

***SELECTED ABSTRACTS***

***POSTER PRESENTATIONS***

IN ORDER OF PRESENTATION



***61<sup>st</sup> Annual Spring Meeting***  
***AMERICAN NEUROTOLOGY SOCIETY***

***April 24-26, 2026***  
***Sheraton Phoenix Hotel***  
***Phoenix Convention Center***  
***Phoenix, AZ***

ANS Posters will be displayed on Friday/Saturday  
ANS Oral presentations are on Saturday/Sunday

## Immune Landscape and PD-L1 Expression in Vestibular Schwannoma: A Transcriptomic Analysis

*Jumah G. Ahmad, MD; David Z. Allen, MD; Vivian F. Kaul, MD*

**Hypothesis:** PD-L1 expression reflects distinct patterns of immune infiltration in vestibular schwannoma (VS), which can be delineated using publicly available transcriptomic data.

**Background:** Although VS is a benign tumor, the tumor microenvironment may influence growth, immune modulation, and therapeutic susceptibility. Immune checkpoint pathways such as PD-L1 signaling have transformed cancer therapy, but their role in benign nerve sheath tumors remains unclear.

**Methods:** Gene expression profiles from 31 VS and 9 normal peripheral nerve samples from the Gene Expression Omnibus were analyzed. Single-sample gene set enrichment analysis (ssGSEA) using the GSVA package in R was performed quantifying immune signatures including T cells, cytotoxic activity, macrophages, IFN $\gamma$  response, antigen presentation, NK cells, B cells, and regulatory T cells. PD-L1 expression was extracted from the same transcriptomic matrix. Differential enrichment between tumors and controls was tested using Limma, and correlations between PD-L1 and immune signatures were evaluated with Spearman's method. Tumors were stratified by PD-L1 expression (high vs. low, median split).

**Results:** Compared to controls, VS samples showed higher enrichment of macrophage (adjusted  $p < 0.001$ ), IFN $\gamma$  response ( $p < 0.001$ ), and cytotoxic ( $p = 1.3 \times 10^{-4}$ ) signatures. PD-L1 expression varied across tumors and correlated positively with antigen presentation ( $\rho = 0.26$ ), IFN $\gamma$  response ( $\rho = 0.15$ ), and NK cell ( $\rho = 0.17$ ) signatures, but weakly negatively with T-cell signatures ( $\rho = -0.19$ ). High PD-L1 tumors trended toward greater cytotoxic and antigen presentation enrichment, though differences were not statistically significant. Clinical variables were unavailable.

**Conclusions:** Transcriptomic profiling reveals distinct immune landscapes in VS and links PD-L1 expression with cytotoxic and antigen presentation pathways. These findings highlight immune modulation in benign nerve sheath tumors and establish a framework for future integrated molecular-clinical studies.

**Learning Objective:** Understand the immune landscape of vestibular schwannoma and the role of PD-L1 in modulating immune signatures.

**Desired Result:** Increase physician knowledge of immune modulation in benign nerve sheath tumors and its potential implications for future therapies.

**Level of Evidence** - Level V.

**Indicate IRB or IACUC:** Exempt.

## A Novel Technique for Superior Semicircular Canal Dehiscence Repair

*Jumah G. Ahmad, MD; Mana Espahbodi, MD; Richard K. Gurgel, MD; Neil S. Patel, MD*

**Objective:** To describe a novel minimally invasive technique for superior semicircular canal dehiscence (SSCD) repair using an endoscopic brow lift sheath.

**Study Design:** Retrospective case series.

**Setting:** Tertiary care referral center.

**Patients:** Adult patients with SSCD syndrome undergoing operative repair.

**Intervention:** Endoscopic-assisted mini–middle fossa approach using a sheathed endoscope and radiopaque glass ionomer for SSCD repair.

**Main Outcome Measures:** Improvement of autophony, pulsatile tinnitus, and sound- or pressure-induced vertigo; radiographic confirmation of repair.

**Results:** Three patients underwent SSCD repair using an endoscopic brow lift sheath introduced through a small craniotomy centered over the superior canal. The sheath's arched extension extends beyond the endoscope lens to retract soft tissue, providing a clear operative field for minimally invasive visualization and instrumentation. This approach minimizes temporal lobe retraction and facilitates faster neurologic recovery compared to the traditional middle-fossa craniotomy. It also enables superior visualization for resurfacing with rigid bone substitutes, a radiopaque glass ionomer, a technically challenging step with the transmastoid approach, which is more suited for plugging and subsequent associated transient postoperative vertigo. This technique is particularly advantageous for older or anticoagulated patients in whom minimizing retraction and bleeding risk is critical. All patients recovered uneventfully, were discharged on the same day or postoperative day one, and demonstrated radiographic evidence of appropriate repair. All reported improvement or resolution of autophony, pulsatile tinnitus, and sound/pressure-induced vertigo at last follow-up.

**Conclusions:** The sheathed endoscopic mini–middle fossa technique combines the visualization and access advantages of the traditional middle fossa approach in addition to the reduced morbidity of the transmastoid route for resurfacing, offering an effective, less invasive alternative for SSCD repair, particularly in higher-risk or elderly patients. Radiopaque glass ionomer allows for demonstration of appropriate repair on post-operative imaging.

**Learning Objective:** Understand the principles and advantages of the sheathed endoscopic mini–middle fossa technique for SSCD repair.

**Desired Result:** Introduce a novel minimally invasive alternative for SSCD repair that reduce morbidity while maintaining effective surgical access and visualization.

**Level of Evidence** - Level V.

**Indicate IRB or IACUC:** Exempt.

## Long-Term Hearing Preservation in Pediatric Cochlear Implant Recipients with Electrode Contacts in the Functional Acoustic Hearing Region

*Elena Quinonez Del Cid, BS; Margaret T. Dillon, AuD, PhD; Lisa R. Park, AuD  
Kevin D. Brown, MD, PhD; Nicholas J. Thompson, MD*

**Objective:** Review the influence of electrode contacts within the functional acoustic hearing region on long-term hearing preservation for pediatric cochlear implant (CI) recipients

**Study Design:** Retrospective review

**Setting:** Tertiary referral center

**Patients:** 69 pediatric CI recipients with functional low-frequency hearing preservation at device activation ( $\leq 80$  dB HL at 250 Hz)

**Interventions:** Cochlear implantation with 24-, 26-, 28-, or 31.5-mm straight electrode array

**Main Outcome Measures:** Proximity of the electrode array to the functional acoustic hearing region was determined with intraoperative x-ray and unaided thresholds at initial activation. Low frequency pure tone average (LFPTA) was calculated using the unaided thresholds at 125, 250, and 500 Hz at the preoperative, activation, 6 month, and annual follow-up visits (out to 3 years post-activation).

**Results:** A linear mixed model analyzed the effects of angular insertion depth (AID) of the most apical electrode contact, proximity, age at implantation, biological sex, preoperative LFPTA, and interval on change in LFPTA. Long-term hearing preservation was significantly influenced by interval ( $p < 0.001$ ), indicating a decline in acoustic thresholds over time. There was also a significant effect of biological sex ( $p = 0.038$ ) with greater LFPTA shifts in males. There were no significant main effects of AID, proximity, or pre-operative LFPTA.

**Conclusions:** The majority of pediatric CI recipients with preserved low-frequency hearing after surgery maintained audible acoustic thresholds long-term, but there were some who had delayed loss of residual hearing. Spatial overlap and deep insertions did not significantly influence long-term hearing preservation.

**Learning Objective:** Attendees should be able to explain the relationship between electrode placement relative to the functional acoustic hearing region and long-term hearing preservation.

**Desired Result:** Learners will acknowledge how electrode placement in relation to the functional acoustic hearing region influences hearing preservation outcomes and apply this information to surgical planning or mapping procedure.

**Level of Evidence:** III

**Indicate IRB or IACUC:** IRB #25-0570, University of North Carolina

## **Automated Facial and Vestibulocochlear Nerve Segmentation in the Cisternal and Intracanalicular Segments Using a Deep Learning U-Net Model**

*Michael Bartellas, MD, MSc; Yeshwant Chillakuru, MD, MSc; Matthew Su, BSc  
Sofiya Yusina, BSc; Daniel Jethanamest, MD, MSc*

**Objective:** To develop and evaluate a deep learning U-Net model capable of automatic segmentation of the facial (CN VII) and vestibulocochlear (CN VIII) nerves within the cisternal and intracanalicular segments on MRI.

**Study Design:** Retrospective imaging study.

**Setting:** Tertiary referral center.

**Patients:** Adult patients with normal anatomy on MRI internal auditory canal (IAC) studies and without skull base pathology.

**Interventions:** Manual segmentation of CN VII and VIII on MRI IAC CISS sequence was performed with 3D Slicer on 22 patients, split into training (70%), validation (15%), and test sets (15%). A U-Net convolutional neural network architecture was trained for automated segmentation using standard data augmentation techniques.

**Main Outcome Measures:** Segmentation performance was quantified using Dice score and manual review.

**Results:** The model was optimized on the validation set (Dice = 0.5350). On the test set, performance improved (Dice = 0.6108). Mean Dice scores were 0.4279 (R CN VII), 0.5475 (R CN VIII), 0.6541 (L CN VII), and 0.6511 (L CN VIII). Manual inspection confirmed anatomically accurate segmentations, with modest Dice values reflecting expected limitations when delineating small-caliber cranial nerves.

**Conclusions:** Our work represents one of the first applications of deep learning–based segmentation for CN VII and VIII. Future improvements in model performance and accuracy of automated delineation of these nerves may have clinical implications for the identification of tumor nerve of origin, enhancing preoperative planning for lateral skull base surgery, and to support research on cochlear nerve integrity in implant candidates with suspected nerve deficiency.

**Learning Objective:** To understand how convolutional neural network–based segmentation models can automate and standardize the delineation of cranial nerve anatomy on MRI.

**Desired Result:** Attendees will recognize how deep learning segmentation can improve reproducibility in cranial nerve identification and support the development of clinically translatable AI tools for skull base imaging and auditory implant research.

**Level of Evidence** – Level IV

**IRB:** NYU Grossman School of Medicine IRB #i25-00262; June 17, 2025

## Hidden Growth: Characterizing Internal Expansion Within Central Necrotic Components of Vestibular Schwannomas

*Ada Chung, BA; Beatrice Katsnelson, BA; Rithvik Ghankot, MS; Ariel Omiunu, MD  
Frank Buono, MS, PhD; Amit Mahajan, MD; Nofrat Schwartz, MD*

**Objective:** Vestibular schwannomas (VS) are routinely monitored for tumor growth post-GKS utilizing repeat MRI; this modality measures outward expansion of VS overlooking tumors that exhibit internal regrowth following central necrosis. We aim to determine prevalence of internal regrowth, preceding tumor outward expansion. Secondly, we explore the application of an AI-based tool for identification of internal regrowth.

**Study Design:** Retrospective cross-sectional study of patients with unilateral VS who underwent GKS between 2001 and 2023. MRI volumetric analysis was performed at time of GKS and follow-up including and excluding central necrotic component.

**Setting:** Tertiary academic center.

**Patients:** 85 patients who underwent GKS of which four patients had internal regrowth. A total of 170 MRIs at baseline and follow-up were analyzed.

**Interventions:** The entire cohort was manually segmented, and clinically significant internal regrowth was determined by a  $\geq 20\%$  increase. These were then compared to AI-based segmentation

**Main Outcome Measures:** Rates of treatment failure and internal tumor regrowth, group differences assessed using Fisher's Exact and Mann-Whitney U Test, and human-to-AI comparisons.

**Results:** 4 of 85 patients (4.7%) demonstrated internal tumor growth. Three of four (75%) met criteria for treatment failure versus 11 of 81 external-growth cases (13.6%), a difference that was statistically significant ( $p = 0.013$ ). No differences in radiation parameters and demographics were noted. Internal tumors were often medium-sized (67%), and external tumors were evenly distributed across all size categories. AI successfully identified internal growth and treatment failure categorization in 100% of cases.

**Conclusions:** Central tumor regrowth following GKS was observed in 5% and accounted for 27% of all treatment failures. This pattern warrants close surveillance to enable early detection of post-GKS progression. Notably, our AI model accurately identified these growth patterns, suggesting its potential in post-treatment monitoring.

**Learning Objective:** Understand the nuanced variability of volumetric assessment and growth classification, and its implications for clinical decision-making.

**Desired Result:** To increase clinician awareness of internal regrowth in vestibular schwannoma volumetry, and to encourage consideration of standardized measurement protocols or AI-assisted tools to improve consistency and optimize patient care.

**Level of Evidence:** Level IV

**Indicate IRB or IACUC:** Yale University's Institutional Review Board (HIC #0704002523)

## Effect of Cochlear Implant on the Cognitive Function of Older Adults A Systematic Review and Meta-Analysis

*Christi A. Joyce; Kelly Zhang; Joost Stultien, MD; Alexandra E. Quimby, MD, MPH*

**Objective:** To assess whether cochlear implantation (CI) affects cognitive function in older adults.

**Data Sources:** MEDLINE, Embase, Cochrane CENTRAL, Web of Science, PsycINFO, and CINAHL.

**Study Selection:** Two reviewers independently screened studies. Eligible studies were published in English language, included adults aged  $\geq 60$  years of age with post-lingual hearing loss who had undergone CI, and reported both pre- and post-CI objective cognitive assessment scores. Interventional studies, cohorts, case-controls, and case series with  $n > 5$  were included.

**Data Extraction:** Data from included studies were independently extracted by two reviewers. Study quality and risk of bias were evaluated.

**Data Synthesis:** Within subjects random effects meta-analysis was performed using the methodology of DerSimonian/Laird. Separate meta-analyses were performed including studies reporting mean pre- and post-CI scores on the same cognitive test (for tests that were reported in  $\geq 3$  studies). Meta-analysis of standardized mean differences (SMD) was additionally performed considering the findings across all studies and reported tests.

**Results:** Twenty-five eligible studies were identified, including a total of 997 patients. Sixty-three separate cognitive tests were applied (including components of cognitive testing batteries) at a mean 14.55 months post-operatively. The most commonly applied was the Mini Mental Status Exam (MMSE) (9 studies). Meta-analysis of mean differences showed no significant effect of CI on MMSE score (mean difference= 0.64, 95% CI=-0.66, 1.95). Considering all studies, there was a small improvement in mean cognitive testing scores post-CI (pooled SMD=0.152, 95% CI= 0.033, 0.271).

**Conclusions:** CI may improve cognitive function in implanted older adults. Further research using uniform measurement tools is needed to better clarify this finding.

**Learning Objective:** Understand current evidence on the effect of cochlear implantation on cognitive function in older adults. Discuss implications of cochlear implantation for mitigating cognitive decline and promoting healthy aging.

**Desired Result:** This study aims to enhance physicians' understanding of the benefits associated with cochlear implantation in older adults. It is expected to increase competence in integrating cognitive outcomes into cochlear implant counseling, and ultimately support timely interventions that may contribute to improved patient outcomes through preservation of cognitive function and quality of life.

**Level of Evidence - Level I**

**Indicate IRB or IACUC:** Exempt.

## Understanding Variability in Vestibular Migraine Outcomes: A Retrospective Review

*Jack M. Dozier; Arvind Ganeshram; Batoul Berri, AuD  
Devin L. McCaslin, PhD; Christopher M. Welch, MD, PhD*

**Objective:** To identify clinical, demographic, and diagnostic predictors of treatment response among patients with vestibular migraine (VM) evaluated at a tertiary neurotology center, emphasizing dizziness characteristics and symptom burden.

**Study Design:** Retrospective chart review.

**Setting:** Tertiary referral center.

**Patients:** Adults ( $\geq 18$  years) diagnosed with VM, without coexisting peripheral or central vestibular disorders, who completed neurotologic evaluation and at least one follow-up. Twenty-seven patients met inclusion criteria.

**Interventions:** Vestibular physical therapy (VPT) alone, VPT with lifestyle modification, or VPT with pharmacologic therapy.

**Main Outcome Measures:** Symptom burden and treatment response were assessed through subjective improvement and clinical follow-up. Predictors included demographics, migraine-associated features, dizziness characteristics, baseline Dizziness Handicap Inventory (DHI) scores, and comorbid mood or sleep disorders. Vestibular testing parameters included caloric responses and presence of spontaneous or positional nystagmus.

**Results:** Among 27 patients (mean age at diagnosis  $49.4 \pm 17.9$  years, 74.1% female), mean dizziness duration before evaluation was  $35.2 \pm 65.2$  months, with 77.8% reporting episodic vertigo. Common migraine-associated features included photophobia (59.3%), phonophobia (37.0%), and aura (48.1%). Vestibular-visual mismatch was present in 70% (14/20). Mean DHI was  $45.1 \pm 20.8$ . Mood disorders affected 81.5% and sleep disturbances 44.4%. 77.8% had spontaneous and/or positional nystagmus, and 51.2% had isolated caloric outliers. Among pharmacologic patients, 20% reported complete resolution, 60% partial improvement, and 20% persistent symptoms. In contrast, 83% of the VPT + lifestyle group and all VPT-only patients achieved complete resolution. However, those managed without medication generally had milder baseline symptoms, suggesting initial severity influenced treatment selection and outcome.

**Conclusions:** Patients with VM demonstrate heterogeneous clinical and psychological profiles. Symptom duration, dizziness pattern, migraine features, and baseline DHI may predict treatment response. Identifying these factors may enable more personalized therapy and inform future prospective studies.

**Learning Objective:** To determine clinical, demographic, and diagnostic predictors of treatment response in vestibular migraine.

**Desired Result:** Improved clinician understanding of prognostic indicators in vestibular migraine to guide individualized, evidence-based treatment strategies and optimize patient outcomes.

**Level of Evidence:** Level IV

**Indicate IRB or IACUC:** University of Michigan IRBMED, determined exempt 5/23/2025, IRB #HUM00273094



## Incidence and Risk Factors of Postoperative Sensorineural Hearing Loss After Cholesteatoma Removal

*Kim B. Le, BS; A. Race Schaeffer, BS; Rohan Vuppala, BS; Christian Jung, BA  
Keshav V. Shah, BS; Michael J. Ruckenstein, MD; Tiffany P. Hwa, MD*

**Objective:** This study aims to evaluate the incidence of sensorineural hearing loss (SNHL) following cholesteatoma surgery and identify potential risk factors contributing to its development.

**Study Design:** Retrospective case-control study

**Setting:** Single tertiary academic medical center

**Patients:** Patients who underwent cholesteatoma removal surgery between January 2021 and June 2024.

**Interventions:** Electronic medical records of qualifying patients were searched for relevant demographics, disease characteristics, extent of surgery, and audiometric data, defining SNHL as a 20dB drop from 250-4kHz. Analysis incorporated descriptive characteristics and general logistic regression.

**Main Outcome Measures:** Postoperative SNHL incidence and resolution rates, predictors of postoperative SNHL

**Results:** 283 patients met inclusion criteria (age  $51.6 \pm 17.4$  years; 155 [54.5%] males). 243 (85.9%) had preoperative mixed or conductive hearing loss, mean air-bone gap (ABG)  $25.9 \pm 13.3$  dB, and 145 (51.06%) demonstrated postoperative improvement in the ABG, with a mean improvement of  $11.92 \pm 9.43$  dB. 36 patients (12.7%) demonstrated new onset postoperative SNHL, with 31 patients (10.9%) diagnosed within the first 6 months postop and 5 patients (1.8%) after 12 months. Of 12 patients with postoperative SNHL and long term (>12 months) postoperative audiometric data, 3 (25%) had resolved or improved. Ear infection did not coincide with SNHL onset. A canal wall down approach (OR 0.282 [0.080, 0.871]; 0.035) was associated with decreased likelihood of SNHL in only the primary surgery cohort. Revision surgery, prosthesis placement, age, sex, primary language, and race did not reach significance.

**Conclusions:** SNHL is a non-negligible complication after cholesteatoma surgery. Future research with larger cohorts may optimize risk stratification to enhance patient counseling and surgical management. There is a possibility of resolution with long-term follow-up in a cohort of patients, but larger studies are needed to identify predictors of resolution.

**Learning Objective:** 1) Identify risk factors associated with SNHL development following cholesteatoma surgery and 2) understand the timeframe and pattern of postoperative SNHL resolution

**Desired Result:** Synthesize pre-existing knowledge about cholesteatoma removal with empiric data about risk factors and temporal patterns to better monitor patients for SNHL

**Level of Evidence** - IV – Retrospective case-control study

**Indicate IRB or IACUC:** University of Pennsylvania Institutional Review Board (#855138; Approved 01/11/2023)

**Low Frequency Ship Motion and Acute Disorientation Predict Post Voyage Mal de Débarquement Symptoms: A Multi Voyage Study**

*Charlotte K. Hughes, MD, MPH; Jae Joon Kim, BS; Kiersten R. Russ, BS; Hudson Liu, BS  
Jong Bin Lee, MD, PhD; Michael J. Eliason, MD; Akihiro J. Matsuoka, MD, DMSc, PhD*

**Objective:** Mal de Débarquement Syndrome (MdDS) often follows prolonged passive motion, yet exposure profiles that confer risk remain unclear. Using a multi-leg voyage aboard a U.S. Navy hospital ship, we sought to link objective motion features with post-voyage symptoms.

**Study Design:** Prospective observational cohort

**Setting:** USNS Mercy (T-AH 19) during its Pacific Partnership 2024 deployment across the Indo-Pacific region

**Patients:** 38 Active-Duty U.S. Navy personnel

**Interventions:** MdDS Calculator, Simulator Sickness Questionnaire (SSQ), Stroop Test, and Symbol Digit Modalities Test (SDMT) after multiple sea transits. Voyage motion was recorded with a shipboard inertial measurement unit (IMU).

**Main Outcome Measures:** SSQ total and subscales; MdDS presence and duration of symptoms.

**Results:** Symptom burden varied by voyage, with rougher legs characterized by slow oscillatory motion showing the highest SSQ and MdDS rates. Low-frequency exposure (0.1-0.2 Hz) and root-mean-square (RMS) amplitude consistently predicted higher SSQ and MdDS. Migraine history was not an independent predictor after accounting for voyage conditions. Disorientation-related SSQ items (vertigo/dizziness) distinguished participants who later reported MdDS more strongly than nausea-related SSQ items. On the most provocative leg (CA-HI), cognitive performance showed modest slowing with longer Stroop interference times. In multivariable and machine-learning models, motion metrics and acute disorientation symptoms ranked as the most informative features for MdDS risk stratification.

