

SELECTED ABSTRACTS

**POSTER
PRESENTATIONS**



**153rd Annual Meeting
AMERICAN OTOLOGICAL SOCIETY**

**April 24-25, 2020
Hilton Atlanta
Atlanta, GA**

Cost Analysis of Intact Canal Wall versus Canal Wall Down Tympanomastoidectomy

Emily Bacalao; Kent Tadokoro, MD, Matthew Kircher, MD

Objective: To examine costs of intact and canal wall down tympanomastoidectomy for chronic otitis media and projected associated healthcare cost.

Background: The current literature regarding costs of treatment for chronic otitis media has lacked a cost-comparison analysis of surgery and cumulative follow-up expenses.

Study Design/Methods: Retrospective sampling of charts from 107 patients undergoing intact canal wall (ICW) or canal wall down (CWD) tympanomastoidectomy. Number of surgeries and outpatient visits within two years collected. A cost analysis simulation was then applied to project long term treatment costs for each group over 15 years.

Setting: Tertiary Academic Center

Patients: status post otologic surgery

Interventions: Therapeutic and rehabilitative

Main Outcome Measures: Healthcare cost

Results: The ICW group had a higher average cost per patient compared to the CWD group (\$5648.75 vs. \$4836.22). Though the median costs per group were similar in each group, those with CWD surgeries tend to have one surgery; whereas ICW patients tended to undergo at least one additional ear surgery. CWD patients had more post-operative visits and necessity for mastoid debridements compared to the ICW group. The accumulated costs for the CWD group surpassed the ICW group at year 12.64.

Conclusions: Intact canal wall surgery incurs a larger upfront cost than CWD. However, projected analysis demonstrates long-term CWD maintenance costs accumulate to surpass ICW costs at 13 years.

Define Professional Practice Gap & Educational Need: Cost considerations in otologic surgery and post-surgical care.

Learning Objective: The learner is expected to gain insight into accumulated costs associated with otologic surgery.

Desired Result: Physicians may wish to consider long-term mastoid cavity maintenance cost as a factor in determining treatment options for patients with chronic ear disease.

Level of Evidence – Level IV

Indicate IRB or IACUC : IRB approved, LU # 211389

**A Structural Analysis of Tympanic Compartments of the Middle Ear
In Patients with Down's Syndrome: A Temporal Bone Study**

Taketoshi Nogaki, MD, PhD; Michael M. Paparella, MD; Sebahattin Cureoglu, MD

Hypothesis: There may be findings peculiar to the temporal bones of children with Down syndrome (DS).

Background: Otitis media with effusion (OME) is a highly prevalent condition with DS. Knowledge of the volume of the tympanic compartments and the area of the tympanic isthmus might be important to find out the pathogenesis of highly prevalent OME in those patients.

Methods: We compared the volume of the epitympanum, mesotympanum, and the areas of the tympanic isthmus and tympanic orifice of eustachian tube in temporal bones from patients with DS. We also investigated the eustachian tube histopathologically.

Results: The mean volume of the epitympanum and the mesotympanum was significantly smaller in the DS group than the control group. We found no significant difference in the mean diameter of the protympanic opening and tympanic orifice between the two groups. The mean narrowest area of the aerated and bony tympanic isthmus also did not significantly differ between the two groups. An immature development of eustachian tube and cartilage was seen. We found mesenchyme remaining at the epitympanum and/or mesotympanum in all specimens in the DS group, and in 5 specimens in the control group.

Conclusions: In the presence of the small middle ear, poorly developed eustachian tube and tensor muscle, a vicious circle occurs, making otitis media with effusion difficult to resolve.

Define Professional Practice Gap & Educational Need: Children with DS often suffer from OME, however there are few anatomical studies on the middle ear, leading to further comprehension about it.

Learning Objective: To understand the middle ear structure in patients with DS.

Desired Result: Attendees will be able to understand about the middle ear structure of the children with DS.

Level of Evidence – V

IRB -Approved: University of Minnesota (#0206M26181)

Can You Hear Me Now? The Impact of Hearing Loss on Patient Health Literacy

*Anthony M. Tolisano, MD; Lilly B. Fang, BS; Brandon Isaacson, MD
J. Walter Kutz Jr, MD; Jacob B. Hunter, MD*

Objective: To elucidate the impact of hearing loss on patient health literacy.

Study Design: Prospective, cross-sectional study.

Setting: Academic otology practice.

Patients: Consecutive adult patients.

Main Outcome Measures: Inadequate health literacy, defined as a score of ≤ 9 on the Brief Health Literacy Screen (BHLS), was compared to patient hearing data utilizing the AAO-HNS hearing classification. Secondary outcome measures included comparisons of inadequate BHLS scores according to patient demographic and clinical information.

Results: 300 consecutive adult patients were evaluated with the BHLS between February and March 2019. Median patient age was 60-years (range, 18-91 years), a slight majority (160, 53.3%) were female, and most patients were White (241, 86.7%) and non-Hispanic (260, 91.6%). Overall, 9.7% of patients had inadequate health literacy. Males had higher rates of inadequate health literacy as compared to females (13.6% vs. 6.3%, OR=2.35, 95% CI 1.06 to 5.25). Audiometric data was available for 284 (95%) patients, of which 235 (82.7%) had class A or B hearing and 49 (17.3%) had class C or D hearing. Patients with Class C or D hearing had a lower median composite BHLS score compared to patients with Class A or B hearing (11.6 vs. 13.6, $p < 0.0001$) and an increased rate of inadequate health literacy (28.6% vs. 4.7%, OR=8.15, 95% CI 3.42 to 19.37). Younger age, males, and poorer hearing were independent predictors of inadequate health literacy on multivariable analysis.

Conclusions: Hearing loss is an independent risk factor for inadequate health literacy. Providers should be aware of this risk and consider implementing strategies to improve counseling for this at-risk group of patients.

Define Professional Practice Gap & Educational Need: Hearing loss is a barrier to the physician-patient relationship that may result in difficulties with medical counseling and optimal patient care outcomes. The effect of hearing loss on patient health literacy has not been previously assessed.

Learning Objective: To elucidate the impact of hearing loss on patient health literacy.

Desired Result: To improve physician awareness of the impact of hearing loss on patient health literacy; to provide a framework for future studies to improve patient-physician counseling as it relates to patients with hearing loss.

Level of Evidence – III.

Indicate IRB or IACUC : This project was approved and in compliance with University of Texas Southwestern Medical Center IRB (STU 032018-085).

Audiometric Outcomes following Transmastoid and Middle Cranial Fossa Approaches for Repair of Cerebrospinal Fluid Otorrhea

Yin Ren, MD PhD; Kareem O. Tawfik, MD; Roberto A. Cueva, MD

Objective: To (1) explore the audiometric outcomes following transmastoid and middle cranial fossa (MCF) approaches for repair of cerebrospinal fluid (CSF) otorrhea and (2) identify clinical features that may influence audiometric outcomes.

Study Design: Retrospective case series with chart review.

Setting: Tertiary skull base referral center.

Patients: Adult patients presenting with CSF otorrhea and/or encephalocele and undergoing operative repair between January 2009 to July 2019.

Interventions: Transmastoid repair, MCF repair, or a combined approach.

Main Outcome Measures: Primary outcome measures included preoperative and postoperative pure-tone average (PTA), air-bone gap (ABG) and word recognition score (WRS). Secondary outcome measures included success of repair, recurrence of CSF leak, and length of hospital stay.

Results: Twenty-nine patients underwent thirty-two operations from 2009 to 2019. The mean age at surgery was 52 ± 13 years and 68.8% of patients were female. Average body mass index (BMI) was 32.6 ± 9.0 kg/m². The most common etiologies of CSF leaks were spontaneous (41%), iatrogenic (28%), and infectious (12%). A total of 20 out of 32 (62.5%) patients underwent transmastoid repair, while 8 of 32 (25%) underwent a MCF approach. Amongst the entire cohort, there were significant improvements in both PTA (35.1 dB preop vs. 24.5 dB postop, $P = 0.006$) and ABG (18.7 dB preop vs. 8.6 dB postop, $P = 0.001$). CSF leak recurred in 3 patients (9.4%). Compared to non-transmastoid approaches, transmastoid repair demonstrated a significant improvement in PTA (17.5 vs. 3.0 dB, $P = 0.003$) and a shorter length of stay (0.3 vs. 1.17 days, $P = 0.005$). On subset analysis, patients with spontaneous CSF leaks demonstrated significant improvements in both PTA (36.5 vs. 24.1 dB, $P = 0.002$) and ABG (21.0 vs. 8.8 dB, $P < 0.001$), whereas those with non-spontaneous leaks did not. Patients with a single skull base defect had better hearing improvements than those with multiple tegmen defects. Finally, ears with encephaloceles had significant improvements in both PTA (13.2 vs. 10.9 dB, $P = 0.023$) and ABG (13.1 vs. 8.8 dB, $P < 0.001$).

Conclusions: The transmastoid approach for treatment and repair of CSF otorrhea and/or encephalocele is effective and safe. It achieves excellent audiometric outcomes and can be done on an outpatient basis. Patients with spontaneous CSF leaks, a single skull base defect, and associated encephaloceles achieve better audiometric outcomes.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge on the feasibility and audiometric outcomes in patients with CSF leaks who undergo surgical repair.

Learning Objective: To analyze the audiometric outcomes and complication rates of transmastoid versus middle cranial fossa repair of CSF leaks.

Desired Result: Attendees will be able to counsel patients on the success rates and complications of transmastoid versus middle cranial fossa approach for repair of CSF leaks and tegmen defects.

Level of Evidence – Level V – case series

Indicate IRB or IACUC : Approved - Kaiser Permanente Southern California Institutional review board (IRB# 10406)

Cytotoxicity of Tetracyclines in Human Tympanic Membrane Fibroblasts

Carolyn O. Dirain, PhD; Patrick J. Antonelli, MD

Hypothesis: Tetracycline antibiotics are less cytotoxic to human tympanic membrane (TM) fibroblasts than quinolones.

Background: Quinolone ear drops have been shown to increase the risk of TM perforations when used after tube placement or for the treatment of acute otitis externa. These findings were verified in both cell culture and animal models. Tetracyclines drop were historically used in the treatment of acute otitis externa. We aimed to determine if tetracyclines are cytotoxic to human TM fibroblasts.

Methods: Human TM fibroblasts were treated with 1:10 dilutions of ofloxacin 0.3%, ciprofloxacin 0.3%, doxycycline 0.3% and 0.5%, minocycline 0.3% and 0.5%, oxytetracycline 0.3% and 0.5% or dilute HCl (control), twice within 24-hours or four times within 48-hours, for two hours each time. Cells were placed back in growth media after the treatments. Cells were observed with phase-contrast microscopy until the cytotoxicity assay was performed.

Results: Human TM fibroblasts had lower survival in only the ciprofloxacin 0.3% and doxycycline 0.5%-treated cells compared to the control after 24h and 48h (all $p < 0.0001$). Fibroblasts treated with minocycline 0.5% increased cell survival after 24h, and both minocycline 0.3 and 0.5% increased survival of TM fibroblasts after 48 h (all $p < 0.0001$). Phase-contrast images mirrored the cytotoxicity findings.

Conclusions: With the exception of doxycycline 0.5%, doxycycline, minocycline and oxytetracycline, at concentrations of 0.3% or 0.5%, are not cytotoxic to human TM fibroblasts. These tetracyclines may be explored as alternative otic agents for the treatment of acute otitis externa.

DEFINE PROFESSIONAL PRACTICE GAP & EDUCATIONAL NEED: Professional practice gaps are the variations or differences in the practice patterns of physicians when compared to current evidence, standards of care or clinical guidelines that are designed to provide optimum patient care. Learning Objectives are short, clear statements about specific outcomes expected of the learner. Lastly, list the desired results in terms of changes in physician knowledge, competence, performance, and/or patient outcome.

Quinolone ear drops have been shown to increase the risk of TM perforations when used after tube placement or for the treatment of acute otitis externa. These findings were verified in both cell culture and animal models. Tetracyclines may be used as alternatives for treatment of acute otitis externa.

LEARNING OBJECTIVE: At the conclusion of this presentation, the attendees will learn that with the exception of doxycycline 0.5%, doxycycline, minocycline and oxytetracycline, at concentrations of 0.3% or 0.5%, are not cytotoxic to human TM fibroblasts.

DESIRED RESULT: Attendees may be able to apply this knowledge by considering the use of tetracycline ear drops for treatment of uncomplicated acute otitis externa.

Level of Evidence – Does not apply. Prospective, *in vitro* study.

Indicate IRB or IACUC : IRB approval #201802084

Evaluating the Impact of Poloxamers on Survival of Human Tympanic Membrane Fibroblasts

Carolyn O. Dirain, PhD; Patrick J. Antonelli, MD

Hypothesis: Poloxamers used for otic drug delivery may be cytotoxic to human tympanic membrane (TM) fibroblasts.

Background: Poloxamers are nonionic copolymers, which are thermo-reversible (ie, liquid at cool temperatures and gel at body temperature). Poloxamer are routinely used as wound dressings. Poloxamers have been promoted for sustained-release otic drug delivery. Though poloxamers have been reported to be safe in the middle ear, application of 25% poloxamer 407 to the rat ear canal was found to cause TM perforations.

Methods: We tested poloxamers 407 and 188, which are found in a commercial otic preparation and wound dressing, respectively. Human TM fibroblasts were treated with 1:10 dilutions of 25% poloxamer 407, poloxamer 188, or phosphate buffered saline (PBS, control), twice within 24-hours or four times within 48-hours, for two hours each time. Cells were placed back in growth media after the treatments. Cells were observed with phase-contrast microscopy until the cytotoxicity assay was performed.

Results: Survival of human TM fibroblasts treated with poloxamer 407 or poloxamer 188 was not different compared to the control after 24h (98 and 99%; $p=0.07$) or 48h (100 and 99%; $p=0.21$). Phase-contrast images mirrored the cytotoxicity findings.

Conclusions: Poloxamers 407 and 188, at concentrations of 25%, are not cytotoxic to human TM fibroblasts. TM perforations in the rats treated with poloxamer may result from other, yet-to-be-determined properties of poloxamers.

DEFINE PROFESSIONAL PRACTICE GAP & EDUCATIONAL NEED: Professional practice gaps are the variations or differences in the practice patterns of physicians when compared to current evidence, standards of care or clinical guidelines that are designed to provide optimum patient care. Learning Objectives are short, clear statements about specific outcomes expected of the learner. Lastly, list the desired results in terms of changes in physician knowledge, competence, performance, and/or patient outcome.

Poloxamers are nonionic copolymers, which at concentrations $\geq 15\%$ exhibit thermo-reversible properties, ie, liquid at cool temperatures and form a gel at higher temperature (eg, body temperature) in a reversible process. This property allows for sustained drug delivery. Poloxamer gels are routinely used as a burn and wound dressings, and now are also use for otic drug delivery. Poloxamers have been shown to be safe and effective vehicle in the middle ear. However, in the rat, 25% poloxamer 407 caused TM perforations. It is unclear whether poloxamers are cytotoxic to the tympanic membrane fibroblasts.

LEARNING OBJECTIVE: At the conclusion of this presentation, the attendees will learn that poloxamer gels, which are being use for otic drug delivery, are not cytotoxic to human TM fibroblasts. However, they may carry a risk of causing perforations in intact TMs.

DESIRED RESULT: Attendees may be able to apply this knowledge by considering the potential adverse impact of poloxamers on TMs when prescribing otic treatment with poloxamers.

Level of Evidence – Does not apply. Prospective, controlled *in vitro* study.

Indicate IRB or IACUC : IRB approval #201802084

Influence of Age on Predictive Models for BPPV

*David R. Friedland, MD, PhD; Taiwo Fasae, MS
Heidi A. Richburg, MS; Richard J. Povinelli, PhD*

Objective: To assess the effect of age on survey-based triage for predicting BPPV.

Study Design: Prospective application of an electronic vestibular survey with subsequent machine learning analyses.

Setting: Tertiary referral center

Patients: Patients referred to a tertiary otology practice for dizziness or imbalance.

Intervention: Machine learning assessment of survey responses using a correlation filter, J48 decision tree analyses, and 10-fold cross validation.

Main outcome measures: Accuracy, sensitivity, and specificity of decision trees for predicting BPPV.

Results: 284 subjects completed an electronic survey regarding vestibular symptoms for the intent of predicting BPPV. Correlation analyses for those <70 years old, those 70-79, and those 80+ years old showed unique predictors for each age group. In those over 80, questions to rule-out migraine were relevant while in younger patients, duration and sensation prevailed. J48 decision tree analysis identified representative decision trees for each age group best distinguishing BPPV. These models showed a statistically significant higher sensitivity but lower specificity between those <70 and those 80+. We also applied a previously reported linear predictor for BPPV to this cohort which also distinguished the oldest group by showing greater specificity (92.9% vs 72.2%).

Conclusions: Paper questionnaires or electronic surveys are often used to triage vestibular patients to improve practice efficiency. Predictive models used to analyze these surveys need to consider age as a variable. Adjustments should be made in the questions asked and the predicted accuracy of the models between younger and elderly adults.

Define Professional Practice Gap & Educational Need: Gaps in knowledge for diagnosing vestibular disorders and gaps in knowledge as to geriatric presentations for otologic conditions

Learning Objective: To recognize age as a factor in interpreting patient symptoms for BPPV

Desired Result: Recognize confounders of BPPV in different age groups.

Level of Evidence – Level III

Indicate IRB or IACUC: PRO00027877, Medical College of Wisconsin; Prior to Start of Data Collection

Cool OtOprotective Lavage (COOL) Therapy for Cisplatin Induced Hearing Loss

*James K. Stanford II, MD; Drew S. Morgan, BS; Nicholas A. Bosworth, BS
Robby Chen, PhD; Bradley J. Walters, PhD
Douglas E. Vetter, PhD; Christopher Spankovich, PhD*

Hypothesis: Localized cooling of the external ear has a protective effect on the susceptibility to Cisplatin induced hearing loss.

Background: We previously demonstrated significant protection from cisplatin induced hearing loss using cool water ear canal irrigation. However, the study was limited to a single bolus injection of cisplatin and acute time period. Here we examined application of localized cooling of the ear canal with repeated doses of cisplatin, over an expanded period of time, and using two methods of cooling.

Methods: Twenty-four guinea pigs (12 male and 12 female) underwent auditory physiological testing (auditory brainstem response and distortion product otoacoustic emissions at 8-32 kHz) pre and post administration of cisplatin. Cisplatin (4 mg/kg ip) was administered in 3 weekly single injections for a total of 12 mg/kg. The left ear of the guinea pigs was exposed to either cool water (20°C; ICS Water Caloric Irrigator) or a cool ear bar (15°C, cooled by a Peltier device; TNM™, Scion NeuroStim) while anesthetized. The animals were tested 3 days post each dosage and 1 month post the final dose. At the end of the experiment animals were euthanized for histological evaluation.

Results: Auditory testing revealed significantly less hearing loss in animals that received the COOL Therapy compared to cisplatin-only control animals. No significant difference was observed between the two methods of cooling.

Conclusion: Localized cooling of the ear during administration of cisplatin mitigated loss of auditory function and loss of hair cells.

Define Professional Practice Gap & Educational Need: It is estimated that 70-100% of patients undergoing cisplatin treatment incur ototoxic adverse events. Currently, a number of investigators are exploring pharmacological otoprotectant strategies. The overarching concern for pharmacological therapies is potential for decrease in the anti-tumor efficacy of the cisplatin and/or a need for invasive methods of administration.

Learning Objective: Describe a novel, localized, and minimally invasive otoprotective strategy.

Desired Result: Encourage studying mechanism and exploring translation to human populations.

Level of Evidence: Does not apply

Indicate IRB or IACUC : IACUC 1540

**Transcutaneous Electrical Nerve Stimulation for Treatment of Tinnitus:
A Systematic Review and Meta-Analysis**

*Young Jae Byun, BS; Joshua A. Lee, BA; Shaun A. Nguyen, MD
Habib G. Rizk, MD; Ted A. Meyer, MD, PhD; Paul R. Lambert, MD*

Objective: To evaluate the treatment efficacy of transcutaneous electrical nerve stimulation (TENS) in patients with tinnitus.

Data Sources: PubMed, Scopus, Web of Science, and Cochrane Library were searched for the following two concepts: “transcutaneous electric nerve stimulation” and “tinnitus.”

Study Selection: Studies were considered for inclusion if they were: 1) double- or single-blinded randomized controlled trials, 2) double- or single-blinded randomized comparison trials, 3) prospective or retrospective observational studies, and 4) case series.

Data Extraction: Tinnitus Handicap Inventory (THI), the Visual Analog Scale (VAS), and perceived tinnitus suppression after treatment. Additional data collected included tinnitus laterality, duration of symptoms, location of electrode placement, time to follow-up, etiology of tinnitus, and treatment side effects.

Data Synthesis: The literature search yielded 54 unique articles. After reviewing 27 full-text articles, 16 studies reporting on 1142 patients were included for final analysis. Four studies provided data available for meta-analysis of pre- and post-treatment THI and VAS (Cochrane Review Manager). TENS showed significant overall reduction on THI (-7.55 [-10.93 to -4.18], $p < 0.0001$) and VAS (-0.65 [-0.99 to -0.30], $p < 0.0002$). Subjective improvement of tinnitus was pooled across thirteen studies using meta-analysis of proportions (MedCalc). Tinnitus suppression occurred in 39.0% [27.1% to 51.6%] patients. Among them, 24.6% [1.4% to 63.3%] experienced persistent improvement at 3 months and 22.2% [12.2% to 29.7%] experienced complete suppression.

Conclusions: TENS represents a safe and feasible treatment option for tinnitus and might be a worthy consideration among the spectrum of interventions developed for tinnitus.

Define Professional Practice Gap & Educational Need: Tinnitus is an increasingly prevalence disorder that can have a profound impact on the social functioning and psychological well-being of patients. Although various treatment modalities have been investigated, no therapy demonstrated compelling benefit in its management. TENS offers an enticing non-invasive method in tinnitus treatment but its efficacy has only been evaluated in small observational studies and a few randomized controlled trials.

Learning Objective: To understand current knowledge on TENS as a treatment option for tinnitus and to analyze its efficacy based on reported outcomes.

Desired Result: Attendees will be aware of TENS as an option for tinnitus management and understand its efficacy in its management.

Level of Evidence: LEVEL II, small RCTs with unclear results

Indicate IRB or IACUC: Exempt.

Necrotizing Otitis Externa: A Systematic Review and Analysis of Changing Trends

*Young Jae Byun, BS; Jaimin Patel, MD; Shaun A. Nguyen, MD
Paul R. Lambert, MD*

Objective: To assess for changes in trends of the disease process, management, and outcomes of necrotizing otitis externa (NOE) over the last decade.

Data Sources: PubMed/MEDLINE, Scopus, Web of Science, Science Direct, and Cochrane Database were used to identify articles in English, published between January 2011 and June 2019.

Study Selection: Studies were considered for inclusion if they contained 1) reported evidence of NOE, 2) details on patient demographics and underlying medical disorder, 3) details on treatments, 4) documented outcomes, and 5) greater than 10 cases.

Data Extraction: Study demographics, underlying conditions, infectious etiology, treatments, signs and symptoms, and outcomes.

Data Synthesis: Thirty-eight studies, comprising 1386 patients with a mean age of 67.2 years, were included. The time period of collected patient data ranged from 1990 to 2018. Temporal subgroup analysis was conducted before and after 2009. Disease-specific mortality was lower in the post-2009 group (4.1% versus 7.4%, $p = 0.026$). Increases in proportions of diabetes ($p < 0.0001$), *Pseudomonas* spp. ($p = 0.002$) and culture negative results ($p < 0.0001$) were also observed in this latter group. The use of piperacillin tazobactam ($p = 0.004$) and adjuvant hyperbaric oxygen therapy ($p < 0.0001$) increased along with the rate of local surgical intervention ($p < 0.0001$), whereas the rate of extensive surgery ($p < 0.0001$) decreased in the post-2009 group.

Conclusions: A decrease in disease-specific mortality of NOE patients was observed in the setting of an increase in prevalence of diabetes. An increase in culture negative results and local surgery were observed.

Define Professional Practice Gap & Educational Need: NOE typically affects elderly diabetic or immunocompromised individuals. With the aging global population and the growing prevalence of diabetes, it can be postulated that the incidence of NOE may increase. An examination of disease process over time may address how this entity is evolving with the population.

Learning Objective: To review and understand the changing trend of the disease process, management, and outcomes for NOE.

Desired Result: Attendees may be able to apply this knowledge in the management of NOE and be aware of the potential need for prolonged systemic antibiotic therapy, guided by patient symptoms, laboratory data, and imaging results.

Level of Evidence: LEVEL IV, historical cohort and case-control studies.

Indicate IRB or IACUC: Exempt.

Prophylactic Migraine Treatment Outcomes in Patients with Stapedial Myoclonus

*Jack Birkenbeuel, BS; Mehdi Abouzari, MD, PhD; Brooke Sarna, BS
Khodayar Goshtasbi, BS; David Bruss, MS
Harrison W. Lin, MD; Hamid R. Djalilian, MD*

Objective: To describe a case series of patients with stapedial myoclonus (SM) whose conditions improved after prophylactic migraine treatment.

Study Design: Retrospective case series.

Setting: Tertiary-care neurotology clinic.

Patients: Six patients with SM, with an average age of 45 ± 17 years (range: 27-69 years), suffering from concurrent migraine symptoms, including those with headache, dizziness, vertigo, and nausea.

Interventions: Treatment with a standard prophylactic migraine protocol used at this neurotology clinic. The migraine regimen consisted of dietary, stress, and sleep modifications to avoid migraine triggers, supplementation with vitamin B2 200 mg bid and magnesium 400 mg bid, and migraine prophylactic medication (*e.g.*, nortriptyline or verapamil) with dose escalation if needed.

Main Outcome Measures: The main outcome measure was reduction or resolution of SM symptoms at 2-month follow-up.

Results: SM in all 6 patients improved from baseline. 67% of patients noted significant (>50%) improvement, with a reduced frequency, duration, and intensity of their symptoms. The remaining 33% of patients experienced complete resolution of SM with their migraine treatment. Response to treatment varied. Caffeine cessation alone resolved the SM in 17% of patients. Lifestyle modifications, including use of vitamin B2 and magnesium qualitatively improved SM symptoms in 50% of patients. Nortriptyline (10-20-30 mg) or verapamil addition (120-180-240 mg) with dose escalation was needed to significantly improve or fully resolve symptoms in the remaining 33%.

Conclusions: We report that treatment with prophylactic migraine treatment can provide long-term relief for patients with SM, which may suggest an etiological association between migraine and SM as well as a possible treatment for SM.

Define Professional Practice Gap & Educational Need: There is a practice gap in minimally invasive treatment for SM. While many treatment regimens have been proposed and utilized for SM, previously reported conservative measures have been shown to be largely ineffective. The only known long-term effective treatment for SM is stapedius tendon tenotomy via tympanotomy. Unfortunately, tenotomy is more invasive and does not always guarantee successful treatment of SM. For this reason, a need to educate otolaryngologists on an innovative, less invasive, new treatment for SM is warranted.

Learning Objective: To educate AOS members on a series of patients with SM treated with a prophylactic migraine regimen and to 1) demonstrate that identified triggers for SM are similar to established triggers for migraine headaches; 2) propose an association between SM and migraines; and 3) propose a novel treatment for SM.

Desired Result: Informing otologists of a possible new treatment for SM that can be incorporated into their practice to improve patient outcomes.

Level of Evidence - IV

Indicate IRB or IACUC: The study has IRB approval from the UC Irvine

**Comparison of Cochlear Implant Device Fixation – Well Drilling vs. Subperiosteal Pocket
A Cost Effectiveness, Case-Control Study**

*Sagit Stern Shavit, MD; Madeleine A. Drusin, MD, MSc
Emery P. Weinstein, BA; Elena B. Elkin, PhD, MPA
Lawrence R. Lustig, MD; George Alexiades, MD*

Objective: To compare surgical characteristics, short and long-term complications between well drilling (WD) and subperiosteal pocket techniques (SPT) for receiver/stimulator (R/S) fixation of cochlear implant (CI), and conduct a comparative cost-effectiveness analysis for the two methods.

Study Design: Retrospective clinical study, decision-analysis model

Setting: Tertiary referral center

Patients: Three-hundred and eighty-eight CI recipients with a minimum of six-month follow-up.

Interventions: CI surgery using either WD or SPT for R/S fixation. A decision-analysis model was designed using data from a systematic literature review of all studies comparing the two methods. Prices were calculated using “out of pocket” prices for operating time and commercial products.

Main Outcome Measures: Surgical operation time, rates of major and minor long-term complications were compared. Cost-effectiveness was calculated to assign a monetary value for the difference between the two methods.

Results: We compared 179 WD with 209 SPT. Surgery time was significantly shorter in SPT (148 vs 169 minutes, $p=0.001$) and remained significant after adjustment for side, surgeon, resident experience and use of intraoperative X-ray. Higher rates of severe complications requiring surgical intervention were found in SPT (10.5% vs 4.5%, $p=0.042$), however, the difference was not significant after adjusting for follow-up time (47.8 vs 32.5 months for SPT, WD respectively; $p<0.001$). The cost-effectiveness model indicated an advantage for SPT but with only \$42 USD difference. Differences in surgical time and estimated price for major complications most effected the model results.

Conclusions: SPT appears to be faster with a non-significant cost-advantage over WD. Further long-term studies are required to determine the differences in complication incidence between the two methods.

Define Professional Practice Gap & Educational Need:

Different fixation methods for the cochlear implant receiver/stimulator have been utilized over the years. The two commonly practiced methods: well drilling (WD) and subperiosteal pocket technique (SPT), each have advantages and disadvantages. Surgeons who practice one method or the other strongly believe in its safety and effectiveness. Previous studies have found SPT to be a faster and safe technique, however, there are only a few studies comparing the two methods, with some finding higher complications rates in SPT, such as migration and device failure, compared to WD.

Learning Objective:

Our study aims to compare our department’s experience with the two fixation methods and to design a decision analysis model, using our results as well as a systematic literature review, to compare cost-effectiveness and determine which of the two methods is advantageous.

Desired Result:

Data regarding short and long-term complications as well as surgical time will be compared between the two methods and will provide better evidence about safety of these methods. The model will allocate a monetary value to each method to calculate cost-effectiveness and will identify the variables that most effect the differences between the two methods, educating physicians to choose their desired technique.

Level of Evidence – Level IV

Indicate IRB or IACUC : Well Cornell Medical Center- exempt, Columbia university IRB-AAAS0667

Factors Associated with Change in Dizziness Handicap Scores in the Treatment of Vestibular Migraine

*James R. Dornhoffer, MD; Yuan F. Liu, MD
Lane Donaldson, MD; Habib G. Rizk, MD*

Objective: To characterize patient factors that influence response to therapy in vestibular migraine patients as measured by change in Dizziness Handicap Inventory (DHI) scores.

Study Design: Retrospective review of a prospectively maintained vestibular database.

Setting: University-based tertiary medical center

Patients: 49 patients seen for treatment of definite vestibular migraine, per Barany Society criteria, from 2015 to 2019

Interventions: A protocol of antidepressants, antiepileptics, beta blockers, and vestibular rehabilitation. Patient's failing initial therapy received botulinum toxin per the PREEMPT protocol.

Main Outcome Measures: Quality of life measured per the Dizziness Handicap Inventory (DHI). Pre- and post-treatment DHI scores, in addition to change in DHI were correlated against patient specific variables to determine factors associated with change in response to therapy. Patient factors included demographic variables, medical comorbidities, comorbid otologic or pain symptoms, treatment modality, and initial DHI scores.

Results: 49 patients underwent therapy for vestibular migraine. This population had a significant DHI reduction of 17.3 ± 25.2 ($p < 0.001$) with therapy. Univariate analysis showed that female gender, comorbid BPPV, and high initial DHI were significantly associated with greater reduction in DHI scores ($b = -7.92$, $p = 0.033$; $b = -18.65$, $p = 0.028$; $b = -0.458$, $p = 0.016$, respectively). Conversely cervicalgia and oscillopsia were significantly associated with a lower reduction in DHI scores ($b = 5.525$, $p = 0.024$ and $b = 21.48$, $p = 0.027$, respectively).

Conclusions: Vestibular migraine is a complex disorder with heterogeneous response to therapy. This study shows that patient specific factors of gender, cervicalgia, oscillopsia, BPPV, and high DHI scores on presentation may influence response to common vestibular migraine therapy.

Define Professional Practice Gap & Educational Need: There is a lack of awareness regarding the association between patient specific factors and comorbidities, and response to therapy in vestibular migraine.

Learning Objective: To characterize the relationship between patient specific factors and response to therapy, as measured through change in quality of life in vestibular migraine populations.

Desired Result: Practitioners and researchers will identify specific patient factors that may modulate response to therapy. Such factors may guide practitioners in counselling patients on prognosis and possible alternative therapy if poor response is anticipated.

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

Indicate IRB or IACUC : Exempt

Three-Dimensional Printing of a Low-Cost Middle-Ear Training Model for Surgical Management of Otosclerosis

*Christopher R. Razavi, MD; Seena Vafae; Deepa Galaiya, MD
Rui Yin, BS; John P. Carey, MD; Russell H. Taylor, PhD
Francis X. Creighton, MD*

Background: Surgical management of otosclerosis is a technically challenging procedure. with studies demonstrating that outcomes are commensurate with surgical experience. Moreover, experts apply less force on the ossicular chain during prosthesis placement than their novice counterparts. Given the predicted decreasing patient pool and the rising cost of human temporal bone specimens it has become more challenging for trainees to receive adequate intraoperative or laboratory-based experience in this procedure. As such, there is a need for a low-cost training model for the procedure. Here we describe such a model, using force applied on the modeled incus and time to completion as objective performance measures.

Setting: Material engineering laboratory

Methods: A surgical model of the middle ear was designed using computer aided design (CAD) software SolidWorks (Dassault Systèmes, France). The model consists of 4 components, the superior 3D-printed component representing the external auditory canal (EAC), a 90 degree torsion spring representing the incus, a 3D-printed base with a stapedotomy underlying the torsion spring, and a 3D-printed phone holder to facilitate video-recording of trials and subsequent calculation of the force applied on the modeled incus. Force applied on the incus is calculated based on Hooke's Law from post-trial computer-vision analysis of recorded video.

Results: The described model was manufactured with a total cost of \$56.50, with an ability to detect force applied to the modeled incus across a range of 1.2 - 5200mN.

Conclusions: We have created a low-cost middle-ear training model with measurable objective performance outcomes. The range of detectable force exceeds expected values for the task.

Define Professional Practice Gap & Educational Need: There is a need for a low-cost simulator for surgical management of otosclerosis given the decreasing case volume/patient pool, rising cost, and decreasing availability of temporal bone specimens.

Learning Objective: Attendees will understand:

The present need for additional training modalities for surgical management of otosclerosis.

That expert surgeons apply less force to the ossicular chain during prosthesis placement than their novice counterparts, thus making applied force on a modeled ossicular chain a useful performance measure for a surgical simulator for this procedure.

Desired Result: Develop a low-cost training model for surgical management of otosclerosis with trendable objective performance measures.

Level of Evidence - V

Indicate IRB or IACUC: Johns Hopkins Homewood IRB: 00001598

Low-Frequency Hearing Preservation following Revision Cochlear Implantation

*Nicholas J. Thompson, MD; Margaret T. Dillon, AuD
Andrea L. Bucker, AuD; English R. King, AuD
Harold C. Pillsbury III, MD; Kevin D. Brown, MD, PhD*

Objective: Preservation of low-frequency hearing is possible following cochlear implantation. Cochlear implant recipients may require revision cochlear implantation as internal devices age, malfunction, or become obsolete, which may increase the risk of low-frequency hearing loss. Limited data exist on hearing preservation in cases of revision cochlear implantation. We sought to determine the degree and stability of low-frequency hearing preservation after revision cochlear implantation at our institution and to perform a systematic review in the literature.

Study Design: Case series and systematic literature review. A literature search on PubMed was completed using the search terms “cochlear implant”, “revision”, “reimplantation”, and “hearing preservation”.

Setting: Tertiary medical center and systematic literature review.

Patients: Cochlear implant recipients with preserved low-frequency hearing requiring revision cochlear implantation.

Interventions: Revision cochlear implantation.

Main Outcome Measures: Low-frequency pure-tone average (LFPTA; 125, 250, and 500 Hz).

Results: Three subjects presented at the study site with low-frequency hearing preservation prior to revision cochlear implantation. All subjects had preserved low-frequency hearing following revision cochlear implantation. Seven additional cases were identified in the literature. The combined cohort’s mean LFPTA was 51.9 dB HL. After reimplantation, the mean LFPTA demonstrated complete hearing preservation (<10 dB shift). Low-frequency hearing thresholds did not change significantly at the 3-month (51.7 dB HL, $p=0.16$) or 6-month (58.1 dB HL, $p=0.38$) intervals. The subject with the longest follow-up interval (24 months) continued to demonstrate low-frequency hearing preservation.

Conclusions: Complete low-frequency hearing preservation is possible after cochlear reimplantation. Subjects experienced stable LFPTA thresholds through at least 6 months post-reimplantation.

Define Professional Practice Gap & Educational Need: There is a lack of knowledge regarding the degree and stability of low-frequency hearing preservation following revision cochlear implantation.

Learning Objective: To understand that complete low-frequency hearing preservation is possible at least 6 months after revision cochlear implantation.

Desired Result: Providers will be better able to counsel cochlear implant recipients about the possibility of continued hearing preservation after undergoing revision cochlear implantation due to device failure or upgrade in device. The importance of soft surgical techniques and measures to preserve residual hearing will be stressed.

Level of Evidence - Level V – Case series with subsequent systematic review

Indicate IRB or IACUC: University of North Carolina IRB#09-2328

Revision Cochlear Implant Surgery: Rates, Etiologies and Speech Perception Outcomes

*Doron Sagiv, MD; Yifat Yaar-Soffer, MA; Ziva Yakir
Michael Wolf, MD; Yael Henkin, PhD; Yisgav Shapira, MD*

Background: There is a steady growth in the number of cochlear implantations due to expanded candidacy criteria and a continuous increase in life expectancy. These trends, combined with longer periods of device usage per cochlear implant (CI) patient, result in increased prevalence of revision cochlear implant (RCI) surgery.

Objective: The goals of the current study were to quantify RCI rates, examine the indications and test the effect of RCI on speech perception performance by means of a within-subject analysis.

Methods: We reviewed the medical records of all patients that underwent RCI since the initiation of the Sheba CI program in 1989 through 2016. Data extracted included background variables, surgical reports, medical follow-up, and audiological evaluations.

Results: During the studied period, 172 revision surgeries (11.7% of the total CIs performed) in 142 patients (78% children, 22% adults) were RCI. The indications for RCI were classified into the following five categories – device failure (46% soft, 25% hard), medical (14%), surgical (7%) and trauma (8%). Group mean speech perception performance was similar before and after RCI for open set monosyllabic words, phonemes, and SRTs. Within subject analysis of 133 patients with full datasets revealed that post RCI speech perception performance was unchanged in 66.9%, improved in 17.3%, and deteriorated in 15.8% of patients, based on a clinically significant change criterion. In the remaining cases datasets were incomplete.

Conclusions: The Sheba RCI rate amounted to 11.7%. Within-subject comparisons indicate that in the majority of patients speech perception performance is either unchanged or improved.

Define Professional Practice Gap & Educational Need: The number of cochlear implantations (CIs) is continuously growing due to expanded candidacy criteria, technological advances, successful hearing outcomes and persistent increase in life expectancy. As with any implanted device, there is an inherent risk for failure, infection and rejection of the device. A lack of uniform methodology in measuring and reporting the performance outcome of revision cochlear implantation makes the patients' consultation challenging and less precise.

Learning Objective: The goals of the current study were threefold: (1) to quantify RCI rate; (2) to examine the indications for a revision surgery; and (3) to test the effect of RCI on speech perception performance by using a within-subject analysis.

Desired Result: We aim to characterize the clinical profile of our patient cohort that underwent RCI surgery, quantify the RCI rate and predict the future burden of revision implantations. In addition, by using within-subject analysis we report the rates of improvement, deterioration or un-changed hearing performance in order to improve patients' consultation while considering re-implantation.

Level of Evidence - Level V

Indicate IRB or IACUC : Institutional Review Boards of Sheba Medical Center, 2016

**Presbycusis Secondary to Loss of Fibrocytes
in the Human Spiral Ligament**

*Astkhik A. Hakobyan, BA; Ivan A. Lopez, PhD
Gail Ishiyama, MD; Akira Ishiyama, MD*

Objective: To compare the number of fibrocytes in the spiral ligament in patients with a history of presbycusis to age-matched normatives in human temporal bones.

Study design: Clinical histopathological correlation using archival human temporal bones

Setting: Archival human temporal bones (HTB) from the NIDCD National Temporal Bone Laboratory at UCLA were analyzed under light microscopy.

Subjects and Methods: Sixteen HTBs from patients with a history of sensorineural presbycusis were used. Eight HTBs from subjects with a history of no auditory or vestibular disorders were used as normative controls. Photomicrographs were analyzed for the presence or absence of fibrocytes in the spiral ligament at the base, middle and apical regions of the cochlea.

Results: Eight human temporal bones of subjects with no history of auditory disease were observed with higher number of fibrocytes in the basal spiral ligament compared with the middle and apical levels of the spiral ligament. In comparison, there appeared to be loss of fibrocytes in the spiral ligament of the basal cochlea, while the middle, and apical levels of the spiral ligament were not prominently decreased from the normative controls. Five of the 16 human temporal bone with presbycusis demonstrated more extensive decrease of fibrocytes in the spiral prominence and the spiral ligament at the basal level of the cochlea.

Conclusion: Presbycusis is associated with a loss of fibrocytes of the spiral ligament at the basal level of the cochlea which may be critical in the pathogenesis of the hearing loss.

Define Professional Practice Gap & Educational Need: It is important to understand the role of fibrocytes in hearing loss and presbycusis.

Learning Objective: The loss of the fibrocytes in the spiral ligament is associated with presbycusis.

Desired Result: Identification of the role of fibrocyte loss may lead to the exploration of new targeted therapies in the management of presbycusis.

Level of Evidence – 3

Indicate IRB or IACUC : IRB 10-001449, **Grant #:** 1U24DC 051910-01

**Surgical Management of Intrapetrous Carotid
Dehiscence Causing Pulsatile Tinnitus**

*Peter E. Ashman, MD; Pierce M. Cooper, BS; Nicole Raia, ScD
Rachel Scheperle, PhD; Yu-Lan Mary Ying, MD
James K. Liu, MD; Robert W. Jyung, MD*

Objective: To describe a novel repair of carotid artery dehiscence causing pulsatile tinnitus. To describe acoustic recordings that correlate with intrapetrous carotid dehiscence.

Study Design: Case series

Setting: Tertiary referral center; hospital

Patients: 2 subjects with pulsatile tinnitus related to bony dehiscence of the intrapetrous carotid canal, versus 3 controls without tinnitus.

Interventions: 1 patient underwent sequential middle fossa transpetrous repair of the carotid dehiscence with bone cement. Both subjects and 3 controls had transcanal recordings to identify an acoustic correlate of the pulsatile tinnitus. Recordings underwent spectrotemporal analysis to differentiate subjects and controls.

Main Outcome Measures: Visual inspection and spatiotemporal analysis of transcanal recordings. Subjective reporting of a change in tinnitus after surgery.

Results: A regular pattern of spikes were recorded from the side of carotid dehiscence in Subject 1, not seen in the nondehiscent asymptomatic ear. In Subject 2 with bilateral carotid dehiscence, regular spikes with a doublet pattern were recorded bilaterally, even after right transpetrous cement repair. In controls, either a nonregular pattern of muted spikes or a regular pattern of doublet spikes were seen, though these were noticeably more diffuse with a noisier baseline. Subject 2 reported dramatic reduction of pulsatile tinnitus in both ears postoperatively.

Conclusions: Acoustic recordings may provide an objective measure to characterize intrapetrous carotid dehiscence as a cause of pulsatile tinnitus. Surgical management of pulsatile tinnitus is possible in cases of intrapetrous carotid artery dehiscence.

Define Professional Practice Gap & Educational Need: 1) Need for objective measures to help identify and differentiate the etiologies of pulsatile tinnitus. 2) Once identified, surgical management of different etiologies of pulsatile tinnitus is infrequently performed with little data available on the efficacy of such treatment.

Learning Objective: 1) To discuss intrapetrous carotid dehiscence as a cause of pulsatile tinnitus. 2) To show characteristics of acoustic correlates of intrapetrous carotid dehiscence. 3) To describe a novel surgical technique to repair petrous ICA dehiscence in a patient with pulsatile tinnitus.

Desired Result: 1) Attendees should be able to describe the etiologies of pulsatile tinnitus. 2) Attendees will be able to understand characteristics of acoustic correlates of intrapetrous carotid dehiscence. 3) Attendees should be able to discuss potential surgical approaches to repair petrous ICA dehiscence in a patient with pulsatile tinnitus.

Level of Evidence - Level V

Indicate IRB or IACUC : Number: Pro2018002337 Institution: Newark Health Sciences IRB; Approval Date: 4/23/19

**The Influence of Measles on the Development of Otosclerosis:
A Case-Control Study**

*Robert J. Macielak, MD; John P. Marinelli, MD; Douglas J. Totten, BA
Christine M. Lohse, MS; Brandon R. Grossardt, MS; Matthew L. Carlson, MD*

Objective: Previous studies have isolated the measles virus from temporal bone specimens with otosclerosis, pointing to a potential relationship. The primary objective of the current work was to determine if a clinical history of measles infection confers increased risk for the development of otosclerosis.

Study Design: Population-based, historical case-control study.

Setting: Olmsted County, Minnesota.

Patients: Incident cases of otosclerosis were matched to three controls on age, sex, and duration of medical record availability.

Main Outcome Measures: Otosclerosis in the presence of measles.

Results: A total of 504 incident cases of otosclerosis were matched to 1,512 controls. The groups were similar in median age (42 years [IQR 32-53] vs. 42 years [IQR 32-53]), sex (308 women [61%] vs. 924 women [61%]), and median duration of medical record availability (15 years [IQR 4-29] vs. 16 years [IQR 6-29]). Overall, there were 25 reported clinical diagnoses of measles infections between 1935 and 1965 occurring at a median age of 5 years (IQR 1-7). Four (0.8%) of these infections occurred among cases and 21 (1.4%) occurred among controls. The odds ratio for the association of a clinical history of measles infection with development of otosclerosis was 0.53 (95% CI 0.17-1.64; $p=0.27$).

Conclusions: These data show that a clinical history of measles infection does not portend an increased risk for the development of otosclerosis. Despite previous studies' identification of the virus in temporal bone specimens, the conflicting findings presented by these clinical data suggest this relationship requires further investigation.

Define Professional Practice Gap & Educational Need: Most data linking measles and otosclerosis comes from autopsy studies, and clinical investigation into the influence of measles infection on the development of otosclerosis is sparse.

Learning Objective: To understand that measles infection does not confer a higher risk of developing otosclerosis.

Desired Result: A more definitive clinical evaluation of the association between measles and otosclerosis.

Level of Evidence: Level IV

Indicate IRB or IACUC: Mayo Clinic: 18-005225 & Olmsted Medical Center: 021-OMC-18

The Utility of Numeric Grading Scales of Middle Ear Risk to Predict Ossiculoplasty Hearing Outcomes

Ryan T. Judd, BS; Michael B. Gluth, MD

Objective: To assess the usefulness of numeric grading scales of middle ear risk in ossiculoplasty

Study Design: Retrospective review

Setting: Tertiary care center

Patients: Adult and pediatric ossiculoplasty cases by a single surgeon from 2013-2019 including: synthetic prosthesis, autograft, bone cement, mobilization of lateral chain fixation.

Interventions: Cases scored via Middle Ear Risk Index (MERI), Ossiculoplasty Outcome Scoring Parameter (OOPS) scale, and Surgical, Prosthetic, Infection, Tissue, and Eustachian Tube (SPITE) method. Pre and postoperative hearing outcomes recorded for short-term (< 4 month) and most recent audiogram.

Main Outcome Measure: Statistical correlation (Spearman) between risk score and postoperative air-bone gap.

Results: 179 cases followed for a mean of 8.45 months had preoperative air-bone gap of 30.3 dB (SD 12.7 dB) and postoperative short-term gap of 20.3 dB (SD 11.1 dB), which was not statistically different than most recent audiogram. Mean MERI, OOPS, and SPITE scores were 4.5 (SD 2.3), 3.1 (SD 1.8), and 2.8 (SD 1.7) respectively. Significant but weak correlations with hearing outcome were noted for all three methods (MERI $r = 0.22$, $p = 0.003$; OOPS $r = 0.19$, $p = 0.012$; SPITE $r = 0.27$, $p = < 0.001$). No scale predicted poor (air-bone gap > 30 dB) outcomes; only low SPITE scores predicted ($p = 0.032$) excellent (AB gap < 10 dB) outcomes.

Conclusions: All three scales correlated with hearing outcomes, but such correlations were weak and no single scale was overwhelmingly superior. Results suggest a more refined statistically-weighted grading scale may be needed, and middle ear risk is only one of several factors driving ossiculoplasty outcomes.

Define Professional Practice Gap & Educational Need: It is known that middle ear risk impacts ossiculoplasty outcomes, but quantifying such risk is ambiguous. Various grading scales exist, but it is unclear how well these correlate with hearing outcomes or if one is superior to the others. Such information is potentially useful for surgeons to critically evaluate surgery outcomes and to counsel patients.

Learning Objective: To review various middle ear risk factors that may impact ossiculoplasty outcomes. To review the current available middle ear grading scales. To look towards potential future development of improved grading scales.

Desired Result: Attendees should recognize the importance of middle ear risk factors and also the gap in using them to predict ossiculoplasty hearing outcomes.

Level of Evidence – Level III (Cohort study)

Indicate IRB or IACUC: IRB18-1713, The University of Chicago Biological Sciences Division. Approved 12/18/2018.

**Prevalence and Severity of Hearing Loss of the Older Old in the United States:
A Population-Based Study**

*Rahul K. Sharma, BS; Anil K. Lalwani, MD
Justin S. Golub, MD, MS*

Objective: The epidemiology of hearing loss (HL) in adults 80 years and over has not been studied at a national, population level. We performed a definitive study of US HL prevalence and severity in the older old using the National Health and Nutrition Examination Survey (NHANES).

Study Design: Cross-sectional, multicentered US population-based epidemiologic study. Federal security clearance was granted to access publicly-restricted age data in the older old.

Setting: NHANES

Subjects: Non-institutionalized, US civilians 80 years and older.

Interventions: N/A

Main Outcome Measures: Pure-tone average (PTA) in the better ear, calculated from air conduction thresholds (0.5, 1, 2, 4 kHz). NHANES sample weighting was used.

Results: 621 subjects were 80 years old or older, representing 9,181,178 Americans. The average PTA was 38.9 dB (95% CI = 37.8, 40.0). 81.4% of subjects (7.5 million) had HL. The rate of PTA worsening was 0.90 dB/year ($p < 0.001$). The mean PTA was 36.6 dB (95% CI=35.3, 37.9) for 80-84-year old's (y/o), 40.9 (38.6,42.9) for 85-90 y/o, 45.8 (42.1, 49.5) for 80-94 y/o, and 50.9 (44.5, 57.4) for ≥ 95 y/o. Prevalence of HL was 77.2% for 80-84 y/o, 86.1% for 85-89 y/o, and 93.8% for ≥ 90 y/o. The average PTA difference between the better and worse ear was 6.75 dB (5.8, 7.1).

Conclusions: These population-level statistics will help guide policy recommendations for optimizing hearing health in the older old. In addition, 6% of those >90 y/o, representing 68,000 Americans, have normal hearing. Factors related to hearing preservation should be investigated to help develop new therapies.

REQUIRED:

Define Professional Practice Gap & Educational Need: An accurate assessment of hearing loss epidemiology is not available for US individuals over the age of 80.

Learning Objective: To understand the pattern and prevalence of hearing loss in those over the age of 80.

Desired Result: To identify that hearing loss is highly and increasingly prevalent in subjects over the age of 80.

Level of Evidence – Level III

Indicate IRB or IACUC: Exemption granted

Incidence of Malignant Otitis Externa: How Demographics Will Lead to Increases by 2060

*Daniel D. Bu, BA; Sean N. Neifert, BS; Zachary G. Schwam, MD
Vivian Z. Kaul, MD; George B. Wanna, MD
Eric K. Oermann, MD; Maura K. Cosetti, MD*

Objectives: To forecast and characterize the trend in incidence of malignant otitis externa (MOE) until 2060 given known demographic changes.

Setting: National sample of U.S. hospitals

Patient: U.S. inpatient hospitalizations for MOE

Intervention: Hospitalization for MOE.

Study Design: Retrospective review and projection using data from the Nationwide Inpatient Sample (NIS) of the US Healthcare Cost and Utilization Project (HCUP) provided by the Agency for Healthcare Research and Quality (AHRQ).

Methods: Complete NIS records from 2003 to 2016 (accounting for nearly 500 million hospitalizations) were used in conjunction with United States Census Bureau data to quantify and project rates of hospitalization for MOE as a function of census area, age group (<25 years, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, and >85), and gender. Poisson regression modelling based on these admission rates was used to formulate projections in the US population between 2020 and 2060

Results: Between 2020 and 2060, the number of hospitalizations for MOE is expected to increase by 46.7%, from 1196 to 1753 cases per year. Most of this increase is driven by patients >65 years old, with incidence expected to double from 545 in 2020 to 1004 cases in 2069. Those aged 55-65 will experience a mild increase, from 217 to 242 cases, with younger age groups demonstrating stable to small increases in MOE incidence.

Conclusions: MOE volume is projected to increase significantly between 2020 and 2060, the majority of which is expected in the population of elderly patients, reflecting demographic trends in age and comorbidities such as diabetes mellitus. Increasing burden of this multifactorial, morbid disease has implications for resource utilization and improved treatment paradigms.

Define Professional Practice Gap & Educational Need: Need to understand the expected trends in volume of malignant otitis media given known demographic trends.

Learning Objective: Ability to describe the increasing trend of malignant otitis media over the next 40 years.

Desired Result: Increased understanding of trends in malignant otitis media. Optimization of healthcare resources to care for increasing trends of hospitalizations due of MOE.

Level of Evidence – Level IIc (Per level of evidence in article using the same database:
<https://onlinelibrary.wiley.com/doi/full/10.1002/lary.26401>)

Indicate IRB or IACUC: Exempt.

Regeneration of Inner Ear Synapses with Novel Bone-Binding Neurotrophin Analogues

*Judith S. Kempfle, MD; Andrea Zhang, BS; Marlon Duro, BS
Carolina Amador, PhD; Boris Kashemirov, PhD
Charles McKenna, PhD; David H. Jung, MD, PhD*

Objective: Emerging research has identified the cochlear afferent synapse as particularly sensitive to noise damage. Brain-derived neurotrophic factor (BDNF) and neurotrophin-3 (NT3) have been successful in promoting neurite outgrowth and restoration of auditory synapses. To improve local delivery and long-term neurotrophic treatment for regeneration of auditory synapses, we have developed a small molecule approach that involves conjugation of BDNF and NT3 analogues with a bisphosphonate, a bone-binding drug that can stably bind to inner ear bone.

Study Design: In vitro and in vivo mouse models.

Setting: Laboratory

Patients: N/A

Interventions:

Small molecule treatment of isolated spiral ganglion neurons to assess neurite outgrowth.
Small molecule treatment of organ of Corti explants to evaluate for synaptic regeneration.
Surgical placement of compounds onto round window membrane in adult noise deafened mice in vivo.

Main Outcome Measures:

- 1) Improvement in neurite outgrowth in vitro.
- 2) Increased number of synapses per inner hair cell in explants.
- 3) Improvement in ABR wave I amplitude in treated adult mice that correlates with histologic synapse regeneration.

Results: We have found that both drugs improve neurite outgrowth and synapse survival in vitro. Treatment with these drugs appears to improve auditory brain stem responses in vivo following noise exposure.

Conclusions: Our data suggest that our novel BDNF and NT3 small molecule agonists have long term neurotrophic properties and could provide a novel minimally invasive treatment method for hearing loss in the future.

Define Professional Practice Gap & Educational Need: Hidden hearing loss continues to be a poorly understood phenomenon, mainly due to the lack of clinically reliable testing for synaptopathy. Studies using animal models, e.g. as done here in mice, provide valuable insight into underlying mechanisms and offer potential solutions for hidden hearing loss that cannot yet be gained in human studies.

Learning Objective: To better understand mechanisms and potential treatments for hearing loss.

Desired Result: Improvement of cochlear neurite outgrowth and synapse regeneration in vitro and in vivo after treatment with bone-binding neurotrophic hybrid molecules.

Level of Evidence: Animal study, N/A

Indicate IRB or IACUC: #829089, Massachusetts Eye and Ear Infirmary.

Vestibular FIESTA Signal Degradation in Patients with Acoustic Neuroma

*Kareem O. Tawfik, MD; Marin McDonald, MD
Omid Moshtaghi, MD; Yin Ren, MD, PhD; Jason Lee
Marc S. Schwartz, MD; Rick A. Friedman, MD, PhD*

Background: Though cochlear fluid signal abnormalities have previously been described in patients with acoustic neuroma (AN), the prevalence of vestibular signal abnormalities in this population is unknown.

Objective:

- 1) Describe the prevalence of degraded Fast Imaging Employing Steady-state Acquisition (FIESTA) signal intensity of the vestibule in patients undergoing middle cranial fossa (MCF) AN resection.
- 2) Assess the impact of degraded vestibular FIESTA signal on preoperative dizziness and postoperative hearing outcomes.

Methods: Adult patients (≥ 18 years) who underwent MCF AN resection between November 2017 and September 2019 were retrospectively reviewed. All patients had preoperative word recognition score (WRS) $\geq 50\%$. A neuroradiologist blinded to patients' clinical outcomes reviewed preoperative magnetic resonance images. Ipsilateral-to-contralateral vestibular/cochlear FIESTA signal intensity ratios were determined using hand-drawn regions of interest. Preoperative dizziness was scored using the Dizziness Handicap Inventory. Preoperative/postoperative pure tone average (PTA) and WRS were reviewed.

Results: Fifty-one patients were reviewed (60.8% female). Mean age was 47 years and mean tumor size 9.2 mm (± 3.8). Hearing was preserved in 56.9% (n=29). Degraded vestibular signal (ratio < 1) was present in 76.5% (n=37) of patients and correlated with degraded cochlear FIESTA signal ($r=0.39$, $p=0.004$). On multivariate analysis including demographics, preoperative PTA/WRS, and tumor characteristics, vestibular FIESTA signal did not predict preoperative dizziness as measured by DHI, nor did it predict absolute postoperative PTA/WRS or the degree of change in PTA/WRS observed after surgery.

Conclusions: While vestibular FIESTA signal degradation may be common in patients with small ANs, it does not appear to predict preoperative dizziness or hearing outcomes after MCF resection.

Define Professional Practice Gap & Educational Need: Though cochlear fluid signal abnormalities have previously been described in patients with acoustic neuroma, the prevalence of vestibular signal abnormalities in this population is unknown. Previous reports have shown that changes in cochlear fluid signal may predict outcomes after hearing preservation surgery, but it is unclear whether vestibular fluid signal abnormalities can predict preoperative dizziness or postoperative hearing outcomes.

Learning Objective: Understand the prevalence of degraded vestibular FIESTA signal among patients with acoustic neuroma. Describe the impact of signal abnormalities on preoperative dizziness handicap and postoperative hearing outcomes.

Desired Result: Increase awareness of existing literature relating to vestibulocochlear fluid signal abnormalities in patients with acoustic neuroma.

Level of Evidence – Level IV

Indicate IRB or IACUC : University of California San Diego IRB # 180978XL

**Reconstruction of the Obliterated Eustachian Tube:
A Case Series and Introduction of the Procedure**

Joonas Toivonen, MD; Dennis S. Poe, MD, PhD

Objective: To investigate the safety and early efficacy of a novel procedure for reconstruction of the obliterated Eustachian tube (ET)

Study Design: Retrospective case series

Setting: Tertiary medical center

Patients: Patients with total obliteration of the nasopharyngeal orifice and a portion of the cartilaginous ET undergoing reconstruction to reanastomose the full length

Interventions: Endoscopic transnasal/transoral reconstruction of the obliterated ET with transtympanic illuminated guidewire guidance

Main Outcome Measures: Otomicroscopy, Valsalva maneuver, tympanometry

Results: 12 ETs (7 patients), ages 17 - 68 years (mean 37.9, SD 15.8) underwent reconstruction. Follow-up ranged from 0.24 to 4.38 years (mean 2.06, SD 1.73). ETs were reconstructed endoscopically with a combined transnasal/transoral approach and transtympanic illuminated guidewire guidance for all subjects. A stent was placed to hold the newly formed ET patent. In three cases an additional steroid-eluting propel stent was placed in the ET orifice. There were no complications directly related to the procedure. 3 ETs (2 patients) needed reoperation.

Conclusions: ET reconstruction is a safe and possibly effective procedure in patients with total obliteration of the ET from various etiologies.

Define Professional Practice Gap & Educational Need: The negative effects of Eustachian tube dysfunction are known but there is no established treatment method for total obliteration of the Eustachian tube.

Learning Objective: To recognize the impact of total obliteration of the Eustachian tube on patients and identify subjects eligible for surgical treatment.

Desired Result: To add awareness of the impact of total obliteration of the Eustachian tube and introduce a possible treatment method.

Level of Evidence - Level V

Indicate IRB or IACUC: Boston Children's Hospital IRB-P00010256

Efficacy of Porcine Small Intestine Submucosal Graft Tympanoplasty

*Timothy Kearney, MS; Andrew E. Bluher, MD
Stephanie Moody-Antonio, MD*

Background: Tympanic membrane perforations adversely affect patient quality of life, contributing to otorrhea, infections, ear pain, water avoidance, and conductive hearing loss. The FDA recently approved the Biodesign® porcine small intestine submucosal (SIS) graft, which offers the advantage of reduced operative time and site morbidity associated with autogenous graft harvest.

Aims: (1) Compare outcomes between tympanoplasties that use autologous temporalis fascia versus those that use SIS grafts. (2) Identify clinical factors that may predict surgical success or surgical failure, as defined by persistent perforation.

Study Design: Retrospective case control study

Setting: Tertiary pediatric hospital

Methods: Patients aged 2-16 years old who had a medial graft tympanoplasty performed by the senior author from 9/1/16 to 9/1/18 with either autogenous fascia or SIS xenograft were eligible for inclusion. Patients who had a concurrent mastoidectomy or ossicular chain reconstruction were excluded. Patients who had a tympanoplasty using an SIS graft were included as cases, while age-matched patients who had temporalis fascia graft tympanoplasties were included as controls. Data regarding perforation size, grafting technique, graft location and mucosal descriptors were also obtained.

Results: Preliminary data shows a perforation healing rate of 72.7% in the Biodesign® group (N=11) and a perforation healing rate of 84.2% in the control group (N=38). Data analysis which seeks to find any correlation between surgical success and patient age, initial perforation size, or perforation location is currently in progress.

Conclusions: Further research is needed to confirm the efficacy of xenografts in a clinical setting.

Define Professional Practice Gap & Educational Need: There remains a need to critically evaluate xenografts for their efficacy in tympanoplasty.

Learning Objective: Xenografts may have lower efficacy for medial graft tympanoplasty in a pediatric tertiary care setting.

Desired Result: Surgeons will continue to remain cognizant of potential for worsened tympanoplasty outcomes when using xenografts in pediatric tertiary care settings, pending further data.

Level of Evidence – IV

Indicate IRB or IACUC: IRB number: 19-05-XX-0144. Approved by Eastern Virginia Medical School Institutional Review Board.

**A Small Natural Compound Protects Sensory Hair Cells
against Electrode Insertion Trauma in an *In Vitro* Model**

*Viraj Shah, BS; Kadri Ila, MD; Jeenu Mittal, MSc
Priyanka Sinha, BS; Rahul Mittal, PhD
Adrien A. Eshraghi MD, MSc*

Hypothesis: Based on the molecular mechanisms involved in loss of residual hearing following cochlear implantation (CI), we hypothesize that the identified compound will provide otoprotection and will prevent loss of residual hearing.

Background: The insertion of electrode array during CI can induce inner ear trauma and damage to sensory cells leading to loss of residual hearing. The aim of this study was to determine the ability of a novel natural compound in providing otoprotection and preservation of residual hearing employing an *ex-vivo* model.

Methods: The organ of Corti (OCs) were dissected from 3-day old rats and were subjected to electrode insertion trauma (EIT). OCs were treated with different concentrations of identified compound and viability of sensory cells were determined by FITC-phalloidin staining.

Results: We observed that the identified compound could prevent the loss of sensory cells in response to EIT in a dose dependent manner. The molecular mechanisms behind otoprotection involve abrogation of oxidative stress, decreased production of proinflammatory cytokines as well as attenuation of activation of cleaved caspase-3 pathway.

Conclusions: The present study will lay the foundation for developing novel treatment modalities for preservation of residual hearing in pursuit of improving quality of life of implanted individuals and their families.

REQUIRED:

Define Professional Practice Gap & Educational Need: The preservation of residual hearing post CI is one of the most important unmet clinical need. There is a need to develop new treatment modalities to prevent the loss of residual hearing to improve clinical outcomes.

Learning Objective: To determine whether identified compound can prevent loss of sensory cells post-CI.

Desired Result: The identified compound provides otoprotection against loss of sensory cells and will open up avenues for developing therapeutic strategies for preservation of residual hearing.

Level of Evidence – Not applicable (Basic Science Research)

Indicate IACUC: The study was approved by the University of Miami Institutional Animal Care and Use Committee (IACUC) (protocol number 18-117).

Quality Indicators for the Diagnosis and Management of Sudden Sensorineural Hearing Loss

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Background: Sudden sensorineural hearing loss (SSNHL) is an ideal entity for quality indicator (QI) development, providing treatment challenges resulting in variable or substandard care. The American Academy of Otolaryngology – Head and Neck Surgery recently updated their SSNHL guidelines. With SSNHL demonstrating a large burden of illness, this study sought to leverage the updated guidelines and develop QIs to serve as a tool for quality improvement initiatives at an individual, institutional, and systems level.

Methods: A guideline-based approach, proposed by Kotter et al (2012) was utilized. Candidate Indicators (CIs) were extracted from high quality SSNHL guidelines analyzed using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) tool. Each CI and its supporting evidence were summarized and reviewed by a nine-member expert panel based on validity, reliability, and feasibility of measurement. Final QIs were selected from CIs utilizing the modified RAND/UCLA appropriateness methodology.

Results: Fifteen CIs were identified after literature review. After the first round of evaluations, the panel agreed on eleven candidate indicators as appropriate QIs with two additional CIs suggested for consideration. An expert panel meeting provided a platform to discuss areas of disagreement before final evaluations. The expert panel subsequently agreed upon eleven final QIs as appropriate measures of high-quality care.

Conclusions: This study proposes eleven QIs for the management of patients with SSNHL. These QIs can serve multiple purposes including documenting the quality of care; comparing institutions and providers; prioritizing quality improvement initiatives; supporting accountability, regulation, and accreditation; and pay for performance initiatives.

Define Professional Practice Gap & Educational Need: Large practice variations remain in the diagnosis and management of SSNHL despite updated guidelines which can be detrimental to patient care. Quality indicators (QIs) serve as an important foundation for quality improvement initiatives, however no QIs currently exist for SSNHL.

Learning Objective: By the end of this session, Otolaryngology – Head and Neck Surgeons, along with all practitioners treating SSNHL, will have a better understanding of how quality indicators are developed and their role in quality improvement initiatives. Healthcare providers will learn about the first proposed quality indicators for SSNHL and how they can be applied.

Desired Result: Adoption of the proposed QIs to improve the quality of care provided to patients with SSNHL, resulting in improved outcomes.

Level of evidence does not apply because: This is not a clinical study.

Indicate IRB or IACUC: Exempt

Utility of the Dix-Hallpike Test in the Assessment of Migraine-Associated Vertigo

Bahbak Shariat-Madar, MD; Samuel Jones; Pamela Roehm, MD, PhD

Objective: The Dix-Hallpike maneuver is a useful, rapid test that can be readily performed in the outpatient clinic to diagnose benign paroxysmal positional vertigo (BPPV). Other common causes of episodic vertigo, particularly migraine, are difficult to distinguish on physical examination, sometimes leading to a delay in diagnosis and treatment. This retrospective chart review seeks to determine whether additional findings during Dix-Hallpike are useful in the diagnosis of disorders other than BPPV that cause spinning vertigo.

Study Design: Retrospective chart review

Setting: Single institution study at a university hospital

Patients: There were 572 patients that underwent an evaluation for vertigo between December 2014 and May 2017.

Interventions: A positive Dix-Hallpike test (inducing either the characteristic geotropic rotary nystagmus or definite subjective spinning sensations in the patient) was associated with BPPV and treated with canalith repositioning maneuvers. During Dix-Hallpike, patients were asked whether or not they had additional symptoms, including head and ear fullness. All patient responses during Dix-Hallpike were recorded. When Dix-Hallpike testing was negative for BPPV, patients were tested with videonystagmography and other tests. Test results were correlated with responses on vestibular testing and the ultimate diagnoses.

Main Outcome Measures: Association of migraine-associated vertigo with head pressure or fullness during Dix-Hallpike testing.

Results: Of 572 patients, 199 patients were lost to follow up. Analysis of the remaining 373 showed 79 had a frankly positive Dix-Hallpike maneuver on initial examination. Among patients ultimately found to have BPPV, meclizine was being used by 52.3% of patients at time of evaluation. Of the remaining 294 patients, patients that reported head pressure or fullness during the Dix-Hallpike testing were associated with a migraine-associated vertigo in 48% of cases, while no reported subjective symptoms or subjective vertigo without nystagmus during Dix-Hallpike testing was associated with migraine-associated vertigo 15.7% and 23.3% of the time, respectively ($p = 0.014$).

Conclusions: When present, head pressure or fullness in the absence of subjective vertigo or nystagmus is suggestive of migraine-associated vertigo. Along with a thorough history and vestibular testing, the Dix-Hallpike test may be a useful adjunct in helping to diagnose migraine-associated vertigo.

Define Professional Practice Gap & Educational Need: There is a lack of physical examination or vestibular testing findings that strongly correlate or aid in the diagnosis of migraine-associated vertigo.

Learning Objective: To identify a useful, cost effective examination finding that can supplement patient history and vestibular testing in diagnosing migraine-associated vertigo.

Desired Result: Attendees will be able to consider additional findings, such as head pressure or fullness in the absence of nystagmus during Dix-Hallpike testing as suggestive of a diagnosis of migraine-associated vertigo.

Level of Evidence - Level V

Indicate IRB or IACUC: Temple University Hospital Approved, IRB 24781

Wide Variation in Provider Use of Canalith Repositioning Procedures among Medicare Beneficiaries

*Steven A. Zuniga, MD; Schelomo Marmor, PhD, MPH
Meredith E. Adams, MD, MS*

Objective: Clinical practice guidelines recommend canalith repositioning procedures (CRPs) for the management of benign paroxysmal positional vertigo (BPPV). As only 10-20% of affected individuals receive CRPs, there is concern for guideline adherence and knowledge dissemination to relevant medical specialties. This study aimed to characterize changes in CRP utilization over time, across all United States regions, and by provider specialty.

Study Design: Cross-sectional analysis with time trends of CRP claims in the Centers for Medicare and Medicaid Service Provider Utilization and Payment database, 2012–2017.

Setting: National administrative claims data.

Patients: Fee-for-service Medicare beneficiaries.

Interventions: Canalith repositioning procedures.

Main Outcome Measures: CRP utilization was analyzed by year, hospital referral region (HRR), and provider specialty.

Results: From 2012-2017, 253,869 CRPs were performed on 146,308 Medicare beneficiaries and CRP utilization increased 95%. CRP use varied widely by geographic region. In 2017, CRP use per 100,000 beneficiaries varied 280-fold across HRRs (range, 6-1786, interquartile range, 126). Most CRPs were performed by physical therapists (42.1%) and otolaryngologists (42.5%), with few by primary care providers (0.5%). These proportions varied between HRRs in highest and lowest utilization quartiles (e.g., otolaryngology, 45.39% and 58.33%; PT, 40.78% and 23.15%, respectively).

Conclusions: CRP utilization increased substantially suggesting improved dissemination and implementation of BPPV management guidelines. Nevertheless, wide geographic and provider-level variation remained, signifying non-uniform provider practices and access to care. Care for BPPV may be improved through education and incentivization of a broader range of providers including primary care physicians.

Define Professional Practice Gap & Educational Need: Outcomes for benign paroxysmal positional vertigo (BPPV) depend in large part on the consistent and efficient delivery of appropriate canalith repositioning maneuvers (e.g., Epley, Semont). Despite the existence of comprehensive clinical practice guidelines for BPPV, considerable geographic and provider-level variation exists in canalith repositioning procedure utilization. The variations contributing to this disparity have yet to be sufficiently elucidated, thus precluding efficacious quality improvement measures.

Learning Objective: Participants will become aware of the marked geographic and provider-level variation in canalith repositioning procedure utilization rates across all regions of the United States over a 6 year period. Participants will learn that the treatment of BPPV with CRPs varies across regions due to differences in provider practice patterns and access to care rather than differences in medical need.

Desired Result: Participants will consider their own adherence to BPPV clinical practice guidelines and consider how education and incentivization of colleagues in different specialties may improve the quality of care for patients with BPPV. Recognition of factors contributing to treatment disparities can facilitate the development and implementation of quality improvement measures for care for BPPV.

Level of Evidence – IV

Indicate IRB or IACUC: Exempt

Not too Late for Steroids: A Look at the Effects of Delayed Onset Steroid Treatment in Sudden Sensorineural Hearing Loss

Lindsay C. Boven, MD; Gauri S. Mankekar, MD

Objective: Controversy still exists over specific time frames in which patients with sudden sensorineural hearing loss (SSNHL) can achieve hearing benefit after treatment with oral or intratympanic (IT) steroid injections. Current guidelines recommend oral steroids within 2 weeks of onset and IT injections within 2-6 weeks. As most of our referral base for SSNHL presents outside the recommended treatment time, the purpose of this study is to determine how delayed administration of oral and IT steroid injections can affect overall hearing.

Study Design: Retrospective case review

Setting: Tertiary referral center

Patients: Electronic health records were reviewed to select patients within the past 4 years who presented to our clinic with SSNHL.

Interventions: We looked at patients given oral steroids or IT injections outside the recommended guidelines, up to 1 year after initial diagnosis.

Main Outcome Measures: Hearing improvement perceived by the patient as well as speech recognition threshold (SRT) scores and word recognition scores on audiogram

Results: When patients were given delayed IT steroids, 62% reported noticeable improvement, while 40% of audiograms showed improvement, with an average increase of 27.5db on SRT scores and an average increase of 8% on word recognition scores. 75% of the patients were given steroid injections 6 months after onset, with notable audiogram improvements, also with lower frequency pure tone average increases. The highest increase in SRT scores was seen in patients treated within 5 months after onset.

Conclusions: From our review, patients treated outside the recommended guideline window not only show subjective benefit, but also show increases in SRT and word recognition scores.

Define Professional Practice Gap & Educational Need: As patients with SSNHL may not always present at immediate time of onset, it is important to be aware of benefits for hearing improvement that can be achieved with delayed initiation of steroid treatment. There is a need to understand how to guide treatment in these patients as many are referred to us after other management by primary clinicians or do not always present during immediate onset.

Learning Objective: Identify the differences in hearing outcomes and improvements seen on audiogram SRT and word recognition scores with oral or IT steroid injections.

Desired Result: Improve ability to determine realistic expectations for hearing improvement seen with delayed administration of oral steroids or IT injections and develop strategies for how to best counsel and manage patients who present with SSNHL, months after onset. Future directions include testing patients who present over 6 weeks out with both oral steroids and IT injection at the same time to look for any additional audiogram improvements.

Level of Evidence - Level IV - Historical cohort or case-control studies

Indicate IRB or IACUC: Approved

Comparative Analysis of Endoscopic and Microscopic Resection of Cholesteatoma A Single Institutional Experience

*Nauman F. Manzoor, MD; Douglas J. Totten, BA
Megan E. McCleod, BS; Elizabeth L. Perkins, MD
David S. Haynes, MD, MBA; Alejandro Rivas, MD*

Objective: To compare outcomes (residual and recurrent disease) of endoscopic and microscopic resection of cholesteatoma.

Study Design: Retrospective single institutional cohort study

Setting: Tertiary referral center

Patients: 377 patients underwent surgical resection of cholesteatoma, between 2012-2016; 200 (53.1%) male, 177 (46.9%) female; median age: 29 (IQR: 12-50).

Interventions: Patients with limited cholesteatoma underwent trans-canal endoscopic ear surgery (TEES) (44) or post-auricular microscopic approach (39). Patients with extensive disease underwent hybrid tympanomastoidectomy involving use of endoscopic dissection (79) or microscopic tympanomastoidectomy (215). Fisher's exact test and Kaplan Meier analysis with log rank tests were used for comparison.

Main Outcome Measures: Residual cholesteatoma, recurrent cholesteatoma, second-look procedure.

Results: For limited cholesteatoma, 16 TEES patients (36.4%) and 3 microscopic patients (7.7%) required a second look ($p=0.002$); 5 TEES patients (11.4%) and 1 microscopic patient (2.6%) developed residual cholesteatoma ($p=0.072$); 1 TEES patient (2.3%) and 0 (0.0%) microscopic patients developed recurrent disease ($p=0.0182$). For advanced disease, 40 (50.6%) hybrid and 33 microscopic patients (15.3%) required second look procedures ($p<0.001$); 12 hybrid (15.2%) and 18 microscopic patients (8.4%) developed residual disease ($p=0.13$); 7 hybrid (8.4%) and 9 microscopic patients (13%) developed recurrence ($p=0.14$). There was no significant difference in residual and recurrence free survival irrespective of disease extent between approaches (log rank; $p=0.105$ (limited) and $p=0.05$ (advanced disease)).

Conclusions: Use of endoscope was not associated with increased residual or recurrent disease but was associated with increased numbers of second look procedures. Multinstitutional study is necessary to evidence any potential difference between both techniques.

Define Professional Practice Gap & Educational Need: Safety and benefit of endoscopic utilization in resection of cholesteatoma.

Learning Objective: Use of endoscopic surgery is non-inferior to traditional microscope based surgery with regards to long-term outcomes of cholesteatoma resection.

Desired Result: The use of endoscopes is a safe alternative to microscope-only resection of cholesteatoma and may provide better visualization of advanced disease.

Level of Evidence – Level 3.

Indicate IRB or IACUC: Approved #190335

Single-Institutional Review of Hearing Preservation Cochlear Implantation Surgeries over 10 Years

*Alyson Kaplan, MD; Natalie Schauwecker, BS; Brandon Isaacson, MD
J. Walter Kutz, MD; Jacob B. Hunter, MD*

Objective: To review a single institution's cochlear implantation (CI) hearing preservation (HP) results over a 10-year period.

Study Design: Retrospective chart review between 2009 and 2018.

Setting: University CI program.

Patients: Aged 18 or older who underwent CI and had a pre-operative pure-tone threshold in the implanted ear ≤ 65 dB at 250 Hz.

Main Outcome Measures: Patient demographics, surgical variables and approach, and pre-operative and post-operative audiometric data.

Results: A total of 396 patients had a CI during the study period. Of these, 135 patients were HP candidates (34%). In 2009, 40% of patients would qualify as HP candidates, falling slightly to 36% in 2018. Preoperative steroid administration increased from 0% in 2009 to 38% in 2017, but fell to 19% by 2018. Use of postoperative steroids increased from 0% of patients in 2009 to 86% in 2016, but fell to 47% in 2018. In total, 61% of HP candidates had unaided thresholds at activation ≤ 85 dB at 250 Hz. During the study period, this varied from 50% in 2009, to 100% in 2016, and fell to 46% in 2018, depending heavily on varying post-operative data collection. Of all patients with preserved hearing at activation and additional unaided testing, 82% of patients maintained pure-tone thresholds ≤ 85 dB at 250 Hz.

Conclusions: HP candidates have not increased in frequency but there has been greater use of perioperative steroids. Nonetheless, the HP outcomes appear to have plateaued, though a substantial percentage of patients maintain residual hearing after 6 months.

Professional Practice Gap and Educational Need: There is currently no large institutional review of hearing preservation techniques and results for cochlear implantation. This study will allow a broader overview of multiple factors that have thought to contribute to hearing preservation in cochlear implantation.

Learning Objective: To characterize the outcomes regarding past and current techniques of hearing preservation surgery in CI.

Desired Result: To better define the characteristics that encompass hearing preservation in cochlear implantation in order to possibly standardize and improve HP surgery as well as sustain low frequency hearing in hearing preservation cochlear implantation candidates.

Level of Evidence: Level V

IRB: STU 032018-085

Use of Electrocochleography to Monitor Coiling of Cochlear Implant Transmitting Wire into Mastoid Cavity

Robert F. Labadie, MD, PhD; Jourdan T. Holder, AuD

Objective: To describe how coiling cochlear implant (CI) transmitting wires into the mastoid after electrode array (EA) insertion affects electrocochleography (ECoChG) signal measured from the most apical CI electrode in response to acoustic signal presented to the external ear.

Study Design: Case report.

Setting: Tertiary-care, academic institution.

Patients: Twelve year-old with normal low-frequency hearing (low-frequency pure tone average <20dB) and profound high-frequency hearing loss who sought simultaneous bilateral CI with ECoChG monitoring in the hopes of preserving residual hearing and using electric acoustic stimulation for aural rehabilitation.

Interventions: ECoChG response was continuously monitored during EA insertion and coiling of the transmitting wire into the mastoid cavity.

Main Outcome Measures: ECoChG response; EA angular insertion depth (AID) from post-operative CT scan; post-operative audiometric thresholds.

Results: On the first side (left), EA insertion had continuous rise of ECoChG signal to 75 μ V without decline during coiling of the transmitting wire. AID was 354°. Post-operative audiogram at 5 weeks showed <10dB decline across all frequencies. On the contralateral right side, EA insertion had continuous rise of ECoChG signal to 105 μ V which declined as the transmitting wire was coiled but resolved with uncoiling and recoiling. AID was 342°. Post-operative audiogram showed \approx 20dB decrement across all frequencies.

Conclusions: While ECoChG monitoring has focused on EA insertion, it may also be useful in monitoring coiling of the transmitting wire into the mastoid which can affect EA location. Data from this case suggests that coiling associated with diminished ECoChG signal results in poorer hearing preservation.

Define Professional Practice Gap & Educational Need: Lack of understanding regarding what happens during coiling of CI transmitting wire within mastoid.

Learning Objective: To appreciate how coiling of the transmitting wire during CI may impact the electrode array.

Desired Result: Coiling of the CI transmitting wire may lead to diminishment of residual cochlear function.

Level of Evidence: V

Indicate IRB or IACUC: Vanderbilt University IRB #15808

Hearing Outcomes of Canal Wall Reconstruction Mastoidectomy with the Use of Silastic Sheeting

*Scott B. Shapiro, MD; Noga Lipschitz, MD; Ahmed Beydoun
Theresa Hammer, AuD; Lisa Wenstrup, AuD; Ravi N. Samy, MD*

Objective: Describe hearing outcomes of canal wall reconstruction mastoidectomy (CWRM) without formal ossiculoplasty where silastic sheeting is placed over the stapes superstructure.

Study Design: Retrospective case review.

Setting: Tertiary referral center at an academic medical center.

Patients: Patients who underwent CWRM for cholesteatoma between 2012-2016 in which surgery included incus removal and placement of silastic sheeting over an intact stapes superstructure.

Interventions: CWRM which included extirpation of cholesteatoma, removal of the incus, and placement of silastic sheeting over the stapes superstructure

Main Outcome Measures: Improvement in air-bone gap (ABG).

Results: 80 patients with mean age of 41 years met inclusion criteria. The mean maximum ABG prior to surgery was 41.3 dB HL with mean ABG 23.3 dB HL. 35 patients (44%) showed improvement in maximum ABG and 26 (33%) in mean ABG. 15 patients (19%) had improvement in mean ABG to less than 20 dB HL. Residual disease was found on subsequent ossiculoplasty during a second look procedure in 6 patients (7.5%).

Conclusions: Despite not including a standard ossiculoplasty, CWRM which includes incus removal and placement of silastic sheeting over the stapes superstructure does not always result in a large conductive hearing loss and even improves hearing in some patients. There is a low risk of residual disease. In a small but not insignificant number of cases the ABG may improve to acceptable level such the surgeon may consider forgoing a second look procedure. In these cases, magnetic resonance imaging with diffuse weighted series is then indicated during follow-up.

Define Professional Practice Gap & Educational Need: There is a lack of contemporary knowledge regarding hearing outcomes after canal wall reconstruction mastoidectomy without ossiculoplasty where silastic sheeting is placed over the stapes superstructure.

Learning Objective: Make practitioners aware that canal wall reconstruction mastoidectomy may result in adequate hearing outcomes without formal ossiculoplasty when silastic sheeting is placed over the stapes superstructure.

Desired Result: When deciding on techniques and approaches on extirpating cholesteatoma, practitioners will consider that in some cases adequate hearing outcomes may be achieved in cases of canal wall reconstruction mastoidectomy without formal ossiculoplasty if silastic sheeting is placed over the stapes superstructure. If good hearing results are achieved with this technique, they will understand a second look procedure may be unnecessary if the patient is followed with magnetic resonance imaging with diffused weighted series.

Level of Evidence - LEVEL IV - Historical cohort or case-control studies

Indicate IRB or IACUC: University of Cincinnati Medical Center IRB (2016-9602)

Microneedle Array Enhances Diffusion of Gadolinium for Intracochlear Imaging

*Chris Valentini, BS; Betsy Szeto, MPH; Aykut Aksit, MS
Jia Guo, PhD; Jeffrey W. Kysar, PhD; Anil K. Lalwani, MD*

Background: Magnetic resonance imaging(MRI) with either intravenous or intratympanic administration of gadolinium has been used for noninvasive evaluation of Meniere's Disease(MD); however, its routine use has been limited due to the need for waiting 4 or 24 hours, respectively, to allow intracochlear diffusion prior to image acquisition. We investigated the effectiveness of round window membrane (RWM) perforation, using a novel microneedle array, to enhance gadolinium diffusion and shorten time needed prior to image acquisition.

Methods: Single microneedle and microneedle array were 3D-printed using 2PP and used to perforate the RWM from harvested guinea pig temporal bones *in situ*. Confocal microscopy was used to evaluate size and shape of RWM perforation. Gadolinium in poloxamer 407 was applied to the round window niche after perforation. Dynamic T1 and T2-weighted contrast enhanced 9.4T MRI was used to assess gadolinium distribution within cochlea every 10-minutes.

Results: Both the single microneedle and microneedle array consisting of five 100- μ m diameter needles created lens-shaped perforations in the RWM. The multi-needle array did not create tears between individual perforations. With both microneedles, *in vitro* MRI imaging showed diffusion of gadolinium from the RWM to the apex within one-hour allowing imaging of the perilymphatic space.

Conclusion: Microneedle array mediated perforations of the RWM enhanced gadolinium diffusion within the cochlea. It shortened the ideal imaging time from 24 following IT injection to less than one hour for intracochlear imaging. With further advances in microendoscope technology to allow their in-office use, microneedles may be useful in facilitating contrast enhanced imaging of the cochlea.

Define Professional Practice Gap & Educational Need: Improved surgical device design for drug delivery to the inner ear through the RWM.

Learning Objective: 1. To understand the structural consequences of creating multiple simultaneous perforations in the guinea pig round window membrane. 2. To understand how diffusion across the RWM is affected by multiple perforations

Desired Result: Novel microneedle arrays designs will allow for increased diffusion of therapeutics into the inner ear by safely creating precise perforations in the RWM. Multiple smaller holes from an array will minimizing hearing loss, preventing the leak of inner ear fluid, promoting more rapid healing, and predictably delivering agents into the inner ear.

Level of Evidence does not apply because: Basic science study

IACUC: Approved - AABA5450

A Roadmap Towards Regeneration of a New Tympanic Membrane from the Scarred Rim of a Tympanic Membrane Perforation

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Benjamin Dekel MD, PhD; Dorit Omer, PhD
Rivkah R. Isseroff, MD; Hilary A. Brodie, MD, PhD*

Objective: Our overarching goal is to develop a protocol for generating a two-dimensional (2-D) TM layer from a miniature sample of a scarred rim of a chronic human TM perforation.

Background: Tympanic membrane (TM) perforation is a common clinical problem in otology practice. Epidermal cells with stem cell-like characteristics were identified around the annulus and umbo.

Methods: We employ regenerative medicine methods to produce a 2-D tissue. First, we produce a single cell suspension from the trimmed margins of the perforation that are routinely removed during standard tympanoplasty. Second, cells are seeded in a keratinocyte serum free and progenitor cell medium (KSFM:PR) and assessed according to their morphology and gene expression. Third, in order to produce a 2-D tissue out of newly generated cells, these cells will be seeded on a fibroblastic feeder layer and the tissue's quality will be evaluated by its mechanical properties.

Results: We succeeded to isolate single cells in 9/12 of the cases. Cells seeded with KSFM:PR proliferated and yielded morphology of normal TM keratinocytes (hTMKR). PCR analysis revealed higher expression of VCAN (P=0.002) and FOXC2 (P=0.015) genes (key regulators of cell migration and markers of normal hTMKR) in our study hTMKR compared to normal human skin keratinocytes. We will present preliminary results highlighting benefits and challenges of different options for producing a 2-D tissue out of regenerated single cells.

Conclusions: We succeeded for the first time to isolate and expand hTMKR from a miniature sample derived from the scarred rim of the perforation. Our next goal is to establish the feasibility of generating a 2-D tissue out of these cells.

Define Professional Practice Gap & Educational Need: Here we recruited regenerative medicine knowledge and methodology to answer a surgical and clinical need in a common otologic surgery.

Learning Objective: We previously reported, for the first time, the feasibility to isolate and expand human TM keratinocytes from the miniature scarred rim of the perforation while maintaining normal and healthy characteristics (morphology and gene expression). In the current study we are developing a novel protocol that will enable us to create a 2-dimensional tympanic membrane out of the newly generated cells.

Desired Result: This project is aiming to reach clinical use at the end of the road: growing neo-TM ready for auto-transplantation from a biopsy taken from the rim of the perforation performed a few weeks prior to surgery.

Level of Evidence - Non applicable – this is a basic science study

Indicate IRB or IACUC: Institutional Review Boards of Sheba Medical Center, 4587-17-SMC

Cochlear Implantation and Electric Acoustic Stimulation in Children with TMPRSS3 Mutation

*Jourdan T. Holder, AuD; William G. Morrel, MD; René H. Gifford, PhD
Alejandro Rivas, MD; Robert F. Labadie, MD, PhD*

Background: Mutations in the TMPRSS3 gene, although rare, can cause high frequency hearing loss with residual hearing at low frequencies. Several previous studies have reported cochlear implant (CI) outcomes for adults with TMPRSS3 mutation with mixed results. Although some studies have suggested that TMPSS3 is expressed in spiral ganglion cells, it remains unclear if previously reported poor CI outcomes in this population were secondary to long durations of deafness or to the effects of the TMPRSS3 mutation. To date, no studies in the literature have reported CI outcomes for children with TMPRSS3 mutation treated with CI.

Objective: The current case series aimed to describe outcomes for three children with sloping hearing loss caused by TMPRSS3 mutation who underwent bilateral CI.

Study design: Case series

Setting: Academic medical center.

Patients: Three children (3-4 years) with TMPRSS3 mutation and normal sloping to profound high frequency hearing loss.

Interventions: CI and electric acoustic stimulation (EAS)

Main Outcome Measures: Outcome measures were residual hearing thresholds, speech recognition scores, and electrode placement determined via intraoperative CT imaging.

Results: All three children maintained residual hearing and received benefit from EAS. Mean change in low-frequency pure-tone-average was 17 dB. Mean word and sentence recognition scores were 80% and 75%, respectively.

Conclusions: Results indicate that CI with EAS is an appropriate treatment for children with TMPRSS3 genetic mutation. Pediatric results from this case series show more favorable CI outcomes than are currently reported for adults with TMPRSS3 mutation suggesting that the intervention may be time sensitive.

Define Professional Practice Gap & Educational Need: Lack of reported CI outcomes for children with TMPRSS3 mutation treated with CI. Clinicians need to understand that CI is an effective treatment option for children with TMPRSS3 mutation that should be sought early.

Learning Objective: To understand that children with TMPRSS3 gene mutation treated with CI and EAS have excellent outcomes and that early intervention and off-label implantation may be necessary to achieve optimal results.

Desired Result: Clinicians will consider implanting children with TMPRSS3 mutation sooner rather than waiting until low frequency hearing progresses.

Level of Evidence - V

Indicate IRB or IACUC: Vanderbilt University IRB #090155

Assessing the Relation between the Degree of Temporal Bone Pneumatization and the Prevalence of a Dehiscence

*Davood K. Hosseini, MD; Brad Girod, MD (presenter); Yilai Shu, MD
Haiying Sun, MD; Yifei Ma, MS; Ksenia A. Aaron, MD
Nikolas H. Blevins, MD; Yona Vaisbuch, MD*

Objective: To determine whether dehiscence in the skull base, superior canal, or major vessels is acquired or congenital and if it is affected by the pneumatization process

Study Design: Retrospective review

Setting: Tertiary academic clinic

Patients: 108 females and 96 males with a mean age of 51.7 years and a BMI of 26.8.

Interventions: Three physicians retrospectively reviewed 408 temporal bone CT scans with varying slice thickness. The petrous apex, infralabyrinthine, and mastoid compartments of the temporal bone were scored based on the degree of pneumatization and correlated to the presence or absence of dehiscence in the jugular bulb, sigmoid sinus, and carotid artery. Clinical data was collected to see if patterns related to the imaging findings could be identified.

Main Outcome Measures: Correlation between the degree of pneumatization and temporal bone dehiscence

Results: Out of a total of 408 temporal bone CT scans, 82 were excluded due to opacification of the air cells or surgical procedures. The data was stratified with logistic regression modeling demonstrated no statistically significant relationship between temporal bone pneumatization and dehiscence findings. There were significant correlations between sound induced vertigo, tinnitus, pulsatile tinnitus and dizziness, in the presence of tegmen mastoideum and semicircular canal dehiscence (SCCD). (4 out of 88, $p=0.019$, 51 out of 81, $p=0.009$, 13 out of 85, $p=0.024$, 9 out of 34, $p=0.019$ respectively). Comparing the traditional CT and cone beam CT scans, the chance of identifying SCCD was 11%, and 3.7% respectively

Conclusions: There is no correlation between the degree of temporal bone pneumatization and the presence of dehiscence. This weakens the hypothesis that skull base or vessel dehiscence in the temporal bone is related to the pneumatization process that occurs until adolescence.

Define Professional Practice Gap & Educational Need: The pathoetiology of temporal bone dehiscence including skull base, superior canal, and the major vessels is unclear. Some argue for congenital etiology and others for an acquired one. Based on the fact that the pneumatization process occurs postnatally and continues until adolescence. This study looks into the prevalence of dehiscence of the temporal bone on CT imaging in relation to the degree of pneumatization.

**High-resolution MRI reveals Lack of Endolymphatic Hydrops
in Vestibular Migraine**

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Objectives: to evaluate the audiovestibular testing results and high-resolution MRI with visualization of endolymphatic hydrops in patients with vestibular migraine (VM)

Study Design: Clinical case series

Setting: University Neurotology Clinic

Subjects: All patients who presented within a 6-month time frame meeting the International Classification of Headache Disorders criteria for vestibular migraine are included

Materials and Methods: The clinical histories, auditory and vestibular testing and outcome of interventions are presented. MRI imaging was performed on a 3T MRI with 16 channel coil, 4 hours following gadolinium iv.

Results: Thirteen patients presented with VM. Of these, 9 (70%) were female and 4 (30%) were male. In most patients, the hearing was symmetrical. In 2 out of 8, there was a significant caloric paresis on the ipsilateral side as the migraine. In all cases, the MRI did not demonstrate endolymphatic hydrops. Successful interventions included supplements, lifestyle changes, and prophylactic medications.

Conclusion: Vestibular migraine can be distinguished by the presence of normal audiometry and MRI with 4 hour delayed iv contrast reveals the absence of endolymphatic hydrops. About 25% of patients with VM have a caloric paresis.

Define Professional Practice Gap & Educational Need. Important to understand the role of audiovestibular testing and high-resolution MRI in the evaluation of VM

Learning Objective: VM can be associated with a caloric paresis, but the hearing remains symmetrical. Hydrops is not likely the mechanism of vertigo in the VM patient.

Desired Result: understand the workup and treatment of VM

Level of Evidence: 3

IRB: UCLA Approved: 13-000089 (GI)