresholds, examining the influence of cognitive performance in older adults is particularly relevant.

Learning Objective: (1) Describe patient factors associated with poorer performance on speech discrimination; (2) Describe how specific morphologic characteristics of the pure-tone thresholds (e.g., the slope across frequencies) influence speech discrimination (not included in abstract due to space limitations but will be presented).

Desired Result: Practitioners and researchers would recognize male sex and advancing age as independent non-modifiable risk factors that influence speech discrimination apart from pure-tone thresholds, cognitive function, socioeconomic status, and years of education. These data may facilitate identification of unmeasured patient factors that influence the impact of peripheral hearing loss on understanding speech.

Level of Evidence: III

Indicate IRB or IACUC: IRB approval was obtained prior to data retrieval and analysis (IRB 20-004354).

Military and Non-Military TBI Associations with Hearing Loss and Self-Reported Hearing Difficulty among Active-Duty Service Members and Veterans

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Objective: Identify associations between history of military and non-military traumatic brain injury (TBI) on hearing loss and self-reported hearing difficulty from the Noise Outcomes in Servicemembers Epidemiology (NOISE) study.

Study Design: Cross-sectional.

Setting: Multi-institutional tertiary referral centers.

Patients: 477 Active-Duty Service members (ADSM) and 520 Veterans.

Interventions: Comprehensive TBI questionnaire.

Main Outcome Measures: Pure-tone hearing thresholds, Hearing Handicap Inventory for Adults (HHIA), and Speech, Spatial and Qualities of Hearing Scale (SSQ)-12.

Results: 26% (124/477) of ADSM and 41% (212/520) of Veterans self-reported a TBI. In ADSM with TBI, 35% were military related, 54% were non-military, and 11% had an occurrence of TBI in both. Among Veterans, 45% of TBIs were military related, 36% were non-military, and 19% in both. Military TBI was associated with increased odds of high frequency (3-8 kHz) hearing loss (≥20 dB) in both ADSM (OR=2.5, CI: 1.2-5.1) and Veterans (OR=1.7, CI: 1.0-2.8) and extended-high frequency (9-16 kHz) hearing loss in Veterans (OR=1.6, CI: 1.0-2.6). ADSM with a military TBI history were more likely to report hearing difficulty on HHIA (OR=6.7, CI: 3.4-12.9) and Veterans with any TBI history (military, civilian, or both) were more likely to report hearing difficulty on HHIA (OR=3.0, CI: 1.9-4.8; 2.0, 1.2-3.4; and 5.5, 2.6-11.4, respectively). SSQ12 results corroborated HHIA findings.

Conclusions: Military TBI was associated with hearing loss, predominately in the higher frequencies. Military TBI was associated with poorer self-perceived hearing ability in ADSM. All types of TBI were associated with poorer self-perceived hearing ability in Veterans, although the strength of this association was greater for military TBI than non-military TBI.

Professional Practice Gap & Educational Need: History of TBI likely affects measured and perceived hearing ability with stronger associations observed for military-related TBI.

Learning Objective: Understand the association between various TBI types on hearing loss and perceived hearing ability.

Desired Result: Provide knowledge on the associations of TBI with hearing and inform efforts to develop future TBI treatments.

Level of Evidence – III

IRB: #FWH20180143H Joint Base San Antonio (JBSA) Military Healthcare System; #3159/9495 Joint VA Portland Health Care System (VAPORHCS) Oregon Health and Science University (OHSU)

Hearing Loss and Frailty Among Older Adults:
The Atherosclerosis Risk in Communities Study (ARIC)

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Nicholas S. Reed, AuD; Pablo Martinez-Amezcua, MD, PhD

Objective: Hearing loss (HL) affects 2/3 of older adults and is associated with declining physical and cognitive function, which could lead to frailty. We tested the hypothesis that, compared to normal hearing, those with HL have greater odds of being pre-frail and frail vs. robust.

Study Design: Cross-sectional analysis using ordinal logistic regression models adjusted for demographic and clinical factors to evaluate the association of hearing loss and frailty status.

Setting: Exam 6 (2016-17) of a community-based cohort of older adults from four U.S. communities (Washington County, MD; Forsyth County, NC; Jackson, MS; and Minneapolis, MN).

Patients: 3,179 adults (mean age = 79.2 years, 58.9% female, 22% Black) with audiometric hearing and frailty assessments.

Interventions: N/A

Main Outcome Measures: Frailty components of a validated phenotype included weakness, low energy, slow gait speed, low physical activity, and weight loss. Participants were categorized as: robust (0 components), pre-frail (1-2), or frail (≥3). Audiometric hearing measurements were categorized based on 4-frequency pure-tone average (0.5, 1, 2, and 4 kHz) as: normal hearing (<25 decibels hearing level), mild (≥25 to <40 dB HL), and moderate+ (≥40 dB HL) hearing loss.

Results: 1,793 (56.4%) were pre-frail and 251 (7.9%) were frail. Compared to those with normal hearing, participants with moderate+ HL had greater odds of being in the next frailer category (e.g., frail vs. pre-frail) (odds ratio from ordinal logistic regression=1.27, 95% CI: 1.04, 1.56).

Conclusions: HL is associated with frailty among older adults. Further studies are warranted to assess if HL treatment may prevent or delay frailty onset.

Professional Practice Gap & Educational Need: Current guidelines do not reflect the potential role of hearing loss in the transition to frailty in older adults.

Learning Objective: To understand the potential contribution of hearing loss to the frailty phenotype in older adults.

Desired Result: Increased interest in addressing hearing loss through appropriate interventions to potentially help prevent older adults from becoming frail.

Level of Evidence: III

Indicate IRB or IACUC: The IRB at each site approved the ARIC study, and all participants provided written informed consent. This study was exempt from IRB approval.

RESIDENT RESEARCH TRAVEL AWARD

Metformin Protects Male but not Female Mice Against Noise-Induced Hearing Loss

Catherine L. Kennedy, MD; Benjamin Shuster; Reza Amanipour, PhD
Beatrice Milon, PhD; Priya Patel, MD; Ran Elkon, PhD
Ronna Hertzano, MD, PhD

Hypothesis: Metformin treatment will protect mice from noise-induced hearing loss.

Background: We published an atlas of cell type-specific transcriptional changes caused by permanent threshold shift (PTS)-inducing noise in the mouse cochlea. We identified metformin as the top-ranking, FDA-approved candidate drug to counteract the transcriptional changes. This study is designed to evaluate metformin as a potential otoprotective drug.

Methods: Male and female B6CBAF1/J mice were obtained at 7-8 weeks of age. At 10 weeks of age, mice underwent a PTS-inducing noise exposure (102.5-105 dB SPL, 8-16 kHz, 2 hours). Auditory brainstem response (ABR) thresholds were obtained at baseline, 24 hours post noise exposure, and 1 week post noise exposure. Mice were administered metformin (200 mg/kg) or a saline control in their drinking water after baseline ABR and for the remaining study duration. Following the 1-week ABR, mice were euthanized and cochlear tissue was analyzed. An additional cohort of ovariectomized females was included to simulate menopause to eliminate the effect of endogenous estrogens.

Results: Metformin treatment reduced the PTS at the 16 kHz and 24 kHz frequencies (p=0.012 and p=0.011, respectively) and outer hair cell (OHC) loss at 32 kHz (p<0.0001) in male mice. In contrast, metformin treatment did not ameliorate hearing loss or OHC loss in the intact or ovariectomized female mice.

Conclusions: Metformin exhibits sex-dependent efficacy as a noise-induced hearing loss therapeutic. These data compel continued investigation into metformin's protective effects and demonstrate the importance of evaluating the therapeutic efficacy of drugs in subjects of both sexes.

Professional Practice Gap & Educational Need: This study aims to identify a potential existing therapeutic that could be used to prevent hearing loss.

Learning Objectives:
1. To understand the role of metformin as a potential otoprotective therapeutic to prevent noise induced hearing loss.
2. To understand the importance of testing otoprotective therapeutics in subjects of both sexes.

Desired Result: To recognize the potential utility of metformin to prevent noise-induced hearing loss

Level of Evidence: Not Applicable

IACUC Protocol: 0721005

Do Elderly Patients Benefit from Expanded Centers for Medicare & Medicaid Services (CMS) Criteria for Cochlear Implantation in Bilateral Hearing Loss?

Sarek A. Shen, MD; Nicholas S. Andresen, MD; Stephen P. Bowditch, AuD
Daniel Q. Sun, MD

Objective: To examine the effect of patient age on longitudinal speech understanding outcomes following cochlear implantation (CI) in bilateral hearing loss.

Study Design: Retrospective cohort study.

Setting: Tertiary academic center

Patients: 1105 adult patients receiving a single-sided CI between 1987-2022

Interventions: None

Main Outcome Measures: Post-operative speech recognition outcomes, including AzBio sentences, consonant-nucleus-consonant (CNC), and Hearing in Noise Test (HINT) in quiet were analyzed at near- (<2 years), medium- (2-8 years) and long- (>8 years) term post-operative intervals.

Results: 86 very-elderly (>80 years), 409 elderly (65-80 years), and 709 non-elderly (18-65 years), patients were included. Short-term post-operative AzBIO scores demonstrated similar magnitude of improvement relative to pre-operative scores in the very-elderly (47.6, 95%CI:[28.9-66.4]), elderly (49.0, 95%CI:[39.2-58.8]), and non-elderly (47.9, 95%CI:[35.4-60.4]). Scores for those >65 years of age remained stable after 2 years post-implant, but in those ≤65 years of age, scores continued to improve for up to 8 years (9.9, 95%CI:[2.1-17.7]) post-implantation. Similar patterns were observed for HINT and CNC scores. Across all age cohorts, patients with pre-operative AzBIO scores between 40-60% had similar WRS scores compared to those with pre-operative scores of <40%, at short term (75.4, 68.9, 95%CI:[-23.1-10.0]) and medium-term (77.2, 83.9, 95%CI:[77.2-83.9]) follow-up.

Conclusions: Patients over the age of 80 gain significant and sustained auditory benefit after CI, including those meeting expanded CMS criteria for implantation. However, patients <65 years of age demonstrated continued improvement over longer period than older patients, suggesting a role of central plasticity in mediating CI outcomes as a function of age.

Professional Practice Gap & Educational Need: There is little data on longitudinal audiometric outcomes in the very-elderly. This study aims to provide insight into the sustained benefit following cochlear implant in this population, as well as patients meeting expanded CMS criteria for implantation.

Learning Objective: To understand the longitudinal audiologic benefit of cochlear implants with respect to age and pre-operative word recognition scores.

Desired Result: Appropriate counseling practices for cochlear implants, particularly in the very-elderly population and patients meeting the expanded CMS criteria for implantation.

Level of Evidence – Level IV

Indicate IRB or IACUC: IRB00188251 Johns Hopkins School of Medicine

Post-Cochlear Implant Computer-based Auditory Training Yields Durable Improvements in Cochlear Implant Quality of Life

James R. Dornhoffer, MD; Christian Shannon, BS; Kara C. Schvartz-Leyzac, AuD, PhD
Judy R. Dubno, PhD; Theodore R. McRackan, MD, MSCR

Objective: To examine the influence of commonly available forms of post–cochlear implant(CI) auditory training on speech recognition and CI quality-of-life(CIQOL) outcomes at 1-year post–activation.

Study Design: Prospective natural experiment

Setting: Tertiary academic center

Patients: 92 adults undergoing cochlear implantation for bilateral severe-to-profound hearing loss

Interventions: Self-reported use of post-CI auditory training as follows:(1)face-to-face training (e.g., speech-pathologist), (2)passive home-based training (e.g., listening to audiobooks), and (3)Computer-based auditory training(CBAT) (e.g., interactive software).

Main Outcome Measures: Change in Consonant-Nucleus-Consonant phoneme(CNCp), CNC word(CNCw), AzBio sentences in quiet, and CIQOL-35 Profile global and domain scores from pre-CI to 1-year post-CI.

Results: Of 92 patients, 76(82.6%) used auditory training in the first-year post-activation, with 19.3% using face-to-face training, 62.0% passive home-based training, and 28.9% CBAT. At 12 months, there was no significant association between use of any auditory training resource and change in speech recognition. However, CBAT use, and no other training, was associated with greater improvements in global and all domain-specific CIQOL scores (*d*-range=0.34–1.02), with significant associations for global scores (*d*=0.81[0.10,1.48]) and scores of communication (*d*=1.02[0.30,1.70]), emotional (*d*=0.79[0.09,1.46]), listening-effort (*d*=1.02[0.30,1.70]), and social domains (*d*=0.75[0.05,1.42]). Controlling for demographics and use of multiple resources, CBAT remained the strongest positive predictor of CIQOL improvement, with significant associations for global scores (ß=9.724[0.196,19.251]) and scores of communication (ß=15.721[4.614,26.827), environmental (ß=21.103[1.872,40.333]), listening-effort (ß=16.770[5.327,28.212]), and social(ß=16.166[0.915,31.418]) domains.

Conclusions: Auditory training with self-directed computer software resulted in improved CIQOL outcomes at 12-months post-activation. Given the availability and low cost of these interventions, this study provides evidence for the use of CBAT to improve real-world functional abilities in new adult CI recipients.

Professional Practice Gap & Educational Need: CBAT is a free and widely accessible form of auditory rehabilitation that may be associated with improved CI outcomes in adults in the first-year post-CI activation. However, the effectiveness of CBAT is remains unknown and long-term effects have never previously been examined in a large natural history observational study of adult CI users.

Learning Objective: To explore the long-term effectiveness of CBAT and other commonly available forms of auditory training in new adult CI recipients.

Desired Result: Practitioners and researchers will learn that the use of CBAT by new adult CI recipients offers durable benefits in real-world functionality as measured by the CIQOL-35 Profile. As such, clinicians should consider counselling on the use of this widely accessible and effective form of auditory rehabilitation for all newly implanted patients.

Level of Evidence – Level IV: Historical cohort or case-controlled studies.

Indicate IRB or IACUC: Pro00077593

Combining Intraoperative Electrocochleography with Robotics-Assisted Electrode Array Insertion

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Camille C. Dunn, PhD; Alexander D. Claussen, MD
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Background: Preserving cochlear function and structure is an important tenet of cochlear implant (CI) surgery, especially in patients with residual acoustic hearing. Despite careful manual insertion technique, the force required to damage the cochlea lies below the threshold of human perception. Additionally, the variable speed and rate of manual insertion may confound interpretation of intraoperative physiologic measures of cochlear activity, such as electrocochleography (ECochG). Robotics-assisted technologies provide slower and steadier electrode array (EA) insertion, facilitate consistent intraoperative ECochG potentials, and allow for fine-tuned alterations during insertion in response to ECochG activity. Here we present outcomes data on patients undergoing robotics-assisted EA insertion integrated with intraoperative ECochG.

Methods: The study was performed on adults undergoing CI surgery. A robotics-assisted CI insertion system (IotaSoft, IotaMotion, Inc.) was used while simultaneously recording ECochG responses with software available from CI manufacturers. The ECochG potentials were acoustically generated with tone-burst of 125-500 Hertz (Hz). Lateral wall EAs were inserted with real-time ECochG feedback, allowing the surgeon to pause, advance, or withdraw the electrode at low speeds (0.1mm/sec). Pure tone averages (PTA; 125, 250, and 500 Hz) were documented before and after surgery.

Results: Sixteen patients underwent robotics-assisted EA insertion integrated with intraoperative ECochG. Surgeons were able to adjust insertion based on ECochG responses. The mean preoperative PTA was 49 decibels (dB). PTA at initial activation, 3-months, and 6-months was 72, 69 and 57 dB, respectively.

Conclusions: Combining robotics-assisted EA insertion with intraoperative ECochG offers real-time feedback during surgery with potential to minimize cochlear trauma and preserve residual acoustic hearing.

Professional Practice Gap & Educational Need: Preservation of residual acoustic hearing is a critical goal in cochlear implant surgery that is often not achieved with manual insertion technique. New methods of insertion that can spare function are thus of interest and necessity.

Learning Objective: Understand the dynamics of implant insertion, significance of residual acoustic hearing, and explore emerging technologies that seek to minimize insertion trauma

Desired Result: To provide attendees with knowledge of intraoperative monitoring modalities and emerging technologies for preserving cochlear function

Level of Evidence: IV

Indicate IRB or IACUC: University of Iowa Hospital and Clinics NR # 00000099

RESIDENT RESEARCH TRAVEL AWARD

Expression of Brain-Derived Neurotrophic Factor in Human Spiral Ganglia Neurons following Cochlear Implantation

Emily C. Wong, MD; Ivan A. Lopez, PhD
Akira Ishiyama, MD; Gail Ishiyama, MD

Hypothesis: It is hypothesized that electrical stimulation following CI stimulates BDNF expression in the afferent auditory pathway.

Background: Brain-derived neurotrophic factor (BDNF) is an important factor in the development and neuroprotection of afferent auditory pathways. In this study, we investigated the expression of BDNF in the afferent auditory pathway following cochlear implantation (CI).

Methods: Archival human temporal bones from seven patients (ages 67-92 years) with a history of CI and four patients with hearing loss without CI (ages 38-92 years) were studied. Temporal bone specimens were immunoreacted with mouse monoclonal antibodies against pan-neurofilaments and rabbit polyclonal BDNF. In cases of unilateral CI, the contralateral unimplanted ear served as a control.

Results: Neurofilament immunoreactivity (IR) localized to spiral ganglion neuron (SGN) nerve fibers in implanted and unimplanted ears. BDNF IR localized to the SGN somata and the surrounding satellite glial cell. The expression of BDNF in the SGN was increased in the implanted ear compared with the unimplanted ear and with otopathologies such as ototoxicity. BDNF expression in the SGN also demonstrated increased expression in CI despite complete loss of the organ of Corti hair cells and supporting cells. Even in the cases of CI with a 6 mm first generation electrode, BDNF expression was upregulated throughout the cochlea.

Conclusions: BDNF expression in the SGN appears to be upregulated by the electrical stimulation from CI. This study provides evidence that the electrical stimulation from CI stimulates BDNF upregulation, which may play a neuroprotective role in rehabilitating hearing in the deafened ear.

Professional Practice Gap & Educational Need: It is important to identify patients who benefit from cochlear implantation early using audiologic criteria as electric stimulation appears to have neuroprotective effect for the primary auditory pathway.

Learning Objective: To understand the patterns of BDNF immunoreactivity in human temporal bone specimens with CI and hearing loss due to other otopathologies.

Desired Result: Participants should be able to identify differences in BDNF IR among temporal bone specimens with CI compared with those without CI and those with hearing loss due to other otopathologies.

Level of Evidence – IV

Indicate IRB or IACUC : UCLA IRB 10-001449

The 3D Structure of Cochlear Incomplete Partition Type-II Malformation from Digitised Human Histopathological Specimens: Implications for Cochlear Implantation

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Hypothesis: i. The scala tympani (ST) and scala vestibuli (SV) of incomplete partition type-II (IP-II) malformations are normal for the 1st 360o; thereafter the compartments fuse. ii. The cochlear duct is normal in length and morphology. iii. The location and number of spiral ganglion neurons (SGN) are normal.

Background: Knowledge of intracochlear and neural three-dimensional (3D) morphology may assist with cochlear implant selection and post-operative programming for IP-II patients.

Methods: IP-II (n=11) human temporal bone histological specimens were identified from the NIDCD National Temporal Bone Registry and sections were digitised. The cochlear duct, scalae, and surgically-relevant anatomy of the round window and hook regions were reconstructed in 3D. The location and number of SGN were quantified by applying a machine learning algorithm.

Results: The 3D morphology of the basal turn was normal, although with a reduced ST cross-sectional area, for the first 360°. Beyond this, ST and SV fused. Cochlear duct length was reduced compared to normal controls (28mm versus 33mm), but remained a distinct endolymphatic compartment. SGN were reduced in numbers compared to age-matched normative data (39% (3-65%)), and often failed to ascend up Rosenthal's canal remaining in an abnormal modiolar location.

Conclusions: Contrary to our hypotheses, cochlear duct and SGN anatomy differed from normal cochlea. Knowledge of 3D anatomy may help facilitate pre-operative discussion of expectations with patients. Surgeons may wish to select shorter-than-normal electrode arrays to limit trauma. Unusual programming maps may occur in patients with post-lingual hearing loss, due to abnormal SGN location.

Professional Practice Gap & Educational Need: The majority of existing descriptions of inner ear malformations are based off clinical imaging. In-depth 3D anatomy of cochlear malformations has not been visualized previously, particularly the location of the neural elements. This knowledge is essential for planning the type of implant to insert to ensure atraumatic cochlear implant insertion. Atraumatic insertion is essential for limiting irreversible histological changes, inflammatory intracochlear changes, and ensuring successful auditory rehabilitation.

Learning Objective: To understand the 3D anatomy of IP-II cochlear malformations

Desired Result: This study helps physicians appreciate the differences in anatomy of the scalae and neural anatomy between normal and IP-II malformations. This may help to inform selection of arrays pre-operatively to prevent intracochlear trauma.

Level of Evidence - V

Indicate IRB: 2019P003755

Impact of Stimulus Frequency on Azimuthal Sound Source Localization in Patients with Single-sided Deafness using Cochlear Implants

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Objective: Characterize localization accuracy across the frequency spectrum in subjects with single-sided deafness (SSD) who have undergone cochlear implantation (CI).

Study Design: Nonrandomized, prospective study.

Setting: Academic tertiary care referral center.

Patients: Patients who have undergone CI for SSD currently receiving care at University of Michigan, Department of Otolaryngology.

Main Outcome Measures:
1. Localization accuracy (quantified in RMS error) for presentation of sounds from an azimuthal array of 24 loudspeakers spaced at 15^{o} intervals in a semi-anechoic chamber both with and without CI.
2. Subjective measure of perceived localization benefit quantified with responses to the Speech, Spatial and Qualities of Hearing Scale (SSQ).

Results: Localization performance was compared across individuals, both with and without CI, using the following stimuli: broadband noise, low-frequency narrowband noise (500 Hz), mid-frequency narrowband noise (1000 Hz), and high-frequency narrowband noise (4000 Hz). Patients displayed improved localization performance with high frequency stimuli (4000 Hz) when using CI and no improvement in localization accuracy at lower frequencies (500 Hz, 1000 Hz).

Conclusions: Stimulus frequency has a significant impact on sound-source localization accuracy in patients with single-sided deafness using cochlear implants. Improved performance with higher frequency stimuli suggests the possibility of greater salience of interaural level difference cues compared with timing difference cues, though further study is needed to fully explore the hypothesis.

Professional Practice Gap & Educational Need: While sound localization performance in subjects with single-sided deafness using cochlear implant has been investigated, the effect of frequency has not been well characterized. Our study seeks to address this gap and demonstrated improved sound localization abilities at high frequency stimuli in patients with single-sided deafness using cochlear implants. This finding provides further insight on how interaural level and timing differences might contribute to sound localization in this patient population. Based on our current understanding, it is unlikely that timing cues are being accurately represented for users of cochlear implants. This knowledge can be helpful for counseling patients and providing education on the limitations of cochlear implantation, and it may also provide evidence to support development of device programming strategies to optimize binaural task performance.

Learning Objective:
1. Characterize differences in objective localization performance at differential frequencies in patients with cochlear implantation
2. Characterize differences in subjective spatial hearing benefit in patients with cochlear implantation

Desired Result: Attendees will demonstrate an improved understanding of the limitations of localization performance from unilateral rehabilitation devices in patients with cochlear implantation.

Level of Evidence - Level III - Cohort and case-control studies.

Indicate IRB or IACUC: Approved 1/28/21, University of Michigan IRBMED Protocol HUM00190678.

Discrepancies Between Expected and Actual Cochlear Implant-Related Functional Outcomes

Joshua E. Fabie, MD; Christian Shannon, BS; Kara Leyzac, AuD, PhD
Judy R. Dubno, PhD; Theodore R. McRackan, MD, MSCR

Objective: Prior research has demonstrated that realistic patient expectations are a critical factor in determining CI candidacy. The current study uses the validated Cochlear Implant quality of Life-Expectations (CIQOL-Expectations) instrument to determine expectations of potential CI users and the degree to which their pre-CI expectations are met.

Study Design: Prospective cohort study

Setting: Tertiary medical center

Patients: 60 adult CI patients

Interventions/Main Outcome Measures: Pre-CI aided and post-CI CNC word and AzBio sentence scores, pre-CI CIQOL-Expectations, and pre-CI and 3/6/12 month post-CI CIQOL-35 Profile scores.

Results: Mean pre-CI CIQOL-Expectations exceeded 12-month mean CIQOL-35 Profile scores for the global measure and the communication, environment, and listening effort domains (d=0.65 to 0.97). The communication and listening effort domain scores had the largest discrepancy between expected and actual post-CI improvement (actual scores 15.1 and 16.3 points lower than expected [d= 0.93 to 0.97], respectively). For 42% of patients, pre-CI global expectations exceeded 12-month post-CI CIQOL-35 Profile global scores, 49% met their expectations, and actual scores exceeded expectations for only 10% of patients. Similar patterns were seen for all CIQOL domains except emotional.

Conclusions: Post-CI functional abilities appear to fall short of pre-CI expectations for a substantial percentage of CI users, which was most apparent for the communication and listening effort CIQOL domains. These results may help clinicians direct personalized counseling toward common misconceptions, which can aid shared decision-making and potentially minimize the mismatch between expected and realized outcomes.

Professional Practice Gap & Educational Need: Understanding the importance of patient expectations in CI candidates and the mismatch between expected and actual performance after receiving an implant

Learning Objective: Post-CI functional abilities fall short of pre-CI expectations for a substantial percentage of CI users

Desired Result: Personalized patient counseling to narrow the gap between expected and realized post-operative hearing performance and improve shared decision making

Level of Evidence – III

Indicate IRB or IACUC: IRB Pro00073019, approved 12/20/2017, Medical University of South Carolina

Investigating Deferral Rates in Cochlear Implantation:
How Often Do Candidates Defer and Why?

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Oliver F. Adunka, MD, MBA; Yin Ren, MD, PhD

Objective: Evaluate the rate at which cochlear implant (CI) candidates decline surgery and identify associated factors.

Study Design: Retrospective cohort study.

Setting: Tertiary referral center.

Patients: 493 CI candidates from 07/1989-05/2020 with complete demographic and socioeconomic data.

Interventions: Diagnostic.

Main Outcome Measures: Age, gender, race, marital and employment status, median household income percentile, distance-to-clinic, and residence in a medically-underserved county.

Results: Of the 493 CI candidates included, 80 (16.2%) patients declined surgery. African American patients were 73% less likely to undergo implantation compared to White patients (OR: 0.27 [0.11-0.68];p=0.005). Asian patients were 95% less likely to undergo implantation [OR: 0.05 [0.009-0.25];p=0.0003) compared to White patients. For every one-year age increase, patients were 4% less likely to undergo implantation [OR: 0.96 [0.94-0.98];p<0.0001] and for every 10 years age increase, the patients were 33% less likely. Compared to the their single counterparts, married patients were more likely to undergo implantation (OR: 1.87 [1.12-3.15];p=0.02). No differences were observed when comparing implanted and non-implanted CI candidates in gender, employment status, distance-to-clinic, or median family income percentile. A chi-square test of independence showed no association between receiving CIs and living in medically-underserved counties (χ^2: 2; N=493; 0.3891; p=.53).

Conclusions: Not infrequently, CI candidates decline surgery. While demographic factors (race, age, and marital status) were associated with the cochlear implantation decision, socioeconomic factors (median family income and residence in a medically-underserved community) were not. Perhaps the cultural components of a patient's race have a larger impact on whether or not the patients get implanted.

Professional Practice Gap & Educational Need: As providers, we are still unsure of how best to counsel all patients, especially when it comes to the underserved communities. Physicians and audiologists need to better understand the reason for why cochlear implant candidates defer surgery, so we can better counsel them.

Learning Objective: After reading this abstract, participants will be able to distinguish which demographic and socioeconomic factors are associated with the choice of a CI candidate to defer surgery.

Desired Result: To improve physician knowledge concerning cochlear implantation deferral and factors associated with it.

Level of Evidence – IV

Indicate IRB or IACUC : The Ohio State University Wexner Medical Center - 2021H0109

Comparison of Speech Recognition and Hearing Preservation Outcomes Between the Mid-Scala and Lateral Wall Electrode Arrays

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Elizabeth L. Perkins, MD; Kareem O. Tawfik, MD

Objective: To assess speech recognition and hearing preservation (HP) outcomes with the Advanced Bionics™ Mid-Scala and SlimJ electrodes.

Study Design: Retrospective cohort.

Setting: Tertiary referral center.

Patients: 233 adult patients implanted between 2013 and 2021 (Mid-Scala: n=134, SlimJ: n=99).

Main Outcome Measures: CNC and AzBio scores at 6 and 12 months; postoperative HP, defined as low-frequency pure-tone average (LFPTA) $\leq$ 80 dB HL; scalar position.

Results: Mean CNC scores did not significantly differ between Mid-Scala and SlimJ recipients at 6 (46.2% vs. 45.7%, p=0.898) and 12 (49.8% vs. 47.3%, p=0.478) months. Similarly, mean AzBio in quiet scores were equivalent for both groups at 6 (55.5% vs. 58.6%, p=0.466) and 12 (59.5% vs. 61.9%, p=0.590) months. HP rates were significantly higher with the SlimJ (48.4%) than the Mid-Scala (30.8%) (p=0.033). Scalar translocations were 34.3% and 16.1% for the Mid-Scala and SlimJ groups, respectively (p=0.022). Postoperative HP was negatively correlated with scalar translocation (r_s = -0.22, p=0.058). Postoperative HP status had a very weak but positive correlation with 12-month CNC (r_s = 0.11, p=0.316) and AzBio in quiet (r_s = 0.12, p=0.259) scores. CNC, AzBio in quiet, and LFPTA shifts at 6 and 12 months were not significantly different between patients receiving the SlimJ versus those with scala tympani insertion of the Mid-Scala (p>0.05).

Conclusions: Compared to Mid-Scala, the lateral wall electrode has superior HP outcomes and fewer scalar translocations while speech recognition scores are equivalent between both electrode arrays. These findings can help providers with electrode selection and patient counseling.

Professional Practice Gap & Educational Need: To our knowledge, direct comparison of the Mid-Scala and SlimJ electrodes regarding hearing preservation and speech recognition outcomes has not been reported in the literature.

Learning Objective: To understand the differences in speech recognition and hearing preservation based on electrode array type from a single manufacturer.

Desired Result: Providers will have knowledge about the better postoperative hearing preservation outcomes with the SlimJ compared to the Mid-Scala electrode array, with the later providing no significant advantage in speech recognition. These results can be utilized for electrode selection and patient counseling.

Level of Evidence: Level IV – Historical cohort or case-controlled studies.

Indicate IRB or IACUC: IRB Exempt (221833, Vanderbilt University).

Understanding Determinants of Satisfaction and Decisional Regret in Adult Cochlear Implant Users

Christian M. Shannon, MS, MPAff, Judy R. Dubno, PhD, Theodore R. McRackan, MD, MSCR

Objective: Determine associations expected and actual cochlear implant (CI) outcomes, decisional regret, and satisfaction in experienced adult CI users.

Study Design: Cross-sectional cohort study

Setting: Tertiary medical center

Patients: 39 adult CI users meeting traditional bilateral hearing loss indications with ≥12 months CI experience

Interventions/ Main Outcome Measures: Patients completed the validated Satisfaction with Amplification in Daily Living (SADL) and Decisional Regret (DR) instruments. Pre- and post-CI outcomes (CI Quality of Life [CIQOL]-Expectations; CIQOL-35 Profile; CNC words, AzBio Sentences) were obtained from a prospectively maintained clinical database.

Results: Using established cutoff scores, 29% of patients reported a substantial degree of post-CI decisional regret. For each CIQOL domain, patients without decisional regret obtained post-CI outcome scores closer to pre-CI expectations as compared to patients with decisional regret (d= 0.25 to 0.95); similar results were observed with higher CI user satisfaction (d=0.24-0.87). Notably, the degree of pre- to post-CI improvement in CNC or AzBio scores did not differ between patients with and without decisional regret or with lower and higher satisfaction. Finally, greater pre-post improvement in CIQOL-35 Profile domain scores demonstrated far stronger associations with lower decisional regret and higher satisfaction than changes in speech recognition scores.

Conclusions: Patients with better alignment of their pre-CI expectations and post-CI outcomes and greater pre/post CIQOL improvement had lower decisional regret and higher satisfaction. This emphasizes the importance of evidence-based pre-CI counseling regarding real-world CI benefits and caution against assuming that improvements in speech recognition are related to patient satisfaction.

Professional Practice Gap & Educational Need: Prior investigations have focused on speech recognition outcomes as the primary driver for levels of satisfaction and regret an individual has with their cochlear implant device. However, audiological factors represent only a component of what determines a patient's attitudes towards their CI, and quality of life outcomes should also be considered to better understand degrees of satisfaction and decisional regret. Therein lies the opportunity to address a glaring research gap to understand how QOL is associated with CI satisfaction and regret.

Learning Objective: Determine the impact speech recognition and QOL outcomes have on a CI patient's levels of decisional regret and satisfaction with their device.

Desired Result: Practitioners and researchers will better understand what factors contribute to a CI user's levels of decisional regret and satisfaction with their device. As such, they will be able to utilize these associations to better tailor the pre-operative evaluation process and address modifiable factors to increase satisfaction and decrease decisional regret in CI patients.

Level of Evidence – Level IV

Indicate IRB or IACUC: Medical University of South Carolina; Pro00049700

Comparison of Pre-Curved versus Straight Electrode Intracochlear Position Using Three-Dimensional Virtual Resectioning from Implanted Human Histopathologic Specimens

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Jennifer T. O'Malley, BA; Joseph B. Nadol Jr., MD; Alicia M. Quesnel, MD

Hypothesis: Perimodiolar electrodes are located closer than straight electrodes to the lateral wall of the modiolus (LWM), where spiral ganglion neurons (SGNs) are located. Electrodes that remain fully in the scala tympani (ST electrodes) are closer to the LWM than translocated electrodes.

Background: Cochlear implant (CI) electrodes have a pre-curved ("perimodiolar") or straight ("lateral wall") design. Data conflict regarding which affords better hearing outcomes, however, CI performance may be related to proximity to SGNs.

Methods: Digitized slides of all processed postmortem human temporal bones (TBs) within one database that underwent cochlear implantation during life were included. Cases with older electrode designs, irregular staining, or trauma precluding evaluation of the electrode course were excluded. Three-dimensional reconstructions of each cochlea were created. The LWM and the electrode medial margin were marked and electrode-LWM distances measured from base to apex.

Results: Thirty-six TBs, including 18 pre-curved (44.4% translocated) and 18 straight electrodes (38.9% translocated), were analyzed. Overall, pre-curved electrodes were located closer to the LWM than straight electrodes (average electrode-LWM distance of 0.69+/-0.34 mm versus 1.26+/-0.26 mm; $p < 0.01$). Pre-curved ST electrodes were located closer to the LWM than straight ST electrodes (0.54+/-0.36 mm versus 1.20+/-0.26 mm, $p < 0.01$). Pre-curved translocated electrodes were located closer to the LWM than straight translocated electrodes (0.88+/-0.20 mm versus 1.36+/-0.25 mm, $p < 0.01$).

Conclusions: For both CI electrodes that remain in the scala tympani and those that translocate, pre-curved electrodes are located closer to the LWM than straight electrodes on average. This data has implications for modeling the electrode-neuron interface.

Professional Practice Gap & Educational Need: Both perimodiolar and lateral wall electrodes are commonly used for cochlear implantation. There is a lack of reliable data regarding the incidence of translocation as well as the final resting position of cochlear implant electrodes in relation to the lateral wall of the modiolus. Here, we investigate differences in these measures in perimodiolar and lateral wall electrodes.

Learning Objective: The final cochlear position of perimodiolar electrodes is closer to the LWM than is the final position of lateral wall electrodes.

Desired Result: A determination of whether there is a significant difference in the average distance between the electrode and the lateral wall of the modiolus in perimodiolar versus lateral wall electrodes.

Level of Evidence: Level III.

Indicate IRB or IACUC: IRB 2020P001593, Mass General Brigham.

Sound Localization in Active Transcutaneous Bone Conduction Users with Single-Sided Deafness

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Nadine Ibrahim, MD; Renee Banakis Hartl, MD, AuD

Objective: To evaluate sound localization accuracy of subjects with single sided deafness (SSD) with active transcutaneous bone conduction implants (atBCI) compared to the unaided condition and normal hearing controls.

Study Design: Prospective Case-Control Study.

Setting: Academic Tertiary Referral Center.

Patients: Normal hearing adults and patients with moderate to profound unilateral sensorineural hearing loss implanted with an atBCI.

Interventions: Frequency-specific localization was assessed in a semi-anechoic chamber using an array of 24 speakers spaced 15^{o} apart. Stimuli were delivered at 70 dB SPL for 0.5 seconds and included broadband noise (BBN) and narrowband noise (NBN) with center frequencies of 500, 1000, and 4000 Hz. Head movements were recorded via an electromagnetic tracking system. The response angle was recorded and compared against the presented stimuli location.

Main Outcome Measures:
(1) Frequency-specific localization deviation and root-mean-square (RMS) error (measured in degrees).
(2) Subjective assessment of perceived localization ability as measured by Speech Spatial Qualities (SSQ) questionnaire.

Results: Statistical analyses were performed using ANOVA and *t*-tests. Normal hearing controls can localize stimuli with minimal RMS error, consistent with the literature. SSD individuals have difficulty localizing in their unaided condition, particularly with NBN. With the atBCI, there were replicable errors with specific locations in space, explained by superimposed air and bone conducted signals summating constructively and destructively within the normal hearing cochlea.

Conclusions: Individuals with SSD have significant difficulty with localization, with poorer performance for NBN stimuli. atBCI may improve but does not normalize localization. There are systematic and reproducible changes in localization performance when using atBCI that may be predicted from interactions of air and bone conducted signal components. Further characterization of these interaural time difference-based interactions may provide the foundation for improvement in device programming strategies to optimize performance for individuals with atBCI for SSD.

Professional Practice Gap & Educational Need: Sound-source localization is challenging in individuals with monaural hearing due to lack of interaural time and level differences. Past studies evaluating percutaneous BCI in SSD patients have demonstrated no improvement in sound localization. However, with atBCI, one small (n=5) study suggested improved localization with the device. Larger studies allowing for granular assessment of localization ability are needed in SSD patients using atBCI to help establish appropriate clinical expectations and to work towards optimizing device outcomes.

Learning Objective:

1. Understand how sound localization abilities of patients with SSD are impacted by use of atBCIs
2. Characterize subjective localization ability of individuals with SSD using atBCIs

Desired Result: To provide improved understanding of localization abilities in SSD following implantation with atBCIs to better inform patient-centered decision making and device selection in this difficult-to-treat population. To lay the foundation for adaptations to device programming to address reproducible performance errors.

Level of Evidence - III

Indicate IRB or IACUC : University of Michigan HUM00190678

Representation of Women in Otolaryngology: A Geospatial Analysis

Mark Nyaeme, BS; Michael Pozin, MS; Nicholas Peterman, BS
Rachael Mann, BS

WITHDRAWN BY AUTHOR

03/22/23

Cigarette Smoking's Association with Sensorineural Hearing Loss - A Population Database Study

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Hypothesis: Chronic use of cigarettes or non-cigarette products with either cigarette-like smoke profile or high nicotine content increases odds for developing sensorineural hearing loss in young populations.

Background: Studies have long associated smoking with sensorineural hearing loss (SNHL). Proposed mechanisms include accelerated cochlear lateral wall degeneration via reactive oxygen species (ROS) native to carbon-based smoke, vessel atherosclerosis, and increased baseline inflammation with associated ROS burden. Currently, the largest published cohort study examining smoking-associated SNHL featured *n*=11,200. This study represents the greatest powered study to date examining the associations of tobacco, non-cigarette nicotine, and cannabis (non-nicotine smoke) use on odds for developing early-onset SNHL, with *n*=35,625,968.

Methods: The TriNetX US Collaborative Network was used to query ~100 million US patients using medical billing codes (ICD-10, CPT, etc.). Cohort inclusion criteria included EHR record after 2003, 18-54 or 55+ years old at index, and status of cigarette, non-cigarette nicotine, or cannabis use. Cohorts were controlled for SNHL-related conditions, including diabetes mellitus and noise exposure. Odds for developing SNHL were calculated against subjects 18-54 years-old who have no nicotine/cannabis use.

Results: Odds for developing SNHL are higher for people 18–54 years-old who use any nicotine product [5.91 (5.71-6.13) (odds-ratio (95% confidence interval))], cigarettes only [4.00 (3.69-4.33), chewing tobacco only [9.04 (7.09-11.63)], or cannabis only [3.99 (3.60-4.44)] compared to control. People 55+ years old who use no products had the third highest odds overall [4.73 (4.63-4.85)].

Conclusions: Both nicotine and smoke exposure appear to independently increase odds for developing SNHL, with nicotine having the strongest association.

Professional Practice Gap & Educational Need: While current evidence strongly suggests that cigarette use increases the risk for developing sensorineural hearing loss, this has not been previously demonstrated at the population level. There is also little understanding of the physiological reason behind this phenomenon, which may limit the possibility of treatment for affected patients, as well as the counseling that can be offered to those who use nicotine or smoke products other than traditional cigarettes.

Learning Objective: To understand the relative odds for developing SNHL posed by consumption of cigarettes, non-cigarette nicotine products, and cannabis in younger populations.

Desired Result: To better delineate the association between use of cigarettes, non-cigarette nicotine products, and cannabis with SNHL.

Level of Evidence – IV

Indicate IRB or IACUC: Jefferson IRB has determined this work exempt from committee review.