**Conclusions:** Objective low-frequency ship motion and acute disorientation during transit – more than migraine history – signaled elevated risk for post-voyage MdDS symptoms. Integrating onboard motion monitoring with brief symptom screening may enable targeted counseling and prevention strategies for high-risk travelers.

**Learning Objective:** Educate readers about the relationship of ship motion exposures to post-voyage MdDS symptoms.

**Desired Result:** Motivate prospective validation studies and testing of mitigation approaches within Neurotology and vestibular care.

**Level of Evidence - III**

**Indicate IRB or IACUC:** UC San Diego IRB (#810413); Naval Medical Center San Diego IRB (#NMCSD.2023.0033)

## Quality of Life with Vestibular Schwannoma Microsurgery Does Surgical Approach Matter

*Alireza Zonnour, MD; Eric Cunningham, BA; Krish Suresh, MD  
Marc Schwartz, MD; Rick Friedman, MD, PhD*

**Objective:** To analyze change in quality-of-life (QOL) after vestibular schwannoma (VS) microsurgery and modifying factors including surgical approach.

**Study Design:** Retrospective cohort

**Setting:** Tertiary center

**Patients:** 74 patients with sporadic VS who completed both pre- and postoperative PANQOL questionnaire, mean age 49.6 years (SD 14.4).

**Interventions:** Microsurgery for tumor resection with single surgical team

**Main Outcome Measures:** Change in QOL from preoperative to one-year postoperative timepoint, measured by the Penn Acoustic Neuroma Quality-of-Life scale ( $\Delta$ PANQOL).

**Results:** 53% underwent translabyrinthine (TL) approach; 47% underwent retrosigmoid (RS). Mean tumor size was 22.3 mm (SD 10.0) for TL, 19.0 mm (SD 4.3) for RS. Mean overall PANQOL score improved postoperatively by 4.88 (SD 12.8) points for TL, 0.51 (SD 10.8) for RS ( $p=0.119$ ). Greatest improvement in PANQOL was found in the anxiety domain (mean=11.6, SD=20.4). On univariate analysis, TL had superior improvement in the hearing ( $\beta=8.14$ ,  $p=0.019$ ) and energy ( $\beta=8.90$ ,  $p=0.033$ ) domains. Mean change in the hearing domain was 5.00 for TL (SD 13.62), and -3.14 for RS (SD 15.58). On multivariate analysis controlling for tumor size and change in hearing with surgery, TL trended toward greater improvement in the hearing domain ( $\beta=7.19$ ,  $p=0.054$ ), while RS had greater improvement in the face domain ( $\beta=-7.22$ ,  $p=0.049$ ). On univariate analysis, larger tumor size was associated with greater improvement in the energy ( $\beta=0.60$ ,  $p=0.018$ ) and pain ( $\beta=0.09$ ,  $p=0.044$ ) domains. Both remained significant on multivariate analysis.

**Conclusions:** VS microsurgery improves QOL, most significantly with respect to anxiety. Interestingly, translabyrinthine surgery demonstrated greater improvement in hearing-related QOL, suggesting positive adaptation to single-sided deafness when accepted upfront as a consequence of surgery. Also of note, patients with larger tumors may experience greater improvement in energy and pain-related QOL with microsurgery.

**Learning Objective:** To understand long-term postoperative quality of life with VS microsurgery and associated factors

**Desired Result:** Attendees will better understand the effects of VS microsurgery on postoperative long-term quality of life and possible effects of surgical approach selection.

**Level of Evidence - III**

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

## Hearing Loss Etiology as a Determinant of Cochlear Implant Rehabilitation Velocity and Trajectory Patterns

*Stephanie M. Younan, MPH, BS; Lourdes Kaufman, BA; Connie Chang-Chien, BS  
Pearl Doan, BS; Nicole T. Jiam, MD*

**Objective:** While deprivation duration has traditionally been found to predict outcomes, emerging evidence suggests etiology may shape rehabilitation trajectories. We investigated whether hearing loss etiology predicts cochlear implant (CI) rehabilitation velocity, plateau timing, and trajectory patterns, independent of deprivation duration.

**Study Design:** Retrospective cohort study with longitudinal trajectory analysis.

**Setting:** Tertiary academic center.

**Patients and Intervention:** 37 adult CI recipients with defined hearing loss etiology had serial outcomes data ( $\geq 2$  timepoints at 1, 3, 6, 12 months post-activation): Genetic/Hereditary (n=11), Age-related (Presbycusis) (n=10), Infectious (Post-Meningitis) (n=6), Otologic/Iatrogenic (n=6), and Noise-induced (n=5).

**Main Outcome Measures:** Twelve-month CNC word recognition scores, rehabilitation velocity (CNC percentage point change per month), and trajectory patterns (characterized by improvement, plateau, or decline across four timepoints).

**Results:** Etiology groups showed significantly divergent 12-month outcomes (Kruskal-Wallis  $H=9.525$ ,  $p=0.049$ ), with Genetic/Hereditary achieving superior performance ( $67.2 \pm 17.1\%$ , median 71.0%) and Infectious showing poorest outcomes ( $32.8 \pm 22.8\%$ , median 36.0%). Intermediate performance was observed in Otologic/Iatrogenic ( $57.5 \pm 23.4\%$ , median 54.0%), Noise-Induced ( $56.8 \pm 9.9\%$ , median 52.0%), and Age-Related groups ( $46.6 \pm 17.1\%$ , median 42.0%). Rehabilitation velocities varied substantially: Noise-Induced and Genetic/Hereditary demonstrated the fastest improvement (median 1.86 and 1.84 points/month), Age-Related showed high variability ( $2.85 \pm 6.00$  points/month, median 1.58), Otologic/Iatrogenic showed moderate velocity (median 1.48 points/month), while Infectious showed near-plateau trajectories ( $-1.03 \pm 1.81$  points/month, median -0.40). Trajectory patterns further distinguished groups: Genetic/Hereditary maintained consistently high performance from early activation (50.0% at 1-month to 75.6% at 12-months), Age-Related demonstrated gradual linear improvement (28.9% to 51.7%), Infectious showed minimal improvement (27.5% to 36.0%), and Noise-Induced exhibited variable trajectories with a 6-month performance peak.

**Conclusions:** Etiology of hearing loss represents a potentially important determinant of CI rehabilitation trajectories. Distinct patterns suggest that the underlying pathology constrains the rehabilitative potential and limits the functional outcome ceiling, indicating utility for etiology-stratified counseling protocols.

**Learning Objective:** To understand how hearing loss etiology independently influences cochlear implant rehabilitation trajectories and outcomes.

**Desired Result:** Implementation of etiology-stratified patient counseling and outcome prediction protocols in cochlear implant programs.

**Level of Evidence** - Level III

**Indicate IRB or IACUC:** UCSF IRB # 25-43648; Approval Date: 07/30/25

## Linking Vestibular Schwannoma and Normal Pressure Hydrocephalus: Insights from a Multi-Institutional Cohort Study

*Marianne Rara, BS; Khushi Bhatt, BS; Hera Kim, BS; Katelyn Tran, BS  
Mehdi Abouzari, MD, PhD; Hamid R. Djalilian, MD*

**Objective:** To investigate the association between vestibular schwannoma (VS) and normal pressure hydrocephalus (NPH).

**Methods:** A retrospective cohort study was conducted using the multi-center TriNetX Research Network. Adults with VS were compared to matched patients without VS. Secondary analyses evaluated the impact of comorbidities, and tertiary analyses assessed prior surgery and radiation. Propensity score matching was limited by platform constraints. Outcomes included NPH prevalence and time to diagnosis, analyzed using TriNetX measures of association and Kaplan-Meier functions.

**Results:** Patients with VS had a significantly higher risk of developing NPH than those without VS (RR: 7.68, 95% CI: 5.84-10.09). VS was also associated with earlier NPH diagnosis ( $p < 0.001$ ; HR: 7.20, 95% CI: 5.47-9.46), though the proportional hazards assumption was violated ( $p = 0.012$ ). Within the VS cohort, comorbid hypertension, cerebral infarction, transient ischemic attacks, and ischemic heart disease were linked to higher NPH rates (RR: 2.78, 95% CI: 2.12-3.64; RR: 2.63, 95% CI: 1.73-4.00; RR: 1.99, 95% CI: 1.15-3.44; RR: 1.90, 95% CI: 1.41-2.57, respectively). All but transient ischemic attacks were associated with earlier diagnosis ( $p < 0.001$ ,  $p < 0.001$ ,  $p = 0.007$ , respectively). No significant differences were observed by sex, neurofibromatosis type 2, schwannomatosis, diabetes, peripheral vascular disease, atherosclerosis, or weight. Prior radiation was associated with increased NPH risk (RR: 2.42, 95% CI: 1.54-3.82) and earlier diagnosis ( $p < 0.001$ ) compared to VS patients without radiation. Patients with prior surgery and those with radiation had comparable NPH risk (RR: 0.78, 95% CI: 0.39-1.56) and time to diagnosis ( $p = 0.593$ ).

**Conclusions:** Vestibular schwannoma is associated with elevated NPH risk. Among affected patients, vascular comorbidities—particularly hypertension, cerebral infarction, transient ischemic attacks, and ischemic heart disease—are linked to greater risk and faster progression. Prior radiation further increases both risk and diagnostic acceleration.

### REQUIRED:

**Learning Objective:** To define the association between vestibular schwannoma and normal pressure hydrocephalus, with attention to how comorbidities modify risk. Provide neurotologists with insight into earlier identification and monitoring strategies for high-risk patients, facilitating evidence-based clinical decision-making.

**Desired Result:** Enhance physician knowledge and competence by enabling neurotologists to identify high-risk patients and consider earlier monitoring or evaluation to improve patient outcomes.

**Level of Evidence:** III

**Indicate IRB or IACUC:** Exempt.

**Pre-Existing Psychiatric Comorbidity: Does it Impact  
Cochlear Implant Outcomes in Veterans?**

*Laasya P. Achanta, BSA; Kaitlyn A. Brooks, MD  
W. Craig Kemper, MD; Nathan R. Lindquist, MD*

**Objective:** To assess psychiatric comorbidities and outcomes for veterans with cochlear implantation (CI).

**Study Design:** Retrospective cohort.

**Setting:** Single institution tertiary-care veterans affairs medical center (VAMC).

**Patients:** Ninety-two adult patients (age range 35-92 years, 99% male) with post-lingual deafness from 1998 - 2024.

**Interventions:** Cochlear implantation.

**Main Outcome Measures:** Represented psychiatric diagnoses, number of psychiatric diagnoses, CI-aided speech recognition scores, CI-aided high-performance (>70% monaurally aided).

**Results:** Twenty-three (25%) patients undergoing CI had comorbid psychiatric diagnoses. For these patients, the most common diagnoses were Post-Traumatic Stress Disorder (25%), Major Depressive Disorder (22%), Alcohol Use Disorder (13%), and Generalized Anxiety Disorder (13%). Most (52%) patients had only one psychiatric diagnosis, while 11 (48%) had multiple. Sixty-nine patients did not have psychiatric comorbidities and formed the control group. Pre-CI WRS were similar between patients with and without psychiatric diagnoses (median pre-CI AzBio 15.5% versus 14%), but patients with psychiatric co-morbidity achieved a lower median CI-aided AzBio score than patients without psychiatric co-morbidity (CI-aided WRS 65.5% versus 80%,  $p=0.15$ ). This finding was not statistically significant. A lower rate of patients with psychiatric disorders became high-performing users when compared to patients without psychiatric disorders in regards to CNC (12% vs 27%,  $p=0.17$ ) and AzBio (39% vs 63%,  $p=0.07$ ), though these did not reach statistical significance.

**Conclusions:** Patients with preexisting psychiatric diagnoses experience comparable improvements in speech perception outcomes after CI, but may have a lower likelihood of reaching high-performance status. Further, higher powered studies are necessary to determine if psychiatric co-morbidity impacts CI outcomes and, conversely, whether CI improves severity of pre-existing mental health diagnoses.

**Learning Objective:** To determine how psychiatric comorbidity affects speech outcomes following cochlear implantation in the veteran population.

**Desired Result:** To evaluate institutional CI outcomes in patients with and without psychiatric comorbidities to inform clinical practice and identify areas for future research.

**Level of Evidence** - Level III

**Indicate IRB or IACUC:** Michael E. DeBakey Veterans Affairs Medical Center IRB #1773722-5, Approved 3/21/2025; BCM IRB H-54164, Approved 2/22/2024.

## The Predictive Power of Computerized Posturography with and without Clinical Features for Accurate Vestibular Migraine Diagnosis

*Anita Singh, BS; Peter James, MD; Matthew Crowson, MD  
Biratal Wagle, MS; Michaela Geffert, MS; James Saunders, MD*

**Hypothesis:** Computerized dynamic posturography (CDP) metrics improve predictive accuracy for vestibular migraine (VM) diagnosis in adults when combined with clinical features.

**Background:** VM affects at least 1–3% of the population but remains underdiagnosed due to the lack of objective biomarkers. CDP objectively quantifies vestibular, visual, and somatosensory integration, potentially revealing balance deficits not apparent clinically. CDP may harbor a diagnostic signal for VM, given the demonstrable impact of VM on vestibular, visual, and somatosensory integration and associated symptoms.

**Methods:** Data from 334 patients (46 VM, 288 non-VM; 13.8% prevalence) and 6,121 CDP trials were analyzed. 15 CDP features (center of pressure, sway, force, moment, and motion metrics) and 9 clinical variables (episode characteristics, migraine history, symptoms, audiometry) were modeled using XGBoost and Random Forest algorithms with 5-fold stratified cross-validation. Three configurations were compared: CDP-only, clinical-only, and combined. Decision thresholds were optimized for  $\geq 80\%$  sensitivity, and SHAP analysis for feature importance.

**Results:** CDP features alone were non-discriminative for the diagnosis of VM (AUC 0.53; sensitivity  $<10\%$ ), whereas clinical features alone achieved moderate accuracy (AUC 0.80; sensitivity 50%). The combined model improved diagnostic accuracy (AUC 0.861, sensitivity 82.8%, specificity 75.2%). Negative predictive value was high (96.4%), though positive predictive value remained limited (36.2%) given low disease prevalence. SHAP analysis showed photophobia (2.29) and phonophobia (1.45) as top predictors, with the strongest CDP feature, vertical force (1.79), ranking second overall.

**Conclusions:** CDP alone is not discriminative for VM, but in combination with clinical features, it provides incremental predictive value for diagnosis of VM. While a gold-standard biomarker for VM remains elusive, these findings support CDP-enhanced, machine learning-based approaches for objective VM diagnosis prediction.

**Professional Practice Gap & Educational Need:** VM remains one of the most frequently overlooked causes of episodic vertigo due to the absence of objective diagnostic markers and the overlap of symptoms with other vestibular and migraine-related disorders. Current diagnostic approaches rely primarily on subjective symptom reporting and clinical pattern recognition, which are limited by inter-clinician variability and patient recall bias. There is a growing need for educational frameworks and clinical tools that bridge traditional neuro-otologic assessment with data-driven analytics which will enable more accurate, objective, and reproducible diagnosis of complex vestibular syndromes such as VM.

**Learning Objective:** Application of machine learning techniques to the development of clinical tools

**Desired Result:** Understanding of the use of machine learning and CDP in streamlining vestibular diagnostics

**Level of Evidence - III**

**Indicate IRB or IACUC:** IRB Study 02000534

## Comparison of Transcranial Facial Motor Evoked Potentials and Prass Probe–Evoked EMG As Predictors of Postoperative Facial Nerve Dysfunction after Acoustic Neuroma Surgery

*Shahid Iqbal, MBBS; Jonathan Dilgen, PhD; Krish Suresh, MD  
Marc Schwartz, MD; Rick Friedman, MD, PhD*

**Objective:** To characterize patterns of transcranial facial motor evoked potential (TcFMEP) changes compared with direct facial nerve stimulation (Prass probe–evoked CMAPs) during acoustic neuroma resection in patients who developed poor postoperative facial nerve function.

**Study Design:** Retrospective case review

**Setting:** Tertiary referral center for acoustic neuroma

**Patients:** Six patients who underwent acoustic neuroma surgery with poor postoperative facial function as defined by House-Brackmann scale of 4 to 6 at post-operative clinic follow up.

### Main Outcome Measures:

- (1) Percentage of post-resection TcFMEP amplitude relative to pre-resection baseline.
- (2) Whether a favorable Prass probe stimulation threshold was achieved on direct facial nerve stimulation.
- (3) Early postoperative House–Brackmann grade.

### Results:

Tumor size ranged from 10–45 mm (mean  $27.3 \pm 12.6$  mm). Surgical approaches included translabyrinthine (n=4), retrosigmoid (n=1), and middle fossa (n=1). TcFMEP amplitudes decreased markedly following resection (range 0–100% of baseline). Only 1 of 6 patients (17%) demonstrated a preserved TcFMEP signal post-resection. In contrast, 4 of 6 patients (67%) demonstrated a favorable Prass probe stimulation threshold despite subsequently developing poor postoperative facial nerve function. All six patients ultimately exhibited poor early facial outcomes (HB IV–VI).

### Conclusions:

TcFMEP changes showed consistent concordance with poor postoperative facial nerve function, whereas Prass probe stimulation produced a high false-negative rate, falsely suggesting intact nerve function in 67% of patients who ultimately had HB IV–VI outcomes. These findings highlight that direct stimulation alone may provide misleading intraoperative reassurance, and TcFMEP may more accurately reflect evolving facial nerve injury during acoustic neuroma resection.

**Learning Objective:** To compare TcFMEP and Prass probe–evoked signals before and after tumor resection and assess their reliability in predicting postoperative facial nerve outcomes.

**Desired Result:** Results which are reflective of the poor facial nerve outcome

**Level of Evidence** - Level V

**Indicate IRB or IACUC:** Exempt (Not applicable)



## Neurotologic Manifestations as Pre-Diagnostic Markers of Lyme Disease A Retrospective Cohort Study

*Amrita Bonthu, MS; Todd Otteson, MD, MPH*

**Objective:** To characterize the temporal relationship of neurotologic conditions to a Lyme disease diagnosis

**Study Design:** Retrospective cohort study

**Setting:** TriNetX Research Network (111 HCOs)

**Patients:** Confirmed Lyme disease (ICD-10A69.2 and LOINC-11006-4). Inclusion required an index diagnosis between 1 and 20 years prior (for adequate follow-up) and ongoing healthcare utilization; exclusions comprised congenital, noise-induced, or ototoxic hearing loss.

**Interventions:** Advanced explore cohort of age, joint pain, and neurotologic symptoms

**Main Outcome Measures:** Frequency of neurotologic symptoms (based on Lyme case reports) and joint pain (for reference) was assessed at pre- and post-diagnostic intervals.

**Results:** The cohort (N=20,843) had a mean age at index of  $50.6 \pm 22.4$  years and was predominantly male (51.5%) and white (93.9%). Pre-diagnosis, facial nerve disorders (3.7%, n=762 vs. 0.3%, n=66), joint pain (35.8%, n=7,466 vs. 20.8%, n=4,327), and dizziness/giddiness (8.0%, n=1,658 vs. 5.2%, n=1,078) all surged in the year prior compared to a 3-5 year baseline. In contrast, sensorineural and unspecified hearing loss (5.0%, n=1,023), tinnitus (1.2%, n=250), and vestibular dysfunction (1.1%, n=199) had a sustained prevalence already present 3-5 years prior. Post-diagnosis, most symptoms fell sharply from their peaks. In the 0-1 month period, this included joint pain (16.1%, n=3,361), dizziness (2.7%, n=571), hearing loss (1.0%, n=204), tinnitus (0.3%, n=54), and vestibular dysfunction (0.3%, n=68). Facial nerve disorders showed continuous resolution (3.1%, n=654 at 0-1 month, falling to 0.4%, n=82 by 3-6 months).

**Conclusions:** The pre-diagnostic peak in neurotologic symptoms may represent a key, often-missed, detection opportunity. The rapid post-diagnosis decline of these acute symptoms, which likely reflects a response to treatment, suggests the potential importance of this early recognition.

**Learning Objective:** To understand the timing and clinical significance of neurotologic symptoms in Lyme disease.

**Desired Result:** Attendees will appreciate the importance of recognizing neurotologic symptoms for the early diagnosis of Lyme disease, highlighting the otolaryngologist's crucial role in both this early detection and in managing the long-term auditory and balance problems that may persist.

**Level of Evidence:** Level III

**Indicate IRB or IACUC:** Exempt.

## **Durability of Hydroxyapatite Bone Cement in Lateral Skull Base Repair**

*Douglas J. Totten, MD, MBA; Hunter L. Elms, MD; Amanda Wissmann Klage, BS  
Evan C. Cumpston, MD; Charles W. Yates, MD; Rick F. Nelson, MD, PhD*

**Objective:** To assess long-term durability of hydroxyapatite bone cement after lateral skull base (LSB) repair

**Study Design:** Retrospective cohort study

**Setting:** Tertiary referral center

**Patients:** Patients who underwent LSB repair with the use of hydroxyapatite bone cement who subsequently underwent computed tomography (CT) imaging of the skull base one or more years after repair

**Interventions:** Middle fossa craniotomy and repair of the lateral skull base using hydroxyapatite bone cement

**Main Outcome Measures:** Thickness of repaired skull base on initial and subsequent CT imaging was measured with calipers at identical sites over previously dehiscent tegmen; change in body-mass index (BMI), diagnosis of obstructive sleep apnea (OSA).

**Results:** 108 lateral skull base repairs with bone cement were performed from 2018-2024 with 2 (1.9%) recurrent leaks. 20 patients had follow-up CT imaging of 23 skull base repairs (3 bilateral) at an average of 38.7 (standard deviation 16.7) months postoperatively. Repair thickness on follow-up imaging ranged from 90.2%-101.4% of initial repair thickness (median: 97.4%, interquartile range: 95.0%-99.5%). Average repair height was 4.4 (0.8) mm postoperatively and 4.2 (0.8) mm at last follow-up (97%,  $p=0.48$ ). Mean BMI at time of initial CT was 36.9 (7.6) kg/m<sup>2</sup> compared to 35.7 (7.6) kg/m<sup>2</sup> at last follow-up. OSA was diagnosed in 11 (47.8%) cases.

**Conclusions:** Hydroxyapatite bone cement repair of sCSF leaks shows no significant deterioration at an average of more than 3 years despite persistence of established risk factors for sCSF leaks.

**Learning Objective:** Hydroxyapatite bone cement provides long-lasting durable repair of the lateral skull base.

**Desired Result:** Hydroxyapatite bone cement is a durable material that may be used in lateral skull base repair.

**Level of Evidence - IV**

**Indicate IRB or IACUC:** Indiana University IRB #13133 (approved 10/14/2022)

**Prevalence of Intraoperative Superior Semicircular Canal Dehiscence  
in Spontaneous Cerebrospinal Fluid Leak Patients**

*Mikayla G. Hubbard, BS; Hunter L. Elms, MD; Douglas J. Totten, MD  
Evan C. Cumpston, MD; Charles W. Yates, MD; Rick F. Nelson, MD, PhD*

**Objective:** Determine superior semicircular canal dehiscence (SSCD) prevalence in lateral spontaneous cerebrospinal fluid leak (sCSFL) patients and assess the predictive value of CT in identifying SSCD.

**Study Design:** Retrospective cohort study.

**Setting:** Tertiary referral center.

**Patients:** sCSFL patients surgically treated between January 2015 and July 2025.

**Interventions:** Preoperative high-resolution CT and middle fossa craniotomy (MCF) skull base repair.

**Main Outcome Measures:** Preoperative CT prevalence of near-dehiscence (1 cut) or definite SSCD ( $\geq 2$ -continuous cuts) and intraoperative near dehiscence (“blue-lined”) or definitive SSCD.

**Results:** One hundred eighty-two MCF repairs were performed on 161 patients (66.0% female). Intraoperative SSCD (7.1%) and “blue-lined” near-dehiscence (9.9%) were both present at lower rates than expected based on CT findings (13.1% SSCD, 12.6% near-dehiscence). Compared to patients with an intact intraoperative superior canal, patients with SSCD or near-dehiscence did not have statistically significant differences in mean  $\pm$  standard deviation age ( $58.7 \pm 11.8$  vs.  $55.0 \pm 10.0$  years), BMI ( $39.2 \pm 9.4$  vs.  $38.9 \pm 9.7$  kg/m<sup>2</sup>), AHI ( $32.4 \pm 32.1$  vs.  $28.7 \pm 33.7$  events/hr), or opening pressure on lumbar puncture ( $23.6 \pm 8.0$  vs.  $24.0 \pm 10.4$  cm H<sub>2</sub>O). Patients with intraoperative SSCD or near-dehiscence were more likely to report dizziness ( $p=0.001$ , OR 4.97, 95%CI 1.71-13.05). CT demonstrated 80.6% sensitivity, 85.4% specificity, 53.1% PPV, and 95.6% NPV in detecting SSCD or near-dehiscent findings.

**Conclusions:** The prevalence of intraoperative SSCD or “blue-lined” near-dehiscence is 17.0% in sCSFL patients, which is 33% lower than predicted by CT. Risk factors known to increase intracranial pressure are not continued risk factors for predicting intraoperative SSCD. CT is optimal at ruling out SSCD in those with sCSFLs but shows lower accuracy in positive identification.

**Learning Objective:** Evaluate SSCD prevalence in those primarily presenting with sCSFL.

**Desired Result:** Elucidate risk factors associated with SSCD in sCSFL patients.

**Level of Evidence:** IV

**Indicate IRB or IACUC:** Indiana University IRB #13133

**Effect of Cochlear Implant Electrode Array to Scala Tympani  
Volume Ratio on Early Hearing Preservation**

*Saangyoung E. Lee, MD; Luke Helpard, PhD; Margaret T. Dillon, AuD, PhD; A. Morgan Selleck, MD  
Nicholas J. Thompson, MD; Matthew M. Dedmon, MD, PhD; Kevin D. Brown, MD, PhD*

**Objective:** Analyze the influence of patient and device variables on the low frequency hearing preservation for cochlear implant (CI) recipients of straight electrode arrays.

**Study Design:** Retrospective Review

**Setting:** Tertiary Care Center

**Patients:** 42 adults with pre-operative unaided hearing thresholds  $\leq 45$  decibel hearing level at 250 Hz.

**Interventions:** Patients underwent cochlear implantation with a 24-, 28-, or 31.5 mm straight electrode array.

**Main Outcome Measures:** A linear mixed effects model analyzed the effects of scala tympani (ST) volume, electrode array volume to ST volume ratio, angular insertion depth (AID), age at surgery, and biologic sex on low frequency pure tone average (LFPTA; 125, 250, & 500 Hz) shifts at CI activation and 6 months post-activation.

**Results:** LFPTA shifts were significantly influenced by ST volume ( $p=0.004$ ), array volume to ST volume ratio ( $p=0.04$ ), and sex ( $p=0.02$ ), with better hearing preservation observed for cases with larger ST volume, smaller array volume to ST volume ratio, and female biological sex. There were no significant main effects of interval ( $p=0.08$ ), age ( $p=0.07$ ), or AID ( $p=0.13$ ).

**Conclusions:** Patient and device variables such as larger ST volume, less array volume to ST volume ratio, female biologic sex are fixed variables that should be considered for hearing preservation in cochlear implantation.

**Learning Objective:** Individual variables, such as scala tympani volume and the ratio of the electrode array volume to scala tympani volume, influence hearing preservation for cochlear implant recipients.

**Desired Result:** The learner will describe how to calculate scala tympani volume and the electrode array volume to scala tympani volume ratio and assess the role of these variables on hearing preservation for cochlear implant candidates with functional low-frequency hearing.

**Level of Evidence:** 3

**Indicate IRB or IACUC:** UNC IRB 09-2328

## Single-Cell RNA Sequencing Analysis of Vestibular Schwannoma Reveals Functionally Distinct Fibroblast Subsets

*Derrick C. Wan, MD; Camille Brenac, MD; Maxime Fieux, MD, PhD; Michael T. Longaker, MD, MBA  
Michael Januszyk, MD, PhD; Konstantina M. Stankovic, MD, PhD; Jennifer C. Alyono, MD*

**Objective:** This meta-analysis aims to define the role of heterogeneous, functionally distinct stromal fibroblast subtypes and their interactions with Schwann cells and immune/inflammatory cell components to better understand how these cells impact VS behavior.

**Background:** While hearing loss is the most common presenting symptom in patients with vestibular schwannoma (VS), tumor size and growth have poorly correlated with degree of severity. Thus, nerve compression alone does not fully explain the hearing loss associated with VS. Tumor development, aggressiveness, and progression are well-recognized as being closely linked to the stromal microenvironment, with complex interactions described between these components.

**Study Design:** We conducted a meta-analysis of four publicly available scRNA-seq datasets representing 28 VS human samples and two nerve controls. Data integration was performed using Harmony, followed by dimensionality reduction for visualization. Differential expression and gene set enrichment analysis were conducted to identify inflammatory markers and pathways involved. Cell-cell interactions were further investigated using CellChat, highlighting key signaling interactions.

**Results:** Five distinct subclusters of tumor-associated fibroblasts were identified with enrichment of inflammatory fibroblasts in tumor samples compared to controls. This group was increased in tumors with greater hearing loss and exhibited elevated NLRP3 inflammasome activity, suggesting these fibroblasts may play a role in tumor-promoting inflammation and tissue damage. Furthermore, this subcluster demonstrated increased intercellular communication with Schwann cells via midkine, a mediator with known role in tumor proliferation, and with immune/inflammatory cells.

**Conclusions:** These findings suggest a potential role for inflammatory fibroblasts in promoting VS tumor behavior leading to hearing loss and identify a previously under recognized cellular subcluster that could serve as a therapeutic target.

**Learning Objective:** To understand fibroblast subgroup functional heterogeneity in vestibular schwannoma and how they may interact with other cellular components in driving tumor behavior.

**Desired Result:** Appreciate fibroblast heterogeneity in tumors and comprehend how specific subsets may impact clinical presentation and be targeted with future therapeutics.

**Level of Evidence** – Does not Apply

**Indicate IRB or IACUC:** Not applicable

## **Audiometric Outcomes of the Middle Cranial Fossa Approach for Tegmen Repair**

*Katelyn Robillard, MD, PhD; Cameron Lindemann, DO; Ethan Hoasjoe, BS  
Lauren Hill, BS; Moises Arriaga, MD*

**Objective:** The primary objective of this study was to determine audiometric outcomes following middle cranial fossa approach for tegmen repair.

**Study Design:** Single-center, retrospective cohort study.

**Setting:** Tertiary referral center.

**Patients:** In a convenience sample of 94 patients (100 cases), 60% were female, and average age at time of surgery was 58 years (range 16 to 79).

**Interventions:** Preauricular infratemporal fossa approach with extradural repair of tegmen defect.

**Main Outcome Measures:** Changes in air conduction pure tone threshold (PTT) and speech reception threshold (SRT).

**Results:** Pure tone and speech audiometry were performed before and after surgery. Average changes in PTTs and SRTs were analyzed using a two-tailed paired t-test. Overall, there was a decrease in PTT from 40.3 to 37.3 dB at 250 Hz ( $p=0.03$ ). In those without encephalocele, there was a decrease in PTT from 38.5 to 30.8 dB at 250 Hz ( $p=0.03$ ). In cases without CSF leak, there was a decrease in PTT from 40.1 to 37.0 dB at 250 Hz ( $p=0.047$ ). In cases without cholesteatoma, there was a decrease in PTT from 38.8 to 35.3 dB at 250 Hz ( $p=0.02$ ). Interestingly, in cases with evidence of cholesteatoma, there was an increase in PTT from 44.6 to 48.8 dB at 2000 Hz ( $p=0.03$ ).

**Conclusions:** These results support our hypothesis that the middle cranial fossa approach leads to stable or improved hearing. Low-frequency improvements were observed in patients without adverse features (e.g., encephalocele, CSF leak, cholesteatoma). While we also expect improvements in those with middle ear effusion due to CSF leak, this was not demonstrated in the current study, likely due to low power ( $n=14$ ). The increased air conduction threshold in patients with cholesteatoma may represent a conductive hearing loss due to progression of disease in the months following surgery or compression of middle ear structures in a newly closed cavity.

**Learning Objective:** Readers should be able to identify changes in pure tone audiometry that demonstrate stable hearing outcomes following surgery to repair tegmen defects.

**Desired Result:** Increase patient and provider awareness of the safety of middle cranial fossa approach for tegmen repair.

**Level of Evidence:** Level III

**Indicate IRB or IACUC:** IRB #581, LSU Health Sciences Center – New Orleans

## Procedural Technique and Position Confirmation Tests for Apical Electrode Placement

*Justin Cottrell, MD; David Landsberger PhD; Arianna Winchester, MD  
William Shapiro, Au; Sean McMenomey, MD; J. Thomas Roland Jr., MD*

**Objective:** The placement of a standard electrode array with an additional electrode placed into the cochlear apex has demonstrated lower pitch perception in patients. We sought to describe a reproducible surgical technique for accurate apical cochleostomy and ground-electrode placement during cochlear implantation in patients with normal anatomy, and to review how placement quality can be assessed using intraoperative methods.

**Study Design:** Cadaveric dissection study with integration of translational procedural and post-operative performance validation.

**Setting:** Tertiary academic center.

**Patients:** Human cadaveric temporal bone specimens and representative surgical cases from cochlear implant recipients that underwent apical electrode placement.

**Interventions:** Stepwise apical cochleostomy technique based on radiologic measurements are employed and documented to insert a ground electrode (ECE1) into the helicotrema. Placement quality is assessed with further cadaveric analysis, intra-operative x-ray, and current spread measurements. Pitch perception utilizing the apical ground was correlated with intra-operative measures.

**Main Outcome Measures:** Accuracy of cochleostomy placement, absence of injury to the facial nerve or carotid canal, and electrophysiologic evidence of apical current modulation.

**Results:** Cadaveric analysis demonstrated 100% accuracy in achieving precise apical cochleostomy placement, without injury to surrounding structures. Translating these improved procedural steps to cochlear implant recipients demonstrated improved performance and current modulation ability utilizing intra-operative and post-operative assessments. Current spread measures appear superior to x-ray for confirming adequate apical electrode placement.

**Conclusions:** A defined procedural framework coupled with real-time confirmation tools at the time of surgery can improve apical electrode placement accuracy. Improved placement consistency will assist in future study of the benefit apical electrode placement may provide cochlear implant patients.

**Professional Practice Gap & Educational Need:** Research is currently underway to study how standard electrode insertion, and placement of an apical electrode, can help shift current towards the apex and improve low frequency pitch perception. Limited literature exists to facilitate a safe and accurate apical electrode placement, in addition to intraoperative placement confirmation. This information is important for improving placement safety, and consistency to facilitate interpretation of surgical outcomes.

**Learning Objective:** To understand how an accurate apical cochleostomy can be made, and how to confirm adequate apical electrode placement at the time of surgery.

**Desired Result:** Improve the surgical consistency and safety of apical electrode placement, and allow for intra-operative confirmation that improves the quality of study in this area of research

**Level of Evidence** - Level IV

**Indicate IRB or IACUC:** IRB# i25-00378

**Sex-Based Differences in Quality of Life for Vestibular Schwannoma Patients  
Among Observation, Microsurgery, and Radiation**

*Nader G. Zalaquett, MD; Christine M. Lohse, MS; Michael J. Link, MD  
Matthew L. Carlson, MD, MBA*

**Objective:** Quality of life (QOL) is an important consideration in vestibular schwannoma (VS) patients when assessing management options. Understanding sex-based differences in QOL may facilitate patient counseling.

**Study Design:** Prospective cohort

**Setting:** Mayo Clinic and Acoustic Neuroma Association

**Patients:** Vestibular Schwannoma patients

**Interventions:** Observation, radiation, or microsurgery

**Main Outcome Measures:** Penn Acoustic Neuroma Quality of Life (PANQOL) scores

**Results:** A total of 481 patients were analyzed. In the observation group, women reported worse anxiety (66 vs. 81,  $p=0.001$ ), facial function (81 vs. 90,  $p=0.02$ ), and total (66 vs. 73,  $p=0.03$ ) PANQOL scores at baseline. At follow-up, men declined more in facial function ( $-5$  vs.  $+3$ ,  $p=0.01$ ). For microsurgery, women reported worse facial function and balance at baseline. At follow-up, men declined more in facial function ( $-16$  vs.  $-3$ ,  $p<0.001$ ), balance ( $-7$  vs.  $+2$ ,  $p=0.04$ ), energy ( $-4$  vs.  $+5$ ,  $p=0.03$ ), and total ( $-5$  vs.  $+2$ ,  $p=0.02$ ) PANQOL scores. For radiation, women reported worse anxiety, balance, pain, and total scores at baseline. At follow-up, anxiety improved in women ( $+5$ ) but worsened in men ( $-6$ ,  $p=0.008$ ). Three sex-based differences exceeded minimally important difference thresholds established for the PANQOL: anxiety at baseline in radiation, balance at baseline in radiation, and balance at follow-up in radiation.

**Conclusions:** Women at baseline had worse anxiety, balance, pain, and overall QOL assessed using the PANQOL, whereas men declined more with treatment and observation. The largest difference in PANQOL change between sexes occurred after microsurgery, with men experiencing greater losses in facial function, balance, energy, and total scores.

**Learning Objective:** Among patients with vestibular schwannoma, women reported worse baseline PANQOL scores, while men experienced greater declines in PANQOL scores after treatment and observation, especially after microsurgery.

**Desired Result:** NA

**Level of Evidence** – Level III

**Indicate IRB or IACUC:** IRB protocol 14-009331



## Virtual and Augmented Reality Applications in Cochlear Implant Workup and Aural Rehabilitation: A Scoping Review

*Andrew L. S. Thornton, BA; Jack Lin, BS; Aaron C. Moberly, MD*

**Objective:** To describe current use of virtual reality and augmented reality (VR/AR) technologies in the preoperative workup, postoperative assessment, and aural rehabilitation of cochlear implant (CI) patients.

**Data Sources:** Searches were performed in PubMed and Embase for English-language, human studies (2000–present) using keywords related to hearing loss, cochlear implantation, and immersive or extended reality.

**Study Selection:** Eligible studies used VR, AR, mixed, or extended reality technologies in CI care, specifically for preoperative counseling, postoperative assessment, or postoperative aural rehabilitation. Two reviewers independently screened titles and abstracts for inclusion.

**Data Extraction:** Thirty-three studies met inclusion criteria (PubMed = 10, Embase = 18, hand-searched = 5). Seven studies overlapped across databases, yielding 26 unique studies. Data were extracted on study design, population, technology platform, and intervention domain. Each study was categorized as focusing on preoperative workup, postoperative rehabilitation, or general hearing applications related to cochlear implantation.

**Results:** Approximately three-quarters of studies focused on postoperative assessment and/or aural rehabilitation, and one-quarter addressed preoperative education or counseling. Most studies (69%, n=18) were pilot or proof-of-concept investigations involving adults or older children, with a smaller proportion designed as randomized controlled trials (15%, n=4).

Preoperative simulations supported counseling and decision-making. VR-based auditory and spatial-hearing training programs (e.g., *BEARS*, *HELIX*, *EarVR*) improved localization accuracy and reduced listening effort. AR wearables enhanced real-world communication and environmental awareness. Across studies, heterogeneity in design, outcome measures, and technology limited direct comparison and evidence synthesis.

**Conclusions:** VR and AR tools show promise for improving CI patient education and aural-rehabilitation outcomes through immersive, interactive experiences. Standardized protocols and validated outcome measures are needed to evaluate real-world efficacy and support clinical integration.

**Learning Objective:** Summarize and evaluate existing uses of VR/AR in CI workup and rehabilitation.

**Desired Result:** Promote evidence-based adoption of immersive technologies to enhance patient engagement and hearing outcomes.

**Level of Evidence:** V

**IRB:** Exempt

## Growth Trends in Neurotology Fellowship Training

*Andrew L.S. Thornton, BA; Alexander Chern, MD  
Jenny X. Chen, MD, EdM; Margaret B. Mitchell, MD, MS-HPed*

**Objective:** To evaluate trends in the growth of neurotology fellowships compared to otolaryngology residency programs

**Study Design:** Retrospective longitudinal analysis of national training program data

**Setting:** Accreditation Council for Graduate Medical Education (ACGME)-accredited otolaryngology and neurotology fellowship programs in the United States

**Patients/participants:** All neurotology fellows and otolaryngology residents from 2017-2024

**Interventions:** Not applicable

**Main Outcome Measures:** Program, fellow, faculty counts, and trainee demographics were collected. Percent change and compound annual growth rate (CAGR) were analyzed in parallel with otolaryngology residency.

**Results:** From 2017-2024, the total number of ACGME-accredited neurotology fellowship programs steadily increased from 23 to 29 (+26%, CAGR 3.4%/yr) and fellows from 29 to 39 (+35%, 4.3%/yr). This significantly outpaced otolaryngology residency growth, with which increased from 1,592 to 1,846 total residents (+16%, 2.1%/yr,  $p < 0.001$ ). Over the last 5 years, an increasing amount of otolaryngology residents have subspecialized (13.8% to 17.9%).

Since 2017, total neurotology faculty expanded from 126 to 146 (+16%, 2.1%/yr), on pace with overall otolaryngology faculty expansion (2,518 to 2,917, +16%, 2.1%/yr). Mean neurotology faculty per program decreased slightly (5.5→5.0).

Female representation in neurotology fellowships rose from 27.6% to 41.0% (5.8%/yr), approaching that of otolaryngology residency programs. With regard to racial and ethnic diversity, while most fellows identify as White (>50%), Asian and Hispanic representation increased over this time (from 13.8% to 25.6% and 3.5% to 10.3%), respectively).

**Conclusions:** Neurotology fellowship capacity and faculty have seen modest expansion since 2017, with notable improvements in female representation. The growth of neurotology fellows has outpaced the growth in otolaryngology residents. Future studies should examine post-training workforce trends and assess the otologic and neurotologic needs of the aging U.S. population.

**Learning Objective:** To describe national growth and demographic trends in neurotology fellowships and contextualize them within otolaryngology training.

**Desired Result:** Recognize workforce trends and identify opportunities to better address evolving population needs.

**Level of Evidence:** III

**IRB or IACUC:** Exempt

## Audiometric Outcomes following Surgical Repair of Cerebrospinal Fluid Leaks

*Vivienne E. Pham, BS; Zheng Hong Tan, PhD; Ada Sher, MD; Oliver F. Adunka, MD MBA  
Desi P. Schoo, MD; Yin Ren, MD PhD; Robert J. Macielak, MD*

**Objective:** To compare audiologic outcomes following surgical repair of temporal bone cerebrospinal fluid (CSF) leaks via either a transmastoid or middle cranial fossa (MCF) approach

**Study Design:** Retrospective case series

**Setting:** Tertiary referral center

**Patients:** Patients presenting with primary CSF leaks involving the temporal bone undergoing surgical repair between January 2017 and August 2024

**Interventions:** CSF leak repair via a transmastoid or MCF approach

**Main Outcome Measures:** Pre- and postoperative four-frequency air-conduction (AC) pure-tone average (PTA), bone-conduction (BC) PTA, and PTA air-bone gap (ABG) in the operative ear

**Results:** Forty-one patients were identified, with 16 patients (39.0%) undergoing a transmastoid approach and 25 patients (61.0%) undergoing a MCF approach for CSF leak repair. Before transmastoid repair, the average AC-PTA, BC-PTA, and PTA ABG were 40.4 dB HL (standard deviation [SD]=13.7), 21.2 dB HL (SD=11.0), and 19.1 dB HL (SD=9.33), respectively, and after surgery, the average AC-PTA, BC-PTA, and PTA ABG were 35.9 dB HL (SD=19.2), 21.9 dB HL (SD=16.4), and 14.1 dB HL (SD=8.51), respectively. Considering these values, there was a significant decrease in PTA ABG after surgery in the transmastoid cohort ( $p=0.0419$ ). Before MCF repair, the average AC-PTA, BC-PTA, and PTA ABG were 33.9 dB HL (SD=15.3), 21.8 dB HL (SD=12.5), and 12.1 dB HL (SD=11.3), respectively, and after surgery, the AC-PTA, BC-PTA, and PTA ABG were 34.0 dB HL (SD=20.8), 22.2 dB HL (SD=11.8), and 11.9 dB HL (SD=14.8), respectively. Considering these values, there was no significant change in the PTA ABG in the MCF cohort ( $p=0.932$ ). When comparing pre- and post-operative PTA ABG change between these cohorts, there was no significant difference ( $p=0.189$ ) between the transmastoid approach (-5.07 dB HL [SD=9.11]) and the MCF approach (-0.242 dB HL [SD=14.0]).

**Conclusions:** While there was noted to be a significant decrease in PTA ABG in the transmastoid cohort, the clinical significance is likely limited given test-retest variability in pure-tone audiometry. Acknowledging this, neither approach to CSF leak repair provides substantial audiometric improvement despite initial documented hearing loss.

**Professional Practice Gap & Educational Need:** The audiometric outcomes after temporal bone cerebrospinal fluid leak repair remain poorly studied.

**Learning Objective:** To identify if there is any audiometric benefit to cerebrospinal fluid leak repair via either a transmastoid or middle cranial fossa approach.

**Desired Result:** That providers will understand the limited audiometric benefit of cerebrospinal fluid leak repair, which will help in clinical decision making and patient counseling.

**Level of Evidence** - Level IV

**Indicate IRB or IACUC:** The Ohio State University IRB Protocol # 2024H0277

## Exploration of Comorbidities and Vestibular Testing in a Criteria Confirmed Vestibular Migraine Cohort

*Bryce Kassalow, BA; Michell, Lee Parlett, BS, MS; Catalina Argandona Lopez, BS  
Charles Keilin, MD; Christopher Welch, MD, PhD*

**Objective:** To determine common comorbidities in a cohort of patients with International Classification of Headache Disorders (ICHD-3) criteria-confirmed Vestibular Migraine (VM), with assessment of the diagnostic utility of formal vestibular testing in this population.

**Study Design:** Cross-sectional case-control study

**Patients:** Comorbidity analysis included all Michigan Medicine patients between 2010 and 2020 whose charts contained ICD-10 codes R42 and G43.909 for “dizziness and giddiness” and “migraine, unspecified, not intractable, without status migrainosus” (n=6440). Vestibular testing analyses included the subset of this cohort that underwent vestibular testing at the University of Michigan (n=263) and compared those who met ICHD-3 criteria (N=120) with those that did not (n=142). Our cohort was predominantly female (79%) and Caucasian (83%).

**Setting:** Tertiary referral center

**Interventions:** Diagnostic

**Main Outcome Measures:** Vestibular testing results in multiple domains, quantitative continuous variables, and demographic data

**Results:** Compared to a large control (n=4,006,687), our broad VM cohort had significantly higher prevalence of multiple comorbidities, including but not limited to Celiac disease (OR=7.14, 95% CI [5.68,9.09]) and POTS (OR=30.3, 95% CI [24.04,38.25]). There were no statistically significant differences in frequencies of vestibular testing abnormalities between criteria-confirmed VM patients and controls utilizing chi-squared tests with Bonferroni correction (positional nystagmus, spontaneous nystagmus, caloric testing, rotational chair abnormalities, and Dix-Hallpike testing all yielded  $p > .05$ ). There was also no intergroup difference in distribution of caloric asymmetry ( $K-S$  Statistic: 0.07,  $p=.87$ ) or preponderance ( $K-S$  Statistic: 0.15,  $p=.22$ ).

**Conclusions:** We found no significant difference in vestibular testing results between patients with ICHD-3 criteria-confirmed VM and controls who did not meet criteria, whereas typical diagnostic criteria and comorbid conditions may be more highly predictive of the condition.

**Learning Objective:** To determine the utility of assessment of comorbid conditions and vestibular testing in diagnosing vestibular migraine

**Desired Result:** By informing clinicians of the diagnostic value, or lack thereof, of formal vestibular testing in patients with criteria-confirmed vestibular migraine, we hope to help this patient population avoid unnecessary testing and allow clinicians to provide more cost-effective care.

**Level of Evidence – Level IV**

**Indicate IRB or IACUC:** HUM00257250, University of Michigan

## A Longitudinal Volumetric Analysis of Near-Total Resection of Vestibular Schwannoma

*Krish Suresh, MD; Michael Brandel, MD; Alireza Zonnour, MD; Eric Cunningham, MD  
Abhishek Bhatt, MD; Rick Friedman, MD, PhD; Marc Schwartz, MD*

**Objective:** 1) Establish a volumetric basis for near-total resection (NTR), 2) analyze volumetric growth after NTR and associated risk factors.

**Study Design:** Retrospective study

**Setting:** Tertiary referral center

**Patients:** 88 patients with sporadic vestibular schwannoma, mean age 50 years.

**Interventions:** Microsurgery with a single surgical team resulting in NTR, determined intraoperatively as a thin layer of tumor left along an adherent interface.

**Main Outcome Measures:** 1) Volumetric growth defined as 10% increase on surveillance magnetic resonance imaging (MRI) compared to baseline postoperative MRI. 2) Need for salvage radiation. 3) Long-term facial nerve function.

**Results:** 88% underwent translabyrinthine surgery; 12% retrosigmoid. Mean preoperative tumor volume was 11.1 cm<sup>3</sup> (SD 10.4). Mean baseline postoperative tumor volume was .183 cm<sup>3</sup> (SD .223); mean percentage of residual tumor was 2.1%. 24 patients (27%) had no appreciable tumor on baseline postoperative MRI. Survival analysis with event defined as 10% volumetric growth resulted in 8 patients experiencing growth at mean 2.5 years; 2-year progression free survival (PFS) was 92%, 5-year PFS 73%. On univariate Cox proportional hazards analysis, retrosigmoid approach was associated with tumor growth (hazard ratio 6.86, p=0.04); 2/8 events were retrosigmoid and notable for preserved cochlear nerve. Survival analysis with event defined as salvage radiation found 5 patients undergoing radiation at mean 4 years; 2-year PFS was 98%, 5-year PFS 85%. Cox analysis found no significant associations. On long-term facial nerve follow-up (mean 2 years), 73% had House-Brackmann (HB) I-II function, 17% HB III, 10% HB IV-VI.

**Conclusions:** NTR has been defined as >95% tumor removal by volume, and this is consistent with our volumetric analysis finding mean 2.1% residual tumor. Retrosigmoid approach with preservation of eighth cranial nerve for hearing preservation may increase risk of tumor growth after NTR.

**Learning Objective:** To understand a volumetric basis for NTR and volumetric progression after NTR with associated risk factors.

**Desired Result:** Attendees will appreciate a more rigorous definition of NTR and risks of regrowth associated with NTR.

**Level of Evidence - III**

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

## Longitudinal Correlation of Hearing Loss and Cochlear Protein Precipitates in *NF2*-SWN Mouse Models

*Isam A. Naber, MD; Marco Giovannini, MD, PhD*  
*Jeremie Vitte, PhD; Christian M. Kabongo, BS*

**Hypothesis:** Our hypothesis is that accumulation of proteins in the inner ear fluid contributes to hearing loss (HL) in *NF2*-related schwannomatosis (*NF2*-SWN) mouse models and mirrors the pathophysiology of patients with vestibular schwannoma (VS).

**Background:** HL in patients with VS does not consistently correlate with tumor size, suggesting mechanisms beyond nerve compression. High-resolution FLAIR MRI showed elevated cochlear signal and intralabyrinthine protein in 94% of ears with VS and HL. Histological studies confirm proteinaceous precipitates within the cochlear spaces, supporting a possible contribution to HL pathogenesis.

**Methods:** Hearing levels of two *NF2*-SWN mouse models (*P0-NF2<sup>Δ2-3</sup>* and *Postn-Cre;Nf2<sup>lox/lox</sup>*) and their control littermates were determined using tone-burst ABR at 3, 6, 9, and 12 months of age. Protein precipitates extent was evaluated on H&E-stained sections from one temporal bone. Contralateral cleared cochleae were immunolabelled to assess hair cell, SGNs and Schwann cell changes. Perilymph was collected for proteomic profiling by mass spectrometry.

**Results:** At 6 months, *Postn-Cre;Nf2<sup>lox/lox</sup>* mice exhibited significant threshold elevations compared to *Nf2<sup>lox/lox</sup>* littermates, and progressed to a wider spectrum of frequencies at 9 months.

**Conclusions:** *Postn-Cre;Nf2<sup>lox/lox</sup>* mice demonstrated a progressive HL compared to controls. Further histological analyses will identify the association of this phenotype with cellular damages caused by an imbalance in protein homeostasis.

**Learning Objective:** To understand if the protein precipitation in inner ear fluids in *NF2*-SWN mouse models contributes to progressive cochlear injury and HL.

**Desired Result:** The progression of HL correlates with the natural history of protein precipitation in cochlear spaces in *NF2*-SWN mouse models.

**Level of Evidence:** Level III

**Indicate IRB or IACUC:** UCLA IACUC #ARC-2019-018.

## **Reconsidering the Management of Middle Ear Myoclonus: A Case Series Presentation and Systematic Review of Surgical Outcomes following Lysis of the Tensor Tympani and Stapedial Tendons**

*Daniel Swanson, MD; Christina L. Zhu, BS; Mona Dabbas, BS; Richa Nathan, BS  
Selena E. Briggs, MD, PhD, MBA; Michael Hoa, MD; H. Jeffrey Kim, MD*

**Objective:** To present a case series of two patients and three ears undergoing surgical intervention for middle ear myoclonus (MEM) and to emphasize that lysis of the tensor tympani (TT) and/or stapedial tendons (ST) should be considered among first-line treatment options

**Data Sources:** A systematic search of MEDLINE, Embase, CENTRAL, and Web of Science was performed for English-language studies published prior to August 2025 using the keywords “myoclonus,” “tinnitus,” “middle ear,” “tensor tympani,” “stapedius,” “surgical management,” and related terms.

**Study Selection:** A total of 756 articles were screened based on title and abstract with 17 articles describing medical and/or surgical management of MEM selected for full-text review.

**Data Extraction:** Two independent reviewers (CZ, DS) extracted data on patient demographics, symptom duration, prior medical therapy, therapeutic response, surgical procedure (lysis of ST, TT, or both), surgical technique (cold steel vs. laser), laterality, and postoperative outcomes.

**Data Synthesis:** Descriptive statistical analysis was performed to summarize management strategies and clinical outcomes

**Conclusions:** All three of our surgical ears treated with lysis of both TT and ST experienced complete resolution in their middle ear myoclonus in the respective ear. Among the 72 total patients in our review with MEM who received surgical intervention, 60 patients (83.3%) previously tried anticonvulsants and/or muscle relaxants prior to surgical intervention, while 12 patients (16.7%) proceeded with surgery as an initial treatment. Complete symptom resolution occurred in 67 patients (93.1%), partial improvement in four patients (5.5%), and recurrence of symptoms in one patient (1.4%). No surgical complications were reported. Lysis of the ST and/or TT is a safe and effective intervention associated with high rates of symptom resolution. Patients should be informed of the high likelihood of complete symptom resolution with surgical intervention in this condition.

**Learning Objective:** To recognize lysis of the TT and/or ST as effective surgical options for middle ear myoclonus.

**Desired Result:** To increase knowledge of the high likelihood of complete symptom resolution of middle ear myoclonus when treated surgically with lysis of the tensor tympani and/or stapedial tendons.

**Level of Evidence - V**

**Indicate IRB or IACUC:** IRB STUDY00009516, Medstar Georgetown University Hospital IRB, approved 7/14/2025

## **Obstructive Sleep Apnea in Patients Undergoing Lateral Skull Base Cerebrospinal Fluid Leak Repair: Prevalence and Postoperative Outcomes**

*Ritu R. Trivedi, BA; Dhillon R. Advano, BS; Antara Gupta, BS  
J. Walter Kutz Jr, MD; Rance J.T. Fujiwara, MD, MBA*

**Objective:** To evaluate the prevalence of obstructive sleep apnea (OSA) in patients undergoing lateral skull base cerebrospinal fluid (CSF) leak repairs and assess its impact on postoperative outcomes

**Study Design:** Retrospective review

**Setting:** Single-institution tertiary care center

**Patients:** 178 adult patients who underwent lateral skull base repair for CSF leaks between May 2013 and June 2024 were included. 64 (36%) patients were male with a median age of 59 years [IQR: 50-68].

**Interventions:** CSF leak repairs via transmastoid and/or middle fossa craniotomy

**Main Outcome Measures:** The diagnosis of OSA was determined based on reported history and available sleep study data. Postoperative outcomes included occurrence of revision surgery, symptom resolution, and postoperative migraine.

**Results:** 83 patients (47%) had a diagnosis of OSA, and 54 patients (30%) reported using continuous positive airway pressure (CPAP) therapy. Among the 36 patients with available sleep study data, the median apnea-hypopnea index (AHI) was 17 [IQR: 6-25] while patients with confirmed OSA had a median AHI of 19 [IQR: 7-27, n=31]. The majority of OSA patients (92%) had idiopathic CSF leaks, with smaller proportions attributed to iatrogenic (6%) and traumatic (1%) causes. There were no significant differences in leak etiology or leak location between patients with and without OSA. In terms of outcomes, OSA status did not significantly affect symptom resolution or the incidence of postoperative headaches. Similarly, CPAP use was not associated with differences in revision surgery rates, symptom resolution, leak etiology, or leak location.

**Conclusions:** While OSA is highly prevalent in patients with lateral skull base CSF leaks, it does not appear to significantly influence surgical outcomes or leak characteristics.

**Learning Objective:** To learn about the prevalence and effect of OSA on postoperative outcomes after a lateral skull base CSF leak repair

**Desired Result:** To guide counseling for patients with OSA who are undergoing lateral skull base CSF leak repair

**Level of Evidence** - Level IV

**Indicate IRB or IACUC:** University of Texas Southwestern Institutional Review Board; STU-2024-0631



## Declining Reimbursements and Rising Volumes: Trends in Medicare-Funded Cochlear Implantation in the United States

*Ashwin Jhawer, BS; Andrew Liu, BA; Divya A. Chari, MD*

**Objective:** To assess whether regional variations in Medicare reimbursement are associated with differences in the number of cochlear implant (CI) surgeries performed.

**Study Design:** Cross-sectional analysis

**Setting:** Medicare B National Summary Files

**Patients:** Medicare B fee-for-service (FFS) beneficiaries who underwent CI surgery from 2017 to 2023.

**Intervention:** Cochlear implantations (current procedural terminology code 69930).

**Main Outcome Measures:** Descriptive statistics of national, state, and regional (Northeast, Midwest, West, South) reimbursement trends were performed. Mixed-effects linear regression models of reimbursement rate with primary outcome CI rate per million FFS beneficiaries per surgeon were performed.

**Results:** 15,548 CI surgeries were included for analysis. From 2017 to 2023, the number of CI surgeries performed nationally increased from 2,074 to 2,895, while the average inflation-adjusted provider reimbursement per CI declined from \$1,168.76 to \$960.08. The Northeast demonstrated the greatest average reimbursement per surgeon, while the West had the highest CI rate. Mixed-effects regression models demonstrated a positive trend between reimbursement and CI rates across regions, although this result was not statistically significant ( $\beta=0.02$ ;  $p=0.27$ ; 95% CI [-0.02, 0.07]). Being in the top quartile of CI reimbursements was associated with higher CI rates across regions and states, although this result was also not statistically significant (region:  $\beta=5.23$ ;  $p=0.49$ ; 95% CI [-9.57, 20.03], state-level:  $\beta=1.58$ ;  $p=0.604$ ; 95% CI [-4.42, 7.59]).

**Conclusions:** Despite declining Medicare reimbursements for cochlear implantation, national CI volumes continued to rise. While higher reimbursement levels trended towards greater utilization, this relationship was not statistically significant, suggesting that factors beyond payment, such as referral patterns, surgeon availability, and patient demand, may play a role in driving access to CI.

**Learning Objective:** To examine how declining Medicare reimbursements and regional payment variation influence trends in cochlear implantation.

**Desired Result:** Identification of whether financial incentives or other non-reimbursement factors drive regional differences in cochlear implant use.

**Level of Evidence – Level IV**

**Indicate IRB or IACUC:** Exempt.

**Long-Term Cochlear Implant Outcomes and Management in Patients Treated with Radiation and Chemotherapy for Childhood Medulloblastoma**

*Wonhee Lee, MS; Matthew Kircher, MD; John Leonetti, MD  
Matthew Carlson, MD, MBA; Karl Khandalavala, MD*

**Objective:** To evaluate long-term cochlear implant (CI) outcomes and postoperative complications in patients who underwent radiation therapy and chemotherapy for medulloblastoma during childhood.

**Study Design:** Retrospective multi-institutional chart review.

**Setting:** Tertiary referral centers.

**Patients:** Patients with a history of childhood medulloblastoma treated with cranial radiation and chemotherapy who subsequently underwent cochlear implantation between 1989 and 2025.

**Interventions:** Cochlear implantation and postoperative management in patients with prior cranial chemoradiation exposure.

**Main Outcome Measures:** Speech-perception outcomes, wound-related complications, device longevity, and reconstructive strategies following CI in irradiated patients.

**Results:** Preliminary review identified approximately ten patients meeting inclusion criteria. The analysis focuses on long-term CI performance and the incidence, timing, and management of wound complications such as flap breakdown, infection, and device exposure. Previous literature on irradiated CI recipients has been limited by short follow-up and smaller sample sizes, often reporting higher complication rates in central nervous system pathology cohorts compared with head and neck malignancies. This study extends current evidence by characterizing outcomes after more than a decade of follow-up, the longest evaluation to date in literature, assessing device durability, delayed wound events, and reconstructive management strategies in post-radiation medulloblastoma survivors.

**Conclusions:** Cochlear implantation following childhood cranial irradiation for medulloblastoma is feasible and provides meaningful hearing restoration, but wound complications are more frequent and may occur years after implantation. Long-term follow-up is critical to identify delayed failures and to optimize reconstructive strategies that preserve device function and improve patient quality of life.

**Learning Objective:** To understand long-term cochlear implant outcomes and management of wound-related complications in patients who received childhood cranial radiation for medulloblastoma.

**Desired Result:** Attendees will recognize risk factors for postoperative complications in irradiated patients and apply multidisciplinary, long-term management strategies to optimize CI success and wound-healing outcomes.

**Level of Evidence** - Level IV – Case series (retrospective chart review)

**Indicate IRB or IACUC:** SUBMITTED - Loyola University Chicago Health Sciences Division IRB #LU 220072

## Adjuvant Radiotherapy Following Lateral Temporal Bone Resection A Multi-National Database Study

*Matthew D. Adams, MD; Andrés Gorbea Dolagaray, MD; LeeAnn T. Marcello, BS*

**Objective:** To elucidate the impact of adjuvant radiotherapy (RT) on overall survival within 12 weeks of lateral temporal bone resection (LTBR), and investigate the rates of complications.

**Study Design:** Retrospective cohort study of the TriNetX database.

**Setting:** TriNetX is a live HIPAA-compliant federated cloud electronic health record research network representing pooled data from 125-million patients from 69 healthcare organizations in the United States.

**Patients:** Subjects with temporal bone neoplasms who underwent LTBR. Cohorts were generated by those who did or did not receive adjuvant RT. Patients were matched 1:1 using propensity score matching for demographics, medical comorbidities, Eastern Cooperative Oncology Group (ECOG) score, and TNM staging.

**Main Outcome Measures:** Five-year overall survival; hazard ratio (HR) and risk ratio (RR) with 95% confidence intervals; rates of complications.

**Results:** 651 patients were identified, 547 patients treated with LTBR alone and 104 treated with LTBR and RT. In the LTBR group, 12 patients developed post-operative meningitis and 27 patients had bone-anchored hearing aid placement. After propensity score matching, 93 patients were identified in each cohort. There was no difference in age or sex between groups. Five-year overall survival was similar between cohorts (65.5% in LTBR alone vs 64.3% in LTBR and RT, HR 0.937, 95% CI 0.527 - 1.668,  $p = 0.751$ ). There was no increased risk for facial nerve palsy between groups (RR 1.016, 95% CI 0.490 - 2.110). The rates of meningitis, CSF leak, and bone-anchored hearing aid placement were not detectable after propensity-score matching.

**Conclusions:** This study supports that RT imparts no added overall survival benefit in patients with temporal bone neoplasia undergoing LTBR, and does not increase the risk of facial nerve palsy.

**Learning Objectives:** 1. Understand the impact of adjuvant RT following LTBR in a patient-matched, multi-national database study, 2. Learn the rates of associated complications and trends in hearing rehabilitation.

**Desired Result:** Clarification of treatment paradigms of temporal bone neoplasia following LTBR and their consequences may improve neurologic and multidisciplinary care. We hope to motivate future studies on the role of adjuvant therapies in lateral temporal bone neoplasia following LTBR.

**Level of Evidence** – Level III.

**Indicate IRB or IACUC:** Exempt.

**Magnetic Resonance Imaging Artifact Associated with the Oticon Sentio  
Transcutaneous Bone Conduction Hearing Implant**

*Theresa B. Hennesy, MD; David A. Zander, MD; Theodore J. Kryzer, BS; Justin M. Honce, MD  
Matthew L. Carlson, MD, MBA; Ashley M. Nassiri, MD, MBA*

**Hypothesis:** Magnetic Resonance (MR) imaging of the temporal bone will be hindered after implantation with an Oticon Sentio Ti bone conduction implant (BCI), which may be partially addressed with metal mitigation techniques.

**Background:** Prior studies have demonstrated that transcutaneous BCIs create significant artifact and distortion on MR imaging. This artifact limits the ability to use MR for surveillance of cholesteatoma or vestibular schwannoma. Since its FDA clearance in July 2024, no published studies have evaluated the MR artifact of the Oticon Sentio device.

**Methods:** One cadaveric head specimen was unilaterally implanted with a Sentio bone conduction device according to manufacturer instructions. MR imaging was performed with a Siemens 1.5 Tesla MRI on XA60 software before and after implantation. Imaging was performed with both standard and metal mitigation techniques. Image scoring (diagnostic vs. non-diagnostic image) and qualitative assessment were performed by two experienced neuroradiologists according to anatomical subsites.

**Results:** Image distortion and artifact were noted in all post-implant imaging sequences. For all sequences, imaging of the ipsilateral middle ear, mastoid, and internal auditory canal (IAC) was nondiagnostic. The Axial T1 Turbo Spin Echo (TSE) high bandwidth sequence had the best artifact reduction; however, the ipsilateral temporal bone remained non-diagnostic. Non-echo planar diffusion-weighted imaging (non-EPI DWI) is nondiagnostic for the ipsilateral temporal bone and the contralateral IAC and middle ear.

**Conclusions:** After implantation of the Oticon Sentio device, the ipsilateral temporal bone is rendered non-diagnostic on all MR sequences due to artifact. The non-EPI DWI HASTE sequence, used for cholesteatoma identification, is nondiagnostic for all ipsilateral and most contralateral temporal bone subsites, which is noteworthy as this implant is commonly used for hearing loss following cholesteatoma treatment.

**Learning Objectives:** Name the anatomical subsites of the temporal bone that are not reliably imaged with MR after implantation with Oticon Sentio. Understand that artifact is maximally reduced with the Axial T1 TSE high bandwidth sequence.

**Desired Result:** Physicians and audiologists would understand the expected extent of MR artifact created by the Oticon Sentio device and consider this in patient selection for transcutaneous bone conduction hearing devices and preoperative counseling.

**Level of Evidence:** V

**Indicate IRB or IACUC:** Exempt

## Tegmen Dehiscence – Predictors of Otic Meningitis and Operative Intervention

*Zachary A. Kons, MD; Carleton E. Corrales, MD*

**Objective:** To identify risk factors for otic meningitis and determinants of surgical management in tegmen tympani and/or tegmen mastoideum dehiscence.

**Study Design:** Retrospective chart review.

**Setting:** Single surgeon practice, single institution.

**Patients:** 63 adults (35F/28M; mean age 53.6±13.3 years; BMI 31.2±6.4 kg/m<sup>2</sup>) evaluated for tegmen dehiscence.

**Interventions:** Retrospective chart review of existing medical records. No study-directed interventions.

**Main Outcome Measures:** Development of otic meningitis and receipt of operative repair. Covariates included demographics, comorbidities (HTN, diabetes, IIH, OSA with CPAP, ETD, CSOM), presenting signs/symptoms, and CT findings. Univariable logistic regression reported odds ratios with 95% CIs and two-sided p values.

**Results:** Otic meningitis occurred in 13/63 (21%); 48/63 (76%) underwent repair. Headache and vision changes at presentation were associated with higher odds of meningitis ( $p=0.005$  and  $0.036$ ), whereas hearing loss was associated with lower odds ( $p=0.023$ ). No presenting sign/symptom significantly predicted undergoing repair. No comorbidity significantly predicted meningitis or operative management, though OSA trended toward greater odds of surgery ( $p=0.071$ ). Encephalocele trended toward lower meningitis odds ( $p=0.064$ ); no CT variable reached significance for meningitis. Concurrent tympani+mastoideum dehiscence predicted repair ( $p=0.040$ ), mastoideum-only predicted nonoperative management ( $p=0.020$ ).

**Conclusions:** In this single-institution cohort, headaches and vision changes identified patients at higher meningitis risk, while hearing loss suggested lower risk. Patterns of CT dehiscence, but not comorbidities, were associated with surgical management. Larger multi-institutional studies are needed to refine predictors and guide standardized indications for repair.

**Learning Objective:** Identify clinical and imaging predictors of otic meningitis and of operative repair in patients with tegmen dehiscence for risk stratification.

**Desired Result:** Determine presenting features, comorbidities, and radiographic findings that affect meningitis risk and correlate with operative management, enabling more effective counseling and management of these patients.

**Level of Evidence – Level III**

**Indicate IRB or IACUC:** IRB Approval 2025P002055

**Assessing Chronic Post-Treatment Dizziness in the Vestibular Schwannoma Population:  
A Survey Hosted by the Acoustic Neuroma Association**

*Robert J. Macielak, MD; William Liu, BS; Nicholas S. Andresen, MD; Yin Ren, MD PhD  
Edward E. Dodson, MD; Oliver F. Adunka, MD MBA; Desi P. Schoo, MD*

**Objective:** To analyze the burden of post-treatment chronic dizziness in the vestibular schwannoma (VS) population.

**Study Design:** Cross-sectional survey.

**Setting:** Online survey.

**Patients:** Patients who have undergone radiation or microsurgery for treatment of VS.

**Interventions:** Microsurgery or radiation.

**Main Outcome Measures:** Self-reported symptoms of chronic dizziness after radiation or microsurgery for VS.

**Results:** Thirty-eight surgical patients and 21 radiation patients completed the post-treatment surveys. Among the post-surgical patients, 35 (92%) were female, 16 (42%) were > 50-years-old, and 19 (50%) underwent surgery within the last two years. Preoperatively, dizziness, vertigo, and imbalance were reported by 29 (76%), 24 (63%), and 28 (74%) patients, and by 28 (74%), 16 (42%), and 33 (87%) patients postoperatively at the time of the survey, respectively. Many surgical patients reported symptoms suggestive of central dizziness, including dizziness in moving cars (16, 42%), with looking at complex patterns (18, 47%), or while in busy environments (22, 58%), and 16 patients (42%) reported dizziness with headaches. Among the post-radiation patients, 17 (81%) were female, 19 (90%) were > 50 years old, and 9 (43%) underwent radiation within the past two years. Pre-radiation, dizziness, vertigo, and imbalance were reported by 12 (57%), 9 (43%), and 12 (57%) patients, and by 14 (67%), 9 (43%), and 17 (81%) patients after radiation at the time of the survey, respectively. Post-radiation patients reported symptoms suggestive of central dizziness, including dizziness in moving cars (9, 43%), with looking at complex patterns (9, 43%), or while in busy environments (11, 52%), and 9 patients (43%) reported dizziness with headaches. At the time of survey completion, there was no significant difference in the Dizziness Handicap Inventory between the surgery (n=22, mean 35.7, SD 23.0) and radiation (n=8, mean 45.0, SD 11.3) cohorts (p=0.17). Considering all patients who have completed the survey (n=59), 43 patients (81%) report experiencing symptoms suggestive of central dizziness after treatment, regardless of the treatment.

**Conclusions:** Chronic dizziness is common after both radiation and microsurgery for VS. Given the prevalence identified herein, VS patients may benefit from additional interventions targeted towards central dizziness if they are still experiencing these symptoms long-term.

**Professional Practice Gap & Educational Need:** Post-treatment vestibulopathy remains understudied in this population.

**Learning Objective:** To better understand chronic dizziness in patients after treatment for vestibular schwannoma.

**Desired Result:** Increase awareness of the impact of vestibulopathy after vestibular schwannoma treatment, with an emphasis on the potential influence of central dizziness on this population

**Level of Evidence – Level V**

**Indicate IRB or IACUC:** The Ohio State University IRB Protocol #2024E1376, approved 1/8/2025

**Comparison of 3 mm and 4 mm Implants in Percutaneous Bone Anchored Hearing Systems: Long-Term Outcomes from a Retrospective Study**

*Dennis Pappas, MD; Nicole Amichetti, PhD, MSc; Sara Al-Dalal, AuD  
Dianna Tingle, AuD; Sara Svensson, PhD*

**Objective:** To compare implant survival, time to loading, and postoperative outcomes between 3 mm and 4 mm implant lengths in percutaneous bone anchored hearing systems (BAHS).

**Study Design:** Retrospective review of medical records was conducted at a single center.

**Setting:** Alabama Ear Specialists

**Patients:** 234 adults

**Interventions:** Percutaneous BAHS

**Main Outcome Measures:** Implant survival at 3 months

**Results:** At 3 months post-surgery, 238 of 240 implants (99%) remained in situ, with no significant difference between implant lengths. Long-term survival was similarly high, with 232 implants (97%) in situ after an average follow-up of  $43 \pm 40$  months. Time to loading was influenced by changes in clinical practice rather than implant length, with earlier cases averaging  $70 \pm 39$  days and more recent cases averaging  $50 \pm 15$  days. No significant differences were observed in the frequency of postoperative complications, including inflammation, infection, or pain, between the two groups.

**Conclusions:** Both 3 mm and 4 mm implant lengths demonstrated comparable survival rates, reliability, and postoperative outcomes in the adult population. These findings support the use of 3 mm implants as a viable alternative in cases where bone thickness may be a limiting factor.

**Learning Objective:** After this presentation, attendees will be able to consider the evidence for and against using 3mm or 4mm implant lengths in clinical practice.

**Desired Result:** Changes in physician knowledge.

**Level of Evidence:** Level V

**Indicate IRB or IACUC:** Exempt.

## Medical Management in Superior Semicircular Canal Dehiscence Syndrome

*Michael S. Castle, MD; Samantha Y. Cerasiello, MD; Kevin A. Peng, MD  
William H. Slattery, MD; Hossein Mahboubi, MD, MPH*

**Objective:** Evaluate the effectiveness of medical therapy for management of symptoms in patients with superior semicircular canal dehiscence syndrome (SSCD).

**Study Design:** Retrospective chart review

**Setting:** Tertiary referral center

**Patients:** Adults 18 years and older with a diagnosis of SSCD

**Interventions:** Medical treatment with nortriptyline, venlafaxine or topiramate prior to offering surgery.

**Main Outcome Measures:** Resolution or improvement of symptoms (dizziness, autophony, ear fullness and hearing loss).

**Results:** Seven consecutive patients were included. All had radiographic evidence of SSCD (three bilateral, four unilateral). All patients presented with vestibular complaints including episodic vertigo, imbalance, or disequilibrium. Four reported autophony, and five endorsed ear fullness. Conductive hearing loss with air–bone gaps was observed in two patients. Three of the seven patients had Cervical Vestibular Evoked Myopotential (cVEMP) testing. Two of the three had cVEMP abnormalities. Medical management strategies included nortriptyline (n=3), venlafaxine (n=2), and topiramate (n=2), selected based on whether they had other features suggestive of migraine or central sensitization. All seven patients reported improvement in vertigo and imbalance including reduced frequency and severity of dizziness. Autophony and ear fullness improved in some but not all cases. One patient, despite initial symptomatic improvement, presented at another facility and underwent SSCD repair, which resulted in worsening of dizziness and return to our office to resume medical therapy.

**Conclusions:** This series highlights that medical therapy may provide meaningful symptomatic relief in patients with SSCD as often comorbid conditions such as vestibular migraine exist and could be offered as an option prior to surgery. Prospective studies with larger cohorts are warranted to further define the role of conservative management in this population.

**Learning Objective:** Readers will become aware of a medical option for managing symptoms in patients with superior semicircular canal dehiscence syndrome, which can provide reasonable improvement/resolution given often present comorbid conditions.

**Desired Result:** Patients with SSCD could be offered a medical option when discussing treatment options other than surgery or observation.

**Level of Evidence - V**

**Indicate IRB or IACUC:** Exempt



## Geographic Practice Cost Index (GPCI) Components and Regional Variation in Medicare Reimbursement for Cochlear Implantation and Stapedectomy

*Jefferson Norwood, MBS; Layla Ali, BS; Cameron Ostroot, BS  
Julia Howard, BS; Iyawna Hazzard, BS; Adedeji Okikiade, MD, PhD*

**Objective:** To evaluate how the three Geographic Practice Cost Index (GPCI) components—Work, Practice Expense, and Malpractice—individually and collectively account for geographic variation in Medicare reimbursement for cochlear implantation (CPT 69930) and stapedectomy (CPT 69660).

**Data Sources:** Centers for Medicare & Medicaid Services (CMS) Physician Fee Schedule 2024B reimbursement files merged with 2025 GPCI indices across 110 Medicare Administrative Contractor (MAC) localities in the United States.

**Study Selection:** Two otologic CPT codes were selected for inclusion based on their relevance to neurotologic practice and consistent representation across MAC localities: cochlear implantation (69930) and stapedectomy (69660).

**Data Extraction:** Reimbursement and GPCI values were extracted from publicly available CMS datasets. Variables included Work, Practice Expense, and Malpractice GPCI indices. Data were standardized to allow comparison across localities.

**Data Synthesis:** Separate linear regressions modeled facility payment as a function of the three GPCI components. Standardized  $\beta$  coefficients and p-values quantified the magnitude and statistical significance of each component's contribution to reimbursement variability. For cochlear implantation, Practice Expense GPCI had the greatest influence ( $\beta = 0.795$ ,  $p < 0.001$ ), followed by Malpractice ( $\beta = 0.391$ ) and Work ( $\beta = 0.349$ ). The pattern was similar for stapedectomy, though with smaller magnitudes ( $\beta_{PE} \approx 0.72$ ,  $\beta_{Work} \approx 0.32$ ,  $\beta_{MP} \approx 0.27$ ). Each 1-point increase in the respective GPCI corresponded to approximate reimbursement increases of \$590, \$540, and \$87 for cochlear implantation.

**Conclusions:** Geographic disparities in Medicare reimbursement for otologic surgery are predominantly driven by Practice Expense GPCI, reflecting the outsized impact of regional overhead and facility costs. Work and Malpractice GPICs contribute modestly but remain statistically significant. Understanding these component effects provides policy insight into how regional economic adjustments shape payment equity for neurotologic procedures.

**Learning Objective:** To understand how individual GPCI components drive regional variation in Medicare reimbursement for common otologic procedures and to recognize the economic factors influencing payment equity.

**Desired Result:** To enhance clinicians' and policymakers' ability to interpret geographic payment variation and advocate for equitable reimbursement frameworks across regions.

**Level of Evidence:** Level III – Cohort/Case-Control Study

**IRB or IACUC:** Exempt – analysis of publicly available CMS data

**Age-Related Decline in Temporal Sound Processing: Insights from Envelope Steepness Map in the Mouse Auditory Cortex**

*Tianrui Guo; Kuniyuki Takahashi, MD, PhD; Shinsuke Ohshima, MD, PhD,  
Tatsuya Yamagishi, MD, PhD; Hiroaki Tsukano, MD, PhD; Arata Horii, MD, PhD*

**Hypothesis:** The ability to sense temporal components of sounds, such as envelope steepness, would be diminished in aged mice.

**Background:** The mouse auditory cortex contains a tonotopic map. Recently, we identified an envelope steepness map encoding the rise-ramp steepness of sounds, which is located orthogonally to the tonotopic map. Temporal components, particularly the sound envelope defined by the rise-ramp steepness, play a crucial role in speech perceptions.

**Methods:** Responses to variations in rise-ramp time were investigated using transcranial macroscale calcium imaging of the auditory cortices of GCaMP6f-expressing mice. Normalized distance relative to the rise-ramp time of 0.01 msec was plotted for each rise-ramp time (0.1 msec, 1 msec, 10 msec, 100 msec) in the logarithmic scale graph: the steeper the slope of the fitted regression lines, the greater distance between the peaks of the rise-ramp time of 0.01 msec and 100 msec. The slope of this regression line was compared between the different age groups: 1/3 months and 6/9/12 months after birth.

**Results:** The slope of the fitted regression line for 5 kHz in bilateral anterior auditory field and 20 kHz in bilateral primary auditory field was significantly less steep in mice at 6/9/12 months after birth than at 1/3 months after birth.

**Conclusion:** The shorter distance from the peak of 0.01 msec to 100 msec in animals 6/9/12 months after birth suggests difficulty in the separation of the rise-ramp time in aged animals. These findings may support the cortical mechanisms underlying age-related decline in speech perception.

**Learning Objective:** To understand cortical mechanisms of age-related decline in speech perception.

**Desired Result:** Age-related alterations in cortical temporal processing will be revealed by envelope steepness mapping.

**Level of Evidence** - Not applicable

**Indicate IRB or IACUC:** Animal Care Committee of Niigata University School of Medicine (#SA00429, #SD01079)

## Digital Twin-Enforced Safety Barriers for Cooperatively Controlled Robotic Skull Base Surgery

*Jonathan Wang, MSE; Andy S. Ding, MD MSE; Hisashi Ishida, MSE; Adnan Munawar, PhD  
Manish Sahu, PhD; Russell H. Taylor, PhD; Francis X. Creighton, MD*

**Hypothesis:** Integrating patient-specific digital twins with cooperatively controlled robotic skull base surgery enables submillimeter virtual constraints to protect critical anatomy.

**Background:** Lateral skull base surgery demands submillimeter precision to safeguard critical structures embedded within dense, complex bone. While manual approaches remain the standard, they are limited by tremor, fatigue, and variability. Cooperatively controlled robots (CCRs), which allow simultaneous surgeon–robot instrument manipulation, combine robotic stability with human expertise. Furthermore, by referencing a digital twin (i.e. preoperative imaging-derived virtual reconstruction of the surgical field), CCRs can enforce safety barriers around vital anatomy. This study evaluates the feasibility and accuracy of digital twin–enforced safety barriers in CCR-assisted skull base surgery.

**Methods:** The CCR consisted of a 5-degree-of-freedom gantry arm coupled to an optically tracked surgical drill. Six cadaveric temporal bones were registered using bone-mounted fiducials. Preoperative CT scans were segmented to delineate critical anatomy (e.g. facial nerve, sigmoid sinus, and IAC). The robot was programmed to provide real-time positional feedback, progressively restricting drill motion as it neared critical anatomy, with a hard stop at 0.5mm. The senior author performed robot-assisted mastoidectomy followed by a translabyrinthine approach to the IAC. Accuracy was assessed by comparing postoperative CT scans with preoperative segmentations.

**Results:** All CCR-assisted procedures were completed without breaching critical structures. Median distances from the drilled cavity to the facial nerve, sigmoid sinus, and IAC were 0.508mm (IQR: 0.499-0.513mm), 0.520mm (IQR: 0.495-0.542mm), and 0.514mm (IQR: 0.504-0.520mm) respectively. One-sample Wilcoxon signed-rank tests confirmed no significant difference from the 0.5mm margin (facial nerve:  $p=0.313$ ; sigmoid sinus:  $p=0.219$ ; IAC:  $p=0.313$ ).

**Conclusions:** Digital twin–guided CCRs enable submillimeter precision during mastoidectomy and translabyrinthine IAC exposure, suggesting a feasible, anatomy-aware platform for safer robotic skull base surgery.

**Learning Objective:** The learning objective was to assess the effectiveness of a CCR system in skull base surgery and to quantify the precision of robot-enforced virtual safety barriers around critical anatomy. While prior studies have explored robotic guidance for drilling in the skull base, these have largely focused on fully autonomous systems. In contrast, our CCR approach allows the surgeon and robot to jointly manipulate instruments, combining the surgeon’s expertise with robotic precision to enhance safety. To our knowledge, this represents the first clinical evaluation of anatomy-specific CCR-enforced virtual barriers in skull base surgery.

**Desired Result:** We hope our study will highlight the potential of robotics to enhance surgical safety and precision in neurotology and stimulate discussion on advancing digital twin–guided interventions for clinical practice.

**Level of Evidence** - Level V

**Indicate IRB or IACUC:** Johns Hopkins School of Medicine IRB00264318

## Long-Term Risk of Osseointegrated Implant Removal or Extrusion: Following Early and Chronic Wound Complications

*Tyler J. Gathman, MD, MS; Lulia A. Kana, MD; Julio J. Roque, BS; Masanari G. Kato, MD; Hyunseo Jung, MD  
Rachel M. Goffeney, AuD; Sandra L. Porps, AuD; and Seilesh C. Babu, MD*

**Objective:** Osseointegrated devices have continuously evolved, broadening indications into pediatrics and single-sided deafness. However, implantation can be complicated by wound infection or breakdown, which can be troublesome for patients and restricts long-term use.

**Study Design:** Retrospective cohort study.

**Setting:** Tertiary care academic.

**Patients:** The study included 1026 primary osseointegrated implant patients, both adults and children, between 2008 and 2024. The mean age was 50.7 years (range 5 – 88), and 39.6% (n = 406) were male. The most common cause of hearing loss was chronic ear disease (37.6%), followed by sudden hearing loss (18.6%) and vestibular schwannoma (17.5%).

**Interventions:** Wound complications, including local infection, irritation, inflammation, and incisional breakdown or dehiscence.

**Main Outcome Measures:** Kaplan-Meier analysis for explantation and extrusion rates in patients with early (< 30 days) and frequent (> three clinical instances) wound complications.

**Results:** Patients with primary osseointegrated implants exhibited a wound complication rate of 7.1% within the first 30 days post-operation and a rate of 5.9% for having more than three clinical instances. The group that experienced early complications showed significantly higher rates of explantation ( $p < 0.005$ ; 14.1%) and equivocal extrusion rates ( $p = 0.99$ ; 6.3%) at 5 years compared to those who did not face early complications, with explantation and extrusion rates at 5 years being 5.9% and 4.4%, respectively.

The cohort with frequent wound complications also had significantly higher rates of explantation ( $p < 0.005$ ; 19.6%) but similar extrusion rates ( $p = 0.99$ ; 4.6%) at 5 years compared to those who did not experience frequent complications, with explantation and extrusion rates being 4.5% and 3.7%, respectively.

**Conclusions:** Wound complication rates following osseointegrated implantation remain low; however, the risk of implant explantation significantly increases, though extrusion occurrence may be independent.

**Learning Objective:** Wound complications may occur following bone-anchored device implantation. When they happen in the early postoperative period or are frequent, they can predispose the patient to device explantation. However, the risk of extrusion may be independent of these factors.

**Desired Result:** Patients with early or frequent wound complications are at an elevated risk of explantation and should be followed carefully in the postoperative period.

**Level of Evidence** - Level III, Retrospective Cohort Study

**Indicate IRB or IACUC:** The study was reviewed and IRB-approved by Henry Ford Health prior to data collection on 12/19/2024 (Trends of Osseointegrated Bone Anchored Hearing Devices).

## **mVOR: An mHealth Solution for Remote Clinical Assessment of Gaze Stability in Unilateral Vestibular Dysfunction**

*Adam Thompson-Harvey, MD; Jesus Gomez, AuD; Gia Oscherwitz, BS; Masud Rabbani, MS  
Bradley Kesser, MD; Sheik Iqbal Ahamed, PhD; Joel Goebel, MD*

**Objective:** To determine whether a smartphone-based (mVOR) gaze-stabilization test (GST) can detect unilateral vestibular dysfunction (UVD) compared to a standard GST system.

**Study Design:** Prospective case-control pilot.

**Setting:** Tertiary neurotology referral center.

**Patients:** Thirty-five adults (18 UVD, 17 controls). UVD patients included 15 s/p surgical ablation and 3 with a caloric asymmetry  $\geq 49\%$ .

**Interventions:** Single-session testing comparing mVOR with a computerized GST system (Bertec Corporation, Columbus, OH).

**Main Outcome Measures:** The best GST score (maximum head velocity,  $^{\circ}/s$ , sustaining visual acuity) from three trials per system, mean differences within patients (lesioned vs non-lesioned sides), and patient-control discrimination.

**Results:** On mVOR, lesioned vs non-lesioned sides: mean  $\Delta = -16.3^{\circ}/s$  ( $p = 0.006$ ); best mean  $\Delta = -22.8^{\circ}/s$  ( $p = 0.007$ ). Lesioned-side vs controls:  $100.9 \pm 34.0$  vs  $142.9 \pm 12.5^{\circ}/s$ ;  $\Delta = -42.0$ ;  $p < 0.001$ ;  $d = 1.59$ . On computerized GST, lesioned vs non-lesioned:  $\Delta = -8.5^{\circ}/s$  ( $p = 0.042$ ); best  $\Delta = -12.5^{\circ}/s$  ( $p = 0.087$ ). Lesioned-side vs controls:  $84.0 \pm 23.1$  vs  $111.2 \pm 22.6^{\circ}/s$ ;  $\Delta = -27.2$ ;  $p = 0.001$ ;  $d = 1.19$ . Non-lesioned patient sides scored lower than controls across devices ( $p = 0.001-0.028$ ). Repeated-measures models showed a main effect of device (mVOR yielded higher absolute velocities) without significant device $\times$ side or device $\times$ group interactions ( $p \geq 0.099$ ).

**Conclusions:** A smartphone-only GST (mVOR) differentiates lesioned-side gaze stability from the normal side and distinguishes UVD from controls, with significant effects comparable to those of a standard GST. Despite an offset in absolute velocity, the lack of device interaction supports mVOR's validity and feasibility for remote assessment and telerehabilitation.

**Learning Objective:** To evaluate the feasibility of using smartphone-based gaze stability testing as an accessible telehealth option for assessing vestibular function and guiding remote vestibular rehabilitation.

**Desired Result:** Validation of an mHealth tool that can serve as an effective, low-cost alternative for telemonitoring vestibular function and improving remote vestibular rehabilitation programs.

**Level of Evidence:** III

**Indicate IRB or IACUC:** University of Virginia IRB approval#: HSR230265, NIH NIDCD STTR Phase 1 award#: 1R41DC022209-01

## Correlation of Intraoperative Electrically evoked Auditory Brainstem Responses in Bilateral Cochlear Implantation

*De'Andre Warren, MD, Anna Johnson, BS, Elena Miller, MPH  
Bradley Kesser, MD, Benjamin Lovin, MD*

**Objective:** To determine the correlation of intra-operative electrically-evoked Auditory Brainstem Response (eABR) and post-operative performance between first and second cochlear implantation for bilateral cochlear implant recipients.

**Study Design:** Retrospective Chart Review

**Setting:** Tertiary Referral Center

**Patients:** Adult and pediatric patients with bilateral sensorineural hearing loss of any etiology who met audiologic criteria for bilateral cochlear implantation and underwent either simultaneous or sequential cochlear implantation with concurrent intra-operative eABR testing from 2015 to 2024.

**Interventions:** None

**Main Outcome Measures:** Primary outcome is change in latency, amplitude, and neural response telemetry (NRT) on eABR between primary and secondary implantation. Secondary outcome is post-implant audiologic performance.

**Results:** 34 patients with bilateral cochlear implants were included after inclusion and exclusion criteria. When comparing intra-operative changes in eABR from first to second implantation for all patients, there was a significant increase in latency at electrodes 6 (+18.2ms,  $p=0.43$ ), 11 (+15.4ms,  $p=0.43$ ), and 16 (+9.3ms,  $p=0.44$ ). There was a positive correlation between patient age and hours of daily use (0.624,  $p<.001$ ), as well as patient age and time between implants (.826,  $p<.001$ ). Finally, when comparing a smaller cohort of 8 adult patients with completed pre- and post-operative AzBio data, post-operative scores were positively correlated with age at implantation (.447,  $p=0.13$ ) hours of daily use (.630,  $p<.001$ ), and negatively correlated with duration of hearing loss (-.544,  $p=.002$ ). There was no correlation between difference in difference between eABR data and AzBio performance.

**Conclusions:** There is increased latency between first and second cochlear implantation without correlation to post-implantation performance without impact on post-operative performance, which may contribute to sound localization. Additionally, increased duration of hearing loss correlated negatively with performance. Larger studies are needed for further statistical analysis.

**Define Professional Practice Gap & Educational Need:** Elucidating Audiometric and performance difference in timing of bilateral cochlear implantation

**Learning Objective:** Impact of bilateral cochlear implantation with respect to timing and performance

**Desired Result:** Improved understanding of potential impact and restoration of binaural audiologic phenomena from bilateral cochlear implantation.

**Level of Evidence** – Level III

**Indicate IRB or IACUC :** University of Virginia IRB Study #301908, Exempt

## Stapedectomy versus Stapedotomy: A Systematic Review and Meta-Analysis

*Trevor Torgerson, DO; Natasha Andreasen, BS; Leila Ledbetter, MLIS, AHIP  
Kristal Riska, PhD; David Kaylie, MD*

**Objective:** The aim of this review is to assess and compare the hearing and complication outcomes following primary stapedectomy and stapedotomy using a systematic review of the literature and meta-analysis.

**Data Sources:** An October 2024 database search included MEDLINE (PubMed), Embase (Elsevier), and Web of Science (Clarivate).

**Study Selection:** Retrieved articles were screened at the abstract and full-text level to obtain a final sample of studies that included primary stapedectomy and stapedotomy interventions with extractable hearing and complication outcome data.

**Data Extraction:** Data was extracted in a blinded and duplicate fashion with resolution using a third party adjudicator where needed. Risk of bias and methodological quality assessment was completed using a modified Downs and Black checklist.

**Data Synthesis:** The final review included 164 studies. In the comparative meta-analyses, no significant differences were noted in the number of patients with ABG  $\leq 10$  dB ( $p = 0.15$ ), postoperative AC PTA ( $p = 0.26$ ), or postoperative ABG ( $p = 0.08$ ) between the two interventions. A significant difference ( $p = 0.03$ ) in new postoperative SNHL was found favoring stapedotomy with more events in the stapedectomy group at an odds ratio of 2.11 (1.10 - 4.07, 95% CI), pooled analysis also found an average of 2.80% (2.03% - 3.57%, 95% CI) more patients with a new postoperative SNHL in the stapedectomy group. Meta-analyses and two sample proportion tests were completed using RevMan and Stata 19.

**Conclusions:** Overall, this work affirms the safety and effectiveness of stapedectomy and stapedotomy techniques for the surgical management of otosclerosis with no clinically meaningful differences in hearing outcomes and a marginally increased risk of SNHL in the stapedectomy group.

**Learning Objective:** To understand the audiometric and complication outcome differences between primary stapedectomy and stapedotomy interventions for the surgical management of otosclerosis.

**Desired Result:** To enable informed intraoperative surgeon decision making and accuracy of preoperative patient counseling for the surgical management of otosclerosis.

**Level of Evidence - Level 1**

**Indicate IRB or IACUC:** Exempt

## Comparison and External Validation of Vestibular Schwannoma Quality of Life Questionnaires

*Samuel Cler, MD; Pawina Jiramongkolchai, MD; Matthew Shew, MD; Nedim Durakovic, MD  
Jacques Herzog, MD; Craig Buchman, MD; Cameron Wick, MD*

**Objective:** Compare the Vestibular Schwannoma Quality of Life (VSQOL) and Penn Acoustic Neuroma Quality of Life (PANQOL) questionnaires to look for survey differences and identify quality-of-life factors in vestibular schwannoma patients.

**Study Design:** Patients, regardless of management, were recruited from the authors' institution and Acoustic Neuroma Association. Participants completed the VSQOL and PANQOL online. Participants were asked to repeat the surveys 2-weeks later to assess retest reliability.

**Setting:** Tertiary academic center and national patient support group.

**Patients:** Patients with a vestibular schwannoma.

**Interventions:** VSQOL and PANQOL questionnaires.

**Main Outcome Measures:** QOL scores reported as mean  $\pm$  standard error of means

**Results:** 436 participants completed the survey (67.4% institutional cohort, 66.7% female, mean age 64.0 years, mean time since diagnosis 10.1 years). Initial management included 42.7% surgery, 14.4% radiation, and 42.9% observation. Mean VSQOL and PANQOL scores were  $73.2 \pm 0.84$  and  $61.5 \pm 0.85$  respectively (scale 0-100; higher scores indicating higher QOL). Demographics and QOL scores were comparable between institutional and ANA cohorts. VSQOL and PANQOL scores were highly correlated (correlation coefficient 0.83,  $R^2=0.71$ ). Initial responses were similar to retest responses in VSQOL (correlation coefficient 0.93,  $R^2=0.87$ ) and PANQOL (correlation coefficient 0.90,  $R^2=0.87$ ). Lower QOL scores were reported with larger initial tumor size, initial surgical management, tumor growth, need for additional treatment, and change in work status. Change in work status had the largest negative association with QOL;  $14.1 \pm 2.1$  lower on PANQOL and  $16.8 \pm 2.4$  on VSQOL. All of the associations with QOL were observed across both questionnaires.

**Conclusions:** VSQOL and PANQOL scores revealed similar trends and had strong retest reliability. Change in work status had the largest negative impact on QOL scores.

**Learning Objective:** Describe and identify trends in vestibular schwannoma quality of life patient reported outcome measures.

**Desired Result:** External validation identifying a strong association between VSQOL and PANQOL scores with high retest reliability. Provides validation that findings using one questionnaire could be applicable to the other questionnaire.

**Level of Evidence** – level III

**Indicate IRB or IACUC:** Approval granted by Washington University Biomedical IRB #202303063, 8/22/2024



## Stereotactic Radiosurgery for Cerebellopontine Angle Tumor Control: Long-Term Efficacy and Clinical Outcomes

*Bora Agabigum, MD, MS; Tyler J. Gathman, MD, MS; Hyunseo Jung, MD  
Jeffrey Turnbull, DO; Alex Lampi, BS, Rafi Hanna, BS*

**Objective:** Stereotactic radiosurgery has proven highly effective in managing small to medium-sized skull base tumors, offering adequate tumor control as a non-invasive modality that minimizes surgical risk. Despite these advantages, long-term studies on clinical and tumor burden outcomes have been limited.

**Study Design:** Retrospective cohort study.

**Setting:** Tertiary care academic.

**Patients:** This study analyzed 135 patients with cerebellopontine angle tumors who received primary stereotactic radiosurgery between 2010 and 2025. The mean patient age was 63.8 years (range 41–90), and 55.5% (n = 60) were male. All patients underwent Gamma Knife treatment. Vestibular schwannoma was the most common diagnosis (94.8%; n = 128), followed by meningioma (4.4%; n = 5) and glomus tumor (0.7%; n = 1). The mean follow-up duration after primary treatment was 5.7 years.

**Interventions:** Stereotactic radiosurgery with Gamma Knife for primary cerebellopontine angle tumor treatment.

**Main Outcome Measures:** Tumor control was evaluated by magnetic resonance imaging at less than 1 year and more than 2 years after treatment. The rates of refractory tumor growth and subsequent surgical resection were also determined.

**Results:** Prior to radiosurgery, the mean maximal tumor dimension measured 13.2 mm. After more than 2 years, 15.5% (n = 16) exhibited persistent tumor growth or treatment failure, while 9.6% (n = 13) ultimately underwent surgical resection. Audiometric testing revealed a mean pre-radiosurgery pure tone average of 38.8 dB, with 21.4% (n = 29) of patients experiencing greater than 20 dB increase after radiosurgery.

Pre-radiosurgery, 2.8% (n = 3) of patients had facial nerve deficits defined as House-Brackman > 1, and no patients developed deficits from initial normal function following radiosurgery. Vestibular testing demonstrated 66.6% (n = 70) of patients had ipsilateral vestibular dysfunction after radiosurgery.

**Conclusions:** Radiosurgery offers effective tumor control with limited need for surgical resection. However, there are demonstrated risks to hearing preservation and vestibular function that require long-term monitoring.

**Learning Objective:** Radiosurgery continues to be an effective option for treatment cerebellopontine angle tumors and in avoiding surgical resection; however, patients require ongoing monitoring of both audiogram and vestibular function.

**Desired Result:** Patients undergoing radiosurgery may retain both hearing and vestibular function; however, any deficits should be promptly identified and managed.

**Level of Evidence** - Level III, Retrospective Cohort Study

**Indicate IRB or IACUC:** The study was reviewed and IRB-approved by Henry Ford Health.

## Virtual Morris Water Maze Performance in Vestibular Migraine

*Alexandra T. Bourdillon MD; Jeffrey D. Sharon MD*

**Objective:** To investigate the differences in spatial navigation in vestibular migraine (VM) using a virtual reality (VR) virtual Morris Water Maze (vMWM).

**Study Design:** Prospective cohort study

**Setting:** Tertiary referral center

**Patients:** Subjects with a history of VM per Barany Society criteria were recruited, as well as healthy controls with no history of migraine or dizziness.

**Interventions:** Participants completed four replicates of VR-based vMWM tasks, including a learning trial (visible target) and three test trials (invisible targets). In each series, Trials 3 and 4 involved new starting positions. Patient-Reported Outcome Measures (PROMs) included: Dizziness Handicap Inventory (DHI), VM-Patient Assessment Tool and Handicap Inventory (VM-PATHI), Headache Impact Test (HIT), Cognitive Failures Questionnaire (CFQ), Visual Vertigo Analog Scale (VVAS), Santa Barbara Sense of Direction (SBSOD) survey, and Video Game Questionnaire (VGQ).

**Main Outcome Measures:** Rate of successful completion across nine testing trials, and time to trial completion (TTC) of Trials 3 and 4. Performance measures were correlated with PROMs.

**Results:** 24 individuals with VM and 31 controls were included. The study arms did not differ by demographics ( $p>0.05$  for each) or overall video game experience ( $p=0.12$ ). Participants with VM had a higher failure rate (53.1%) compared with controls (42.5%), a difference that was statistically significant ( $p<0.01$ ). Average TTC of Trials 3 and 4 were longer in the VM arm ( $17.3\pm4.7s$ ) compared with healthy controls ( $15.8\pm5.4s$ ), which neared statistical significance ( $p=0.06$ ). Between-group differences were statistically significant in Trial 4 ( $p=0.019$ ), but not Trial 3 ( $p>0.90$ ). Correlation analyses between maze performance and PROMs demonstrated that only VM-PATHI was statistically significantly correlated with completion rate ( $p=0.03$ ) and TTC ( $p<0.05$ ).

**Conclusions:** Participants with VM have higher failure rates than healthy controls in VR-based vMWM assessment. Maze performance is correlated with VM-PATHI.

**Learning Objective:** To examine how spatial navigation abilities may be impaired in individuals with VM and the opportunities for VR-based maze tasks to quantify such disease features.

**Desired Result:** To consider the utility of VR-based maze tasks in assessing spatial navigation abilities in the management of VM.

**Level of Evidence - III**

**Indicate IRB or IACUC:** 23-38758.

## Radiomorphometric Analysis of Internal Auditory Canal Access: Retrolabyrinthine vs Established Hearing-Preserving Approaches

*Aaron Tucker, BA; Sammy Gao, BS; Brendon Warner, MD; Arman Saeedi, MD, MPH  
Lawrance Lee, MD; Nauman F. Manzoor, MD*

**Objective:** The retrolabyrinthine approach is a presigmoid hearing preservation option for the management of IAC lesions, although its microsurgical technique offers limited lateral IAC visualization. We aim to compare internal auditory canal (IAC) volume exposure via retrolabyrinthine, retrosigmoid, and middle cranial fossa (MCF) approaches.

**Study Design:** Updated radiomorphometric analysis of cadaveric temporal bones.

**Interventions:** IAC dissections were performed on thirteen cadaveric temporal bones. High-resolution computed tomography scans were used to generate 3D segmentations of the IAC before and after dissection. 0° and 30° angles at the level of the semicircular canals were utilized to measure IAC exposure without violating the inner ear structures via retrolabyrinthine, retrosigmoid, and middle cranial fossa (MCF) approaches.

**Main Outcome Measure:** The percent of post-dissection accessible IAC volume for each approach.

**Results:** Thirteen cadaveric temporal bones (7 left, 6 right) were included. The mean IAC volume was  $232.8 \pm 85.1 \text{ mm}^3$ . The retrolabyrinthine approach offered less median IAC exposure than the MCF and retrosigmoid approaches at the 0° angle (retrolabyrinthine: 65.1% [IQR 14.5%]; retrosigmoid: 90.3% [IQR 3.9%]; MCF: 95.9% [IQR 7.1%],  $p < .001$ ) and 30° angle (retrolabyrinthine: 75.6% [IQR 13.5%]; retrosigmoid: 99.5% [IQR 0.6%]; MCF: 99.9% [IQR 0.7%],  $p < .001$ ). Compared with 0° views, the 30° angle improved median IAC exposure of all three approaches (retrolabyrinthine: +10.5%,  $p = .019$ ; retrosigmoid: +9.2%,  $p < .001$ ; MCF: +4.1%,  $p < .001$ ). Pre-dissected retrolabyrinthine corridor width ranged 1.1-7.1 mm (median 4.4 mm) and sinodural angle ranged 57.5°-96.5° (median 76.4°). Using log-transformed analyses, neither measure was significantly correlated with the IAC exposure of any approach.

**Conclusions:** Established hearing preservation approaches to the IAC remain the gold standard for maximizing lateral IAC exposure. While the key advantage of the retrolabyrinthine approach is hearing preservation without the need for craniotomy and intracranial parenchymal retraction, the approach may only be appropriate for select patients with limited involvement at the IAC fundus. The increased IAC exposure of the 30° angled view for all approaches suggests a global benefit of angled endoscopic assistance. Larger feasibility studies are needed to identify anatomical features of favorable candidates.

**Learning Objective:** Participants should be able to compare IAC exposure of established hearing-preserving surgical approaches versus the retrolabyrinthine approach, and to and comprehend the benefit of endoscopic assistance.

**Desired Result:** To improve awareness of the endoscopic-assisted retrolabyrinthine approach, and to describe which patients with IAC tumors are favorable surgical candidates.

**Level of Evidence - III**

**IRB:** Exempt

## Prevalence of Magnetic Resonance Imaging Completion Among Bone Anchored Hearing Implant Patients

*Malia A. Tieu, BS; Doron Sagiv, MD*

**Objective:** To analyze the prevalence of post-implant magnetic resonance imaging (MRI) amongst patients with an implanted bone-conduction hearing device (BCD).

**Study Design:** Retrospective cross-sectional study

**Setting:** A nationwide repository of deidentified electronic health records (Epic Cosmos Database) sourced from over 300 million patients across the United States.

**Patients:** Adult patients who underwent BCD implantation between 2010 to 2025.

**Interventions:** Epic Cosmos database search using CPT codes for BCD implantation and MRI.

**Main Outcome Measures:** Type of MRI, Age, Race, Active Diagnoses documented in patients' problem list using Systematized Nomenclature of Medicine - Clinical Terms (SNOMED-CT).

**Results:** Our cohort includes 10,338 patients (43.01% males) who underwent BCD implantation, with a mean age at implantation of 53.11 years of age (range 18-100). The frequency of post-BCD MRI completion was 23.68% for any MRI, and 12.47% for brain MRI. The prevalence of post-BCD MRIs was significantly higher among patients aged 51 to 65 years at the time of implantation ( $P$ -value =  $4.006e-02$ ). Post-BCD MRI completion of any MRI was also positively associated with a history of neurological disorders (Odds Ratio (OR)= 2.267,  $p$ -value=  $8.629e-96$ ) or cardiovascular disorders (OR= 1.567,  $p$ -value=  $7.227e-34$ ). Specifically, patients with acoustic neuroma (OR= 6.918,  $p$ -value=  $3.538e-78$ ), hypertension (OR= 1.686,  $p$ -value=  $3.018e-35$ ), and diabetes (OR= 1.547,  $p$ -value =  $1.770e-13$ ) were more likely to complete any MRI following BCD implantation. As expected, patients with a history of acoustic neuroma were also more likely to receive a brain MRI (OR= 9.129,  $p$ -value=  $1.211e-29$ ).

**Conclusions:** The prevalence of post-BCD MRI is higher among patients who were ages 51-65 years at the time of implantation and among patients with neurological disorders, hypertension, and diabetes. These patient demographics should be considered when consulting patients considering a BCD.

**Learning Objective:** To analyze the prevalence of MRI completion among BCD implantees based on potential risk factors such as age and medical history.

**Desired Result:** To inform clinicians of the risk factors associated with future MRI utilization among patients undergoing BCD implantation, thereby supporting more individualized patient counseling.

**Level of Evidence** – Level IV

**Indicate IRB or IACUC:** Exempt

## Intraoperative Electrocochleography and Clinical Factors Associated with Cochlear Implant Performance in Idiopathic Sudden Sensorineural Hearing Loss

*Matthew J. Wu, MD; Amit Walia, MD; Jordan Varghese, MD; Doug Fitzpatrick, PhD  
Matthew Shew, MD; Jacques Herzog, MD; Craig A. Buchman, MD*

**Objective:** To identify clinical and electrophysiologic factors associated with cochlear implant (CI) performance in idiopathic sudden sensorineural hearing loss (ISSNHL) and to determine whether these factors explain variability in CI outcomes.

**Study Design:** Retrospective, cross-sectional study (7/2021–10/2024).

**Setting:** Tertiary referral center.

**Patients:** Adult CI recipients with unilateral ISSNHL and contralateral ear  $\leq 35$  dB hearing loss in the non-implanted ear.

**Interventions:** Single-manufacturer CI with intraoperative intracochlear electrocochleography (ECochG).

**Main Outcome Measures:** CI speech perception (AzBio in Quiet, CNC) and ECochG-total response (ECochG-TR) in relation to ISSNHL-relevant clinical factors (e.g., steroid use and vestibulopathy).

**Results:** Thirty-three adults underwent CI following ISSNHL. The median age was 58.0 years (range: 24.0–81.0); 51.5% were female. Prior to implantation, 27.3% (n=9) had vestibulopathies, and 81.8% (n=27) received oral/intratympanic steroids, of which 14.8% (n=4) were steroid-responsive, defined by documented hearing improvement after corticosteroid therapy. At six months, median speech perception scores were 71.0% (range: 12.0–95.0) for AzBio in Quiet and 48.0% (range: 4.0–76.0) for CNC. Older age (>50 years), female sex, duration of deafness >2 years, cardiovascular comorbidity, vestibulopathy, or steroid use alone did not affect CI speech perception at six months or ECochG-TR ( $p>0.05$ ). Steroid-responsiveness, while not statistically significant ( $p>0.05$ ), suggested a clinically meaningful improvement at six months for AzBioQ (median difference 16.0; 95%CI: –16.0, 29.0) and CNC (median difference 12.0; 95%CI: –8.0, 34.0). ECochG-TR was weakly associated with CI speech perception at six months for AzBioQ ( $R^2=0.19$ ) and CNC ( $R^2=0.13$ ).

**Conclusions:** Among ISSNHL CI recipients, most clinical factors did not significantly influence speech outcomes or electrophysiologic responses, except for steroid-responsiveness, which may be a positive prognosticator. Compared with non-ISSNHL patients, the weak relationship between ECochG-TR and speech performance may reflect differences in ISSNHL-related pathophysiology.

**Learning Objective:** To evaluate how clinical recovery features and intraoperative electrophysiologic measures relate to CI performance in ISSNHL.

**Desired Result:** Attendees will learn that most traditional ISSNHL factors related to hearing recovery show limited prognostic value for CI performance except for steroid-responsiveness.

**Level of Evidence** – Level IV

**Indicate IRB or IACUC:** Washington University in St. Louis (IRB#: 202507213)

## Impact of Perioperative Blood Transfusion on Oncologic Outcomes after Lateral Temporal Bone Resection

*Bailey H. Duhon, MS; Xiaowen Sun, PhD; Mike Hernandez, MS  
Marc-Elie Nader, MD; Paul W. Gidley, MD*

**Objective:** To evaluate the impact of perioperative blood transfusion on survival and recurrence outcomes following lateral temporal bone resection (LTBR).

**Study Design:** Retrospective cohort.

**Setting:** Tertiary academic center.

**Patients:** Patients diagnosed with temporal bone and parotid malignancies requiring LTBR from 2012-2023.

**Interventions:** Perioperative blood transfusion (intraoperatively and within 72-hours postoperatively).

**Main Outcome Measures:** Recurrence-free survival (RFS), disease-specific survival (DSS), and overall survival (OS).

**Results:** One-hundred twenty-one patients underwent LTBR. Approximately one-third required perioperative blood transfusion (n=39/121), averaging 2 units (range 1-5 units). Transfused and non-transfused patients were well-balanced on baseline characteristics including TNM staging, surgical margins, histological subtype, and adjuvant treatment. However, tumor subsite and perineural invasion differed significantly between groups and were included in multivariable models, along with T stage, to control for confounding and assess independent effect of perioperative transfusions. Despite comparable baseline risk, RFS, DSS, and OS were significantly lower in the transfusion group (median RFS, 17 vs 50 months; median DSS, 23 months vs median not reached; median OS, 22 vs 82 months; all  $p < 0.050$ ). Univariable Cox regression of all preoperative risk factors demonstrated that ASA class 4 (HR 5.6, 95% CI 1.4 - 22.9,  $p = 0.005$ ), transfusions (HR 1.9, 95% CI 1.1 – 3.2,  $p = 0.015$ ), and N1+ stage (HR 1.7, 95% CI 1.0 – 2.9,  $p = 0.059$ ) were associated with increased hazard of recurrence. Transfusion remained significant in the multivariable analysis (HR 2.4, 95% CI 1.1-5.2,  $p = 0.031$ ). Additionally, transfusions were a strong predictor of lower DSS (HR 4.5, 95% CI 2.2 – 9.2,  $p < 0.001$ ) and OS (HR 3.1, 95% CI 1.7 – 5.6,  $p < 0.001$ ) on univariable analysis.

**Conclusions:** Perioperative blood transfusion after LTBR is associated with poorer oncologic outcomes, including higher recurrence rates and mortality.

### Learning Objectives:

- 1) Understand the oncologic outcomes and transfusion requirements of patients undergoing lateral temporal bone resection.
- 2) Interpret clinical data and individually assess the association between perioperative transfusion and oncologic outcomes, taking tumor- and patient-specific factors into account.
- 3) Describe predictors of poor recurrence-free, disease-specific, and overall survival using data from this large, single-institution cohort to inform management decisions for a rare subset of cancers that may be infrequently encountered elsewhere.

**Desired Result:** Attendees will be able to apply these learning objectives to guide perioperative management decisions aimed at optimizing oncologic outcomes and minimizing potential adverse effects of blood transfusions when performing lateral temporal bone resection.

**Level of Evidence – Level III**

**Indicate IRB or IACUC:** The MD Anderson Cancer Center IRB# PA19-0106

**Concurrent Validity of the Welling and Melbourne Temporal Bone Dissection  
Scales Across Five Years of Resident Training**

*Aaron Snow, MD; Mikayla Huestis, MD; Nicholas Anthony, BS  
Stephanie Moody-Antonio, MD; Peter G. Volsky, MD*

**Objective:** To evaluate the concurrent validity of the Welling and Melbourne scales in assessing otologic surgical skill using paired ratings of temporal bone dissections completed by otolaryngology residents over five years.

**Study Design:** Retrospective validation study.

**Setting:** Tertiary academic temporal bone dissection laboratory.

**Patients/Subjects:** Fifty-five temporal bone specimens dissected by residents (PGY 2–5).

**Interventions:** Each dissection was evaluated using both the Welling and Melbourne scales by one faculty rater. Checklist items were coded as binary indicators (Agree/Disagree or Complete/Incomplete) and summed for total scores.

**Main Outcome Measures:** Correlation between total Welling and Melbourne scores overall and across subgroups defined by PGY year and difficulty level.

**Results:** The mean Welling and Melbourne total scores were  $20.3 \pm 7.2$  and  $15.3 \pm 2.7$ , respectively. The two scales demonstrated a strong positive correlation (Pearson  $r = 0.72$ ,  $p < 0.001$ ; Spearman  $r = 0.73$ ,  $p < 0.001$ ). Correlations remained robust across subgroups: by PGY ( $r = 0.63$ – $0.78$ ) and by difficulty ( $r = 0.69$ – $0.82$  for “Easy–Average” dissections). The relationship persisted across five years of training, supporting consistency between the two assessment systems.

**Conclusions:** The Welling and Melbourne scales show strong concurrent validity in evaluating temporal bone dissection performance. Despite differences in structure and scoring emphasis, both provide comparable measures of resident skill, supporting their interchangeable use for competency assessment and educational benchmarking.

**Learning Objective:** To understand how the Welling and Melbourne temporal bone dissection scales align in assessing otologic surgical skill.

**Desired Result:** Demonstrate that both scales reliably measure similar constructs of surgical competence, enabling consistent cross-platform evaluation in simulation-based otologic training.

**Level of Evidence** - Level III.

**Indicate IRB or IACUC:** IRB # 22-04-NH-0089

## Comparing 2D and 3D Magnetic Resonance Imaging-Derived Radiomic Features of Vestibular Schwannomas for Predicting Facial Nerve Outcomes After Retrosigmoid Resection

*Nicole Page, BS; Murphy Kenny, BS; Sai Chandan Reddy, BS; James Feghali, MD  
Christopher Jackson, MD; Francis Creighton, MD; George Liu, MD*

**Objective:** To investigate the relationships of magnetic resonance imaging (MRI)-derived 2D and 3D features of vestibular schwannomas with facial nerve (FN) outcomes after retrosigmoid resection.

**Study Design:** Single-center retrospective cohort study

**Setting:** Tertiary referral center

**Patients:** Adults who underwent retrosigmoid resection of vestibular schwannoma tumors between August 2016 and January 2024. Six different surgeons were involved.

**Interventions:** Tumor segmentations were performed on MRI sequences using 3D Slicer software to analyze tumor volumes, elongation, surface area, and centroid displacement relative to the porus acusticus center. 2D measurements were made using radiology image software.

**Main Outcome Measures:** Short- (<2 weeks) and long-term postoperative FN exam scores, binarized as good (House-Brackmann I-II) and Poor (III-VI). Predictive features were assessed by area under receiver operating characteristic curve (AUC).

**Results:** 44 subjects with good FN baseline function ages 37-84 years were analyzed. 82% had gross total resections. Median follow-up duration was 3.6 years. Larger tumor volume and maximum diameter were associated with poor short- and long-term FN outcomes ( $p<0.01$ ). There was no difference between volume and maximum diameter for predicting long-term FN outcomes ( $AUC=0.95$  versus  $0.94$  respectively,  $p=0.88$ ). Higher surface area ( $AUC=0.95$ ,  $p<0.001$ ) and lower elongation (more spherical shape;  $AUC=0.68$ ,  $p<0.05$ ) also predicted poor long-term FN outcomes, as did dorsal and medial tumor centroid position relative to the porus acusticus ( $AUC=0.83$  and  $0.79$ ,  $p<0.01$ ). In analysis of only gross total resections ( $n=31$ ), surface area, tumor volume, and max diameter remained significant predictors of FN function ( $AUC>0.93$ ,  $p<0.001$ ), while elongation did not ( $AUC=0.7$ ,  $p=0.19$ ).

**Conclusions:** Tumor volume and maximum diameter were similar predictors of short- and long-term FN outcomes. Large multi-institutional prospective studies are needed to validate these findings.

**Learning Objective:** To understand how 3D radiomic features such as tumor volume, surface area, and elongation may influence facial nerve outcomes following resection of vestibular schwannomas.

**Desired Result:** To affirm that maximum tumor diameter is an adequate proxy for tumor volume and to demonstrate that novel 3D radiomic features may provide insight into facial nerve prognosis in resection of vestibular schwannomas.

**Level of Evidence:** III

**Indicate IRB or IACUC:** IRB00322104, Johns Hopkins University



## Postoperative Hearing Recovery in Vestibular Schwannoma: A Case Series

*Clifford J. He, BA; Hayley A. Granberg, BA; Krish Suresh, MD,  
Marc Schwartz, MD; Rick Friedman, MD, PhD*

**Objective:** Characterize patients demonstrating postoperative hearing improvement following vestibular schwannoma resection using Thornton and Raffin's 95% critical-difference model for word-recognition scores (WRS).

**Study Design:** Retrospective case series.

**Setting:** Single tertiary academic center

**Patients:** Nine of 442 patients (2.0%) undergoing hearing preservation microsurgery with postoperative WRS improvement beyond test variability thresholds.

**Interventions:** Microsurgical resection via retrosigmoid (n=7) or middle-fossa (n=2) approaches with postoperative nimodipine.

**Main Outcome Measures:** Change in tumor-side WRS using Thornton and Raffin's model, all obtained from standardized pre- and postoperative institutional audiograms. This model treats speech discrimination performance as a binomial variable, accounting for retest variability and inherent variability in percentage of correct responses across 50-word tests, to define the minimum change required for statistical significance ( $p < 0.05$ ) based on test length and baseline score.

**Results:** Patients' mean age was 50 years old (SD=9); six had left-sided tumors. Mean maximal linear diameter was 18.2 mm (SD=4.7). All were NF2-negative. Postoperatively, all patients received nimodipine. Mean tumor-side WRS improved from 51.6% (SD=11.2%) to 82.0% (SD=9.7%) ( $p < 0.001$ , Thornton & Raffin model), while mean PTA improved from 45 dB (SD=8) to 40 dB (SD=6). Eight had postoperative follow-up audiogram within two weeks (mean 8.9 days, SD=2.2), and one on postoperative day 78. Five achieved gross-total resections, two near-total, and two subtotal.

**Conclusions:** Statistically significant hearing recovery following vestibular schwannoma resection is rare but possible. Incorporating binomial critical-difference model provides a framework for distinguishing true auditory improvement from test variability. Factors associated with hearing recovery are difficult to study given the rarity of this phenomenon; it may be due to relief of mass effect on the cochlear nerve. Regardless we wish to draw attention to this rare and underreported phenomenon.

**Learning Objective:** Recognize measurable postoperative hearing recovery in vestibular schwannoma and apply Thornton and Raffin's model for accurate outcome interpretation.

**Desired Result:** Enhance clinician awareness of statistically validated hearing improvement with vestibular schwannoma surgery.

**Level of Evidence:** Level V

**Indicate IRB or IACUC:** UC San Diego Health (#161794)

## Longitudinal Study of Non-Traditional Cochlear Implant Indications Practice Impacts and Referral Trends

*Shawn M. Stevens, MD; Frances Nowlen, BS; Michael A. Roarke, BS; Samuel Barber, MD  
Marine Prevost, AuD; Jaysen Moreno, AuD; Nancy Flores, AuD*

**Objectives:** Compare practice composition, referral patterns, surgical conversion rates, and causes of failed conversion for non-traditional CI candidates (nonTradCI) vs. traditional CI candidates (TradCI).

**Study Design:** Prospective cohort study. Longitudinally captured every CI encounter at our institution from 2021-July 2025 (program inauguration-endpoint).

**Setting:** Single tertiary care center.

**Patients:** Adult patients (>18yrs) pursuing TradCI or nonTradCI. NonTradCI defined as asymmetric hearing loss (AHL) or single side deafness (SSD). AHL criteria: PTA4 >60dB HL and aided CNC <50% in implanted ear; PTA4 30-60dB and word score 50-80% in better ear. Established SSD criteria.

**Interventions:** Candidacy workup, surgical referrals, CI surgery.

**Main Outcome Measures:** Demographics, referral patterns, surgical conversion rates, conversion failures.

**Results:** 709/731 patients/ears were evaluated for CI. Breakdown by indication was: 7.3%SSD (52 patients/ears), 30.7%AHL (218 patients/ears), and 62.0%TradCI (416/439 patients/ears). The relative distribution of nonTradCI vs. TradCI remained constant from 2021-2025. SSD patients were significantly younger (mean 53.5+/-16.5 yr) than AHL (69.1+/-15.5 yr,  $p<0.0001$ ) and TradCI (62.7+/- 22.5 yr;  $p=0.0005$ ). NonTradCI were less likely to be referred by an outside group than TradCI (22%vs34.4%;  $p=0.0004$ ). Further, SSD patients were the least likely to be referred [6/52 (11.5%)], compared to AHL [53/218 (24.3%);  $p=0.04$ ] and Trad CI [143/416 (34.4%);  $p=0.0009$ ]. Overall, 589 patients have reached a conversion endpoint (70.9% surgery). The surgical conversion rate was significantly higher for TradCI vs nonTradCI (76%v62%;  $p<0.0003$ ). Conversion rates improved from 2021-23 (42-52%) to 2024-25 (75%) in NonTradCI candidates. Assessing conversion failures, the most common causes among nonTradCI were: loss to followup, candidate choice to not continue, and insurance denial.

**Conclusions:** NonTradCI indications comprise roughly a third of our adult CI practice. Surgical conversion and referral rates were lower for nonTradCI candidates. This trend may be improving.

**Learning Objective:** Describe the impact of nonTradCI indications on practice makeup and referral patterns.

**Desired Result:** Increase awareness of non-traditional CI indications and their expanding impact on surgical practices.

**Level of Evidence - III**

**Indicate IRB or IACUC:** PHXU-24-500-074-73-12. St. Joseph's Dignity Health

## **Iatrogenic Third Window Syndrome following Retrosigmoid Trigeminal Microvascular Decompression in a Patient with Malformed Vestibular Aqueduct**

*Simon D. Beatty, MD; John I. Lane, MD; Nicholas L. Deep, MD*

**Objective:** To report the first documented case of iatrogenic induced third window syndrome in a patient with a malformed vestibular aqueduct following trigeminal nerve microvascular decompression (MVD) managed successfully with surgery.

**Study Design:** Case Report

**Setting:** Single Tertiary Center

**Patients:** 34-year-old female underwent retrosigmoid MVD for trigeminal neuralgia. Immediately postoperatively, she developed autophony for voice, eyes, footsteps, pulsatile tinnitus, and Tulio phenomenon. Otoscopy was normal. Post-MVD audiogram demonstrated ipsilateral low frequency conductive hearing loss with a suprathreshold bone conduction and intact acoustic reflexes. Cervical VEMP testing showed lowered threshold on the effected side. Temporal bone CT demonstrated normal superior canals without dehiscence but revealed a malformed vestibular aqueduct with two apparent openings intracranially caused by hyperostosis of the posterior petrous bone. Notably, on review of the operative note from her MVD surgery, the neurosurgeon commented that the left cerebellar hemisphere was unusually adherent to the petrous dura requiring significant dissection to release it.

**Interventions:** Transmastoid ligation of the endolymphatic duct and sac and obliteration of the mastoid with bone cement.

**Main Outcome Measures:** Resolution of third window symptoms

**Results:** Patient reported immediate resolution of third window symptoms after surgery, with preservation of normal hearing thresholds.

**Conclusions:** In a patient with a malformed vestibular aqueduct, microdissection around the endolymphatic sac during retrosigmoid MVD likely unmasked a previously auto-occluded cochlear third window fistula. This resulted in acute onset of third window symptoms postoperatively. Surgical ligation of the endolymphatic duct and sac with mastoid obliteration successfully resolved her symptoms.

**Learning Objective:** Recognize how vestibular aqueduct malformations can contribute to third window physiology.

**Desired Result:** To increase awareness that malformed vestibular aqueducts, including enlarged vestibular aqueduct, may present with third window symptoms. Preoperative imaging review can help identify at-risk patients. Surgical obliteration of the endolymphatic duct and sac with mastoid cavity closure is an effective management strategy in select cases.

**Level of Evidence** - Level V

**Indicate IRB or IACUC:** Exempt

## National Trends in Bone Conduction Hearing Implants in the Last 10 Years

*Christopher Z. Wen, MD; Rishi Katragadda, BS; Emily Chow, MD; Daniel Karasik, MD  
Audrey Lawrence, BS; Marcelina Puc, MS; Adam C. Kaufman, MD, PhD*

**Objective:** To describe national trends in patients receiving bone conduction hearing implants (BCHI)

**Study Design:** Retrospective cohort study

**Setting:** US institutions participating in the Epic Cosmos database

**Patients:** Adult and pediatric patients undergoing BCHI placement between January 2015 and December 2024

**Main Outcome Measures:** Sociodemographic factors, device type, and changes in implantation rate over time

**Results:** 10,767 patients received percutaneous BCHI (p-BCHI) placement and 1,506 received transcutaneous BCHI (t-BCHI). p-BCHI rates fell sharply in 2020 during the COVID pandemic, and after a brief recovery declined from 1.36 to 0.94 per 100,000 between 2021 and 2024. Since device-specific coding began, t-BCHI doubled from 0.29 to 0.59 per 100,000. By 2024, the t-BCHI rise outpaced the reduction in p-BCHI since 2021, supporting partial substitution rather than persistent volume loss. Substitution was uneven; t-BCHI uptake was higher in pediatric vs adult patients (0.74 vs 0.59 per 100,000) and rural vs urban residents (0.98 vs 0.53), and lower in Black vs White patients (0.20 vs 0.73). Recipient-level models showed higher odds of t-BCHI for pediatric (OR 1.26, 95% CI 1.12–1.42;  $p<0.0001$ ) and rural patients (OR 1.26, 95% CI 1.11–1.43;  $p<0.001$ ); sex, race, and ethnicity did not differ by device type among recipients, consistent with access-driven gaps. Compared with p-BCHI, t-BCHI had lower odds of replacement (OR 0.69, 95% CI 0.55–0.86;  $p<0.001$ ) but higher odds of removal/explantation (OR 3.94, 95% CI 3.03–5.11;  $p<0.0001$ ).

**Conclusions:** U.S. practice is shifting from p-BCHI to t-BCHI. Growth in t-BCHI likely explains a substantial share of the recent p-BCHI decline, but substitution is inequitable—faster in pediatric and rural populations and slower among Black patients—highlighting targets for equitable diffusion.

**Learning Objective:** To describe the disparities that exist for patients receiving bone conduction hearing implants.

**Desired Result:** Greater understanding of the healthcare disparities that exist for patients receiving a bone conduction hearing implant and how recent events have impacted who receives these interventions.

**Level of Evidence - IV**

**Indicate IRB or IACUC:** Exempt

## Identifying Geographic Regions with the Lowest Cochlear Implant Incidence: Where to Direct Outreach Resources

*Ashley M. Nassiri, MD, MBA; Theresa B. Hennesy, MD; Matthew L. Carlson, MD, MBA  
Bridget Mosley, MPH; Liza Creel, PhD; Vinaya Manchaiah, AuD, PhD*

**Objectives:** In an effort to focus outreach and to direct programmatic changes to effectively reach at-risk patient populations, this study examines zip-code level data to determine the effect size of various patient factors in cochlear implant (CI) incidence across regions in the U.S.

**Study Design:** Deidentified CI data were acquired from prospectively collected patient registries from two CI manufacturers (Cochlear Americas and Advanced Bionics), which supply an estimated 85% of CIs in the U.S.

**Setting:** U.S. CI centers.

**Patients:** Adults  $\geq 20$  years old who underwent CI between 2015 and 2023.

**Interventions:** Cochlear implantation.

**Main Outcome Measures:** Percentages of White population, poverty, and higher education; Rural Urban Commuting Areas (RUCA) categorization.

**Results:** The study cohort included 69,947 adults  $\geq 20$  years old who underwent CI between 2015 and 2023. CI candidates residing in zip codes with the lowest percentage of White residents ( $< 66\%$  of the population), highest poverty rates ( $> 17\%$  of the population), and lowest rates of associate degrees ( $< 24\%$  of the population) were at higher risk for untreated CI candidates ( $p < 0.0001$  for all). Metropolitan areas had lower CI incidence compared to rural zip codes (334 vs. 390 per 100,000 person-years, respectively,  $p < 0.0001$ ). Multivariate analysis identified non-White race as an independent factor associated with a 34% increased risk of untreated CI candidates (relative risk 1.34,  $p < 0.0001$ ). Living in a high poverty or metropolitan zip code presented 15% and 7% increased risks, respectively ( $p < 0.0001$ ).

**Conclusions:** Metropolitan zip codes with the highest rates of non-White populations have the lowest incidence of CI. This study identifies the most at-risk geographic locations for low CI incidence and can guide resources more effectively to reach the greatest number of CI candidates.

### Learning Objectives:

- Describe the patient factors that affect risk of untreated hearing loss.
- Understand the effect of urban-rural determination on incidence of CI.
- Appreciate that non-White race has the highest relative risk of untreated hearing loss when compared with poverty rate, higher education rate, and urban-rural determination.

**Desired Result:** Physicians, audiologists, and researchers would better understand geographic factors influencing incidence of CI and thus adapt more efficient strategies for increasing access to CI.

**Level of Evidence:** III

**Indicate IRB or IACUC:** Exempt

## Understanding Facial Nerve Recovery in Skull Base Osteomyelitis: The Role of Severity and Surgical Treatment

*Hetal Lad, BS; Lucy Revercomb, BS; Emma Thompson, BA; Joseph Chong, BS  
Devanshi Patel, MD; Michael Ray Moentmann, MD; Yu-lan Mary Ying, MD*

**Objective:** Skull base osteomyelitis (SBO) is a rare, aggressive complication of malignant otitis externa. Facial nerve paralysis is considered to be a marker of advanced disease and portends poor prognosis. However, it is uncertain how severity of facial nerve paralysis at presentation and surgical interventions for SBO influence recovery of facial nerve function.

**Methods:** Retrospective chart review.

**Setting:** Tertiary academic healthcare system.

**Patients:** Patients treated for SBO at Rutgers Health between 2011 and 2025.

**Intervention:** Mastoidectomy with pressure-equalization tube placement for intraoperative tissue culture.

**Main Outcome Measure:** Facial nerve paralysis was graded using the House-Brackmann (HB) scale and categorized as mild (HB I-II) or severe (HB  $\geq$  III). Recovery was defined as improvement by at least one HB grade or complete resolution on a subsequent visit. Analyses were conducted in R, significance at  $p < 0.05$ .

Results: Among 48 patients with confirmed SBO, 19 (38.8%) presented with facial nerve palsy. 13 patients had severe paralysis while 4 had mild paralysis, 2 were ungraded. Over a median follow up of 255.7 days, 35.3% (6/17) demonstrated partial recovery. 30.8 % (4/13) recovered from severe facial nerve palsy while 50% (2/4) recovered from mild facial nerve palsy ( $p=0.58$ ). 57.9% (11/19) of patients with facial nerve paralysis underwent surgical intervention, 90% of whom demonstrated severe facial nerve palsy. 57.1% of patients who did not undergo surgical intervention demonstrated severe facial nerve palsy. 30% (3/10) of patients that underwent surgery demonstrated recovery of facial nerve function compared with 42.9% (3/7) of patients without surgical management ( $p=0.64$ ).

**Conclusions:** Facial nerve palsy occurs frequently in patients with SBO, with a majority having severe paralysis if any deficit is present. Surgical intervention does not significantly impact recovery.

Learning Objective: To understand the impact of severity of facial nerve paralysis and surgical management on the recovery of facial nerve function in patients with skull base osteomyelitis.

**Desired Result:** Clinicians will recognize the importance of evaluating facial nerve function throughout SBO management and benefits of early identification.

**Level of Evidence - III**

**Indicate IRB or IACUC:** Rutgers University Pro2024002225

**Assessing the Effectiveness of an Artificial Intelligence Language  
Model in Improving Patient Counseling in Otolaryngology Surgery**

*Ha Eun Kim, BS; Alex W. Yang, MD; Gregory S. Hill, MD  
David Holovac, BS; Jason Peart, BS; Charles A. Riley, MD; Anthony M. Tolisano, MD*

**Objective:** To assess whether integrating a large language model (ChatGPT) into pre-operative counseling improves patient understanding, satisfaction, and communication in otolaryngology surgery, and to examine how pre-operative preparedness relates to post-operative satisfaction and engagement.

**Study Design:** Prospective randomized controlled trial.

**Setting:** Tertiary military academic center.

**Patients:** 31 adults scheduled for otolaryngology surgery.

**Interventions:** After standard counseling, intervention arm participants interacted with ChatGPT to ask additional surgery-related questions. Both groups completed pre- and post-operative surveys using a 5-point Likert scale.

**Main Outcome Measures:** Pre-operative satisfaction and confidence metrics (Q1-Q8), post-operative satisfaction measures (Q1.1-3.1), correlation between pre- and post-op understanding and confidence metrics between the control and intervention groups. Counseling duration, ChatGPT interaction time, and number of questions asked.

**Results:** The average physician encounter lasted 10.9 minutes in the intervention group and 10.7 minutes in the control group. ChatGPT interactions averaged 6.2 minutes with 4.5 questions per patient. Pre-operative confidence, preparedness, and communication ratings (Q1, Q2, Q6, Q7) were strongly correlated ( $p < 0.05$ ), confirming internal consistency of the counseling measures. Pre- and post-operative composite satisfaction scores did not differ between groups ( $p > 0.10$ ), but the control group showed greater understanding of surgical risks ( $p = 0.012$ ) and satisfaction in communication ( $p = 0.034$ ). Patients whose questions were fully answered pre-operatively reported significantly higher post-operative satisfaction in both groups ( $p < 0.05$ ).

**Conclusions:** Both groups demonstrated that thorough pre-operative communication and resolution of patient questions were key predictors of post-operative satisfaction. ChatGPT integration did not improve overall post-op satisfaction.

**Learning Objective:** To understand how a conversational AI model (ChatGPT) influences pre-operative communication, patient confidence and satisfaction in otolaryngology surgical settings.

**Desired Result:** To guide structured deployment of AI-assisted counseling as a complement to physician communication, emphasizing its use for question clarification and expectation management.

**Level of Evidence:** Level II

**Indicate IRB or IACUC:** Walter Reed National Military Medical Center IRB was obtained WRNMMC-2023-0423 (approval date 07/31/2024).

## The Interaction between Cognition and Balance Differs by Clinical Diagnosis

*Anat Lubetzky, PT, PhD; Maura Cosetti, MD (presenter); Carly Feist BA  
Brittani Morris, DPT; Jen Kelly, DPT*

**Objective:** Cognitive decline is known to be associated with balance dysfunction however, since both balance and cognition are multidimensional, this relationship is not straightforward. We investigated the relationship between cognition function and measures of balance among three clinical groups: unilateral vestibular hypofunction (UVH), unilateral hearing loss (UHL) and definite Meniere's Disease (MD.)

**Study Design:** cross-sectional

**Setting:** outpatient academic center

**Patients:** 30 patients (10 UVH, 10 UHL, 10 MD) completed a computerized neurocognitive battery and tests of balance function.

**Interventions:** We evaluated the Pearson's correlations between balance measures and cognitive performance.

**Main Outcome Measures:** Static balance: Duration standing on foam with eyes closed (seconds, longer is better), Dynamic balance: gait speed (m/s, higher is better), Self-reported: Activities-Specific Balance Confidence Scale (% , higher is better). Cognitive Domains: age-adjusted standardized scores (higher is better): Cognitive flexibility, composite memory, executive function, reaction time, sustained attention, verbal, visual and working memory.

**Results:** Unique patterns emerged per group. MD: Patients with better static balance (longer hold) showed better cognitive flexibility ( $R=0.51$ ) and executive function ( $R=0.49$ ). Faster walking was associated with better sustained attention ( $R=0.5$ ) and verbal memory ( $R=0.6$ ). Higher ABC (balance confidence) was correlated with better composite memory ( $R=0.63$ ), sustained attention ( $R=0.6$ ) and verbal memory ( $R=0.74$ ). UHL: Better static balance showed better sustained attention ( $R=0.6$ ); Higher balance confidence was associated with better composite memory ( $R=0.61$ ), sustained attention ( $R=0.44$ ), verbal memory ( $R=0.62$ ), visual memory ( $R=0.56$ ) and working memory ( $R=0.43$ ). Vestibular: no correlations were observed. When the 3 groups were combined, no correlations above 0.2 were observed between cognitive domains and balance function.

**Conclusions:** The relationship between balance performance and cognition is nuanced and may be disease-specific. Balance function in isolated vestibular loss appears independent of domain-specific cognitive performance.

**Learning Objective:** Participants will explain the relationship between various domains of neurocognitive function (e.g., executive function, reaction time) and balance function.

**Desired Result:** Increased understanding and appreciation for the complex relationship between cognitive performance and balance function in patients with unilateral vestibular hypofunction (UVH), unilateral hearing loss (UHL) and definite Meniere's Disease (MD.)

**Level of Evidence – IV**

**Indicate IRB or IACUC:** STUDY-21-01026, Mount Sinai



## What Factors Matter in Approach Selection for CSF Leak Repair? A Cohort Analysis of Safety and Efficacy

*Zheng Hong Tan, PhD; Vivienne E. Pham, BS; Ada Sher, MD; Oliver F. Adunka, MD, MBA  
Desi P. Schoo, MD; Robert J. Macielak, MD; Yin Ren, MD, PhD*

**Objective:** To assess the factors influencing the surgical approach for the repair of lateral skull base cerebrospinal fluid (CSF) leak and its subsequent outcomes.

**Study Design:** Retrospective case series.

**Setting:** Academic tertiary referral center.

**Patients:** Patients with a lateral skull base CSF leak who underwent repair via an either transmastoid or MCF approach between January 2017 and August 2024.

**Interventions:** CSF leak repair via either a transmastoid or MCF approach.

**Main Outcome Measures:** Persistent leakage (defined as continued CSF leak within 3 months of surgery), long-term recurrence (defined as a new leak > 3 months after surgery).

**Results:** Sixty-six patients were identified, of which 21 (32%) underwent a transmastoid repair and 45 (68%) underwent a MCF approach. The average age at surgery for the transmastoid cohort was 59.6 years (Standard Deviation [SD] $\pm$ 14.5) while average for the MCF cohort was 58.4 years (SD $\pm$ 12.1). There were no associations between surgical approach and age ( $p=0.728$ ), sex ( $p=0.956$ ), race ( $p=0.382$ ), prior skull base surgery ( $p=0.967$ ), pre-operative hearing loss ( $p=0.215$ ), or the number of tegmen defects ( $p=0.061$ ). In the transmastoid cohorts, there were 10 patients (48%) with tegmen tympani defects and 10 patients (48%) with tegmen mastoideum defects and 1 patient (5%) with defects in both locations. For the MCF approach, there were 5 patients (11%) with tegmen tympani defects, 29 patients (64%) with tegmen mastoideum defects, and 11 patients (24%) with defects in both locations. This resulted in a significant difference in dehiscence location between the transmastoid and MCF cohorts ( $p=0.0052$ ). There were no immediate post-operative complications in either cohort. No patients in the transmastoid cohort had persistent leakage compared to 2 patients (4.4%) in the MCF cohort ( $p>0.999$ ). The average length of hospital stay for the transmastoid cohort was 1.28 days (SD $\pm$ 1.3) compared to 3.06 days (SD $\pm$ 2.12) for the MCF cohort ( $p<0.0001$ ). There was not a significant difference in long-term CSF leak recurrence rate, with 3 patients (14.2%) in the transmastoid cohort having recurrence compared to 2 patients (4.4%) in the MCF cohort ( $p=0.159$ ).

**Conclusions:** Despite standard preconceptions, there were no demographic, efficacy, or safety differences between the two approaches to temporal bone CSF leak repair, showing clinical success no matter the scenario. Rather than patient demographics, these data suggest that leak location and provider experience are better decision-points regarding approach selection.

**Learning Objective:** To identify the prevalence of demographic, efficacy, and safety differences between different approaches to CSF leak repair

**Desired Result** Providers will be educated on the viability of the MCF approach on older patients and appreciate the role of the defect location on approach selection, improving clinical decision making and patient counseling.

**Level of Evidence** - Level IV

**Indicate IRB or IACUC:** The Ohio State University IRB #2024H0277

**Comparison of Audiometric Outcomes Between Different Surgical Approaches  
Following Lateral Skull Base Repair of Cerebrospinal Fluid Leaks**

*Dhillon R. Advano, BS; Antara Gupta, BS; Ritu R. Trivedi, BA  
J. Walter Kutz Jr., MD; Rance J.T. Fujiwara, MD, MBA*

**Objective:** To investigate the differences between audiometric outcomes following lateral skull base repair of cerebrospinal fluid (CSF) leaks using a transmastoid, middle fossa craniotomy, or combined approach.

**Study Design:** Retrospective review

**Setting:** Single-institution tertiary care center

**Patients:** 183 adult patients who underwent 202 lateral skull base repairs for CSF leaks between May 2013 and June 2024 were included. 66 (36%) patients were male, and the median age was 59 years [IQR: 50-68].

**Interventions:** CSF leak repairs via transmastoid and/or middle fossa craniotomy

**Main Outcome Measures:** Audiologic data included pure tone average (PTA), air-bone gap (ABG), mean air conduction, word recognition score (WRS), and tympanogram type.

**Results:** 183 patients underwent 202 lateral skull base repairs via transmastoid (n = 52), middle fossa craniotomy (n = 98), or combined approach (n = 52) for spontaneous CSF leaks (n = 161), traumatic CSF leaks (n = 7), or iatrogenic CSF leaks (n = 15). Postoperatively, PTA increased by 1.67 dB (p = 0.007) and mean ABG decreased by 3.33 dB (p = 0.028) when compared to their pre-operative values. There was no significant change in median WRS postoperatively. Tympanogram distributions shifted postoperatively with Type A increasing from 24% to 45%, Type B decreasing from 64% to 42%, and Type C increasing from 12% to 13%. There were no significant differences in ABG, PTA, and WRS between different operative approaches.

**Conclusions:** Postoperatively, patients who underwent lateral skull base repair for CSF leaks had improved hearing with no differences in outcomes between three surgical approaches: transmastoid, middle fossa craniotomy, or combined approaches.

**Learning Objective:** To learn about the audiometric implications of using different surgical approaches to a lateral skull base CSF leak repair

**Desired Result:** To guide decision-making for clinicians when choosing the type of approach for lateral skull base CSF leak repair

**Level of Evidence - Level IV**

**Indicate IRB or IACUC:** University of Texas Southwestern Institutional Review Board; STU-2024-0631

**Migraine History is a Risk Factor for Revision Surgery after Lateral Skull Base Cerebrospinal Fluid Leak Repair.**

*Antara Gupta, BSA; Dhillon R. Advano, BS; Ritu R. Trivedi, BA  
J. Walter Kutz Jr, MD; Rance J.T. Fujiwara, MD, MBA*

**Objective:** To identify the risk factors for revision surgeries after lateral skull base cerebrospinal fluid (CSF) leak repair

**Study Design:** Retrospective review

**Setting:** Single-institution tertiary care center

**Patients:** 183 adult patients who underwent lateral skull base CSF leak repair between May 2013 and June 2024 were included. 66 (36%) patients were male, and median age was 59 years [IQR: 50-68].

**Interventions:** CSF leak repair via transmastoid and/or middle fossa craniotomy

**Main Outcome Measures:** Incidence of revision surgery following primary repair

**Results:** Among 183 patients who had lateral skull base cerebrospinal fluid (CSF) leak repair, 50 (27%) underwent a transmastoid approach, 93 (51%) underwent middle fossa craniotomy, and 40 (22%) underwent a combined approach. Revision surgery was required in 21 patients (12%). A history of migraines was present in 43 of the 183 patients (24%), of whom 10 (23%) required revision surgery. 48% of patients who underwent revision had a history of migraines. On multivariate binary logistic regression analysis, a history of migraines was a significant predictor of revision surgery (OR=3.67, 95% CI [1.15, 12.0]; p=0.028). A combined surgical approach was also associated with increased risk of revision surgery (OR=7.16, 95% CI [1.31, 60.7]; p=0.037). We found no significant association between revision surgery risk and patient demographics, comorbidities (including diabetes, hypertension, hyperlipidemia, obstructive sleep apnea, idiopathic intracranial hypertension), history of meningitis, or history of prior surgery or leak etiology.

**Conclusions:** Patients with a history of migraines are at increased risk of revision surgery after lateral skull base CSF leak repairs.

**Learning Objective:** To learn about common factors identified in patients who undergo revision surgeries after lateral skull base CSF leak repairs

**Desired Result:** To inform clinician decision making when counseling operative candidates for lateral skull base CSF leak repairs

**Level of Evidence** - Level IV

**Indicate IRB or IACUC:** University of Texas Southwestern Institutional Review Board; STU-2024-0631

**Pre-operative Facial Nerve Tractography of Vestibular Schwannomas:  
A Systematic Review of the Impact of Acquisition Schemes and Analysis Pipelines**

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Kaith K. Almefty, MD; Michael T. Lawton, MD; Richard D. Dortch, PhD*

**Objective:** Evaluate how diffusion-MRI (dMRI) acquisition and processing choices influence the accuracy and clinical utility of pre-operative CN VII tractography in vestibular schwannoma (VS), especially in large VS (i.e., Koos Grade III/IV). Literature often cites  $\geq 87\%$  “success rate” of tractography, yet in reality its role falls short of standard of care, motivating a neuroimaging methodology-focused re-appraisal.

**Study Design:** Systematic review of PubMed articles (1990–2024) per PRISMA 2020; risk of bias assessed with QUADAS-2 (patient selection, index test, reference standard, flow/timing) by two independent reviewers; no meta-analysis due to heterogeneity.

**Setting:** Not applicable.

**Patients:** Adults with sporadic VS undergoing microsurgical resection; *in-vivo* MRI; sample size  $\geq 5$ ; intra-operative validation required. Excluded: non-English articles, review articles, NF-2.

**Interventions:** Pre-operative dMRI tractography of CN VII with intra-operative stimulation/visual confirmation as reference.

**Main Outcome Measures:** Primary outcome was concordance rate between pre-op CN VII tractography and intra-operative localization. Secondary outcomes are: sensitivity, PPV, and false discovery rate (FDR) derived from TP/FP/FN; optionally the rate of CN VII shape agreement and CN VIII visualization where reported.

**Results:** Twenty-two studies met inclusion/exclusion criteria. Protocols varied widely across field strength, acquisition, preprocessing, signal modeling, tracking algorithms, validation methods, and reporting, precluding robust quantitative synthesis. QUADAS-2 flagged high bias across studies.

**Conclusions:** The practical reliability and repeatability of CN VII tractography in VS remain undetermined. Standardized reporting using sensitivity/PPV/FDR is recommended, alongside prospective work to optimize acquisition, preprocessing, modeling, tracking, and validation.

**Learning Objective:** Recognize how acquisition-to-validation choices impact CN VII tractography reliability and apply standardized metrics when interpreting or designing protocols.

**Desired Result:** Improve reporting consistency, enable realistic patient counseling, and inform protocol optimization for safer skull-base surgery.

**Level of Evidence** – III.

**Indicate IRB or IACUC:** Exempt.

**Motion Sickness Susceptibility and Stroop Performance Predict Mal de Débarquement Syndrome (MdDS) Risk: A Machine Learning Approach**

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Jong Bin Lee, MD, PhD; Michael J. Eliason, MD; Akihiro J. Matsuoka, MD, DMSc, PhD*

**Objective:** To identify predictive factors for Mal de Débarquement Syndrome (MdDS) risk using machine learning approaches and develop a risk stratification model for individuals susceptible to persistent phantom motion sensations following prolonged travel.

**Study Design:** Predictive modeling study using logistic regression and random forest machine learning algorithms.

**Setting:** USNS Mercy (T-AH 19) during its Pacific Partnership 2024 deployment across the Indo-Pacific region

**Patients:** 38 Active-Duty U.S. Navy personnel

**Interventions:** Assessment of motion exposure history, motion sickness susceptibility (Simulator Sickness Questionnaire, SSQ), and cognitive performance testing (Stroop test and Symbol Digit Modalities Test, SDMT).

**Main Outcome Measures:** MdDS criteria score (0-5); participants scoring  $\geq 4$  were classified as high-risk for MdDS.

**Results:** Motion sickness susceptibility (SSQ scores) and Stroop test performance emerged as the strongest predictors of MdDS tendency in both models. Higher SSQ scores and poorer Stroop performance significantly increased odds of MdDS score  $\geq 4$ . Greater motion exposure showed modest association with increased risk. SDMT and other cognitive metrics demonstrated minimal predictive value.

**Conclusions:** Machine learning-driven modeling indicates that high motion sickness susceptibility and reduced cognitive flexibility are strongly linked to MdDS symptom development. These findings offer insight into risk stratification, enabling targeted screening and preventive strategies for individuals susceptible to MdDS.

**Learning Objective:** To understand risk factors for MdDS development; to recognize the role of motion sickness susceptibility and cognitive flexibility in vestibular disorder onset; to apply machine learning techniques in clinical risk prediction

**Desired Result:** Development of a validated screening tool for early identification of individuals at high risk for MdDS to enable preventive interventions

**Level of Evidence - III**

**Indicate IRB or IACUC:** UC San Diego IRB (#810413); Naval Medical Center San Diego IRB (#NMCS.D.2023.0033)

**Audiometric Outcomes Following Surgical Repair of Temporal Bone Cerebrospinal Fluid Leaks with and without Ossicular Chain Reconstruction**

*Savannah Nicks, DO; Gabriele Noreikaite, DO; Rebekkah Lee, DO  
Bora Agabigum, MD; Robert Conway, DO; Seilesh Babu, MD*

**Objective:** To identify if there is a difference in audiometric outcomes between patients who underwent lateral temporal bone resection via the following approaches: transmastoid, transmastoid with ossicular chain reconstruction, and middle cranial fossa.

**Study Design:** Retrospective Chart Review

**Setting:** Tertiary Care Institute

**Patients:** Patients from 2009 to 2024 that underwent a lateral temporal bone CSF leak repair at a tertiary institute

**Interventions:** Intervention was based on approach at time of surgery: transmastoid without ossicular chain reconstruction (TM without OCR), transmastoid with ossicular chain reconstruction (TM with OCR), and middle cranial fossa (MCF).

**Main Outcome Measures:** Post-operative audiogram testing (i.e. pure tone average (PTA), word recognition score (WRS), or air bone gap (ABG)).

**Results:** A total of 72 patients (n = 72) were included. There were 46 patients with TM approach without OCR, 15 with TM approach with OCR, and 11 with MCF approach. There was a -2.6 dB change in PTA for TM approach without OCR, there was a -2.3 dB change for TM with OCR, and a -4.8 dB change for MCF approach. There was little change in WRS or ABG across groups.

**Conclusions:** In summary, hearing outcomes were similar across all groups regardless of approach or OCR at time of transmastoid approach.

**Learning Objective:** To determine if surgical approach or OCR at time of surgery changes hearing outcomes in patients after repair of lateral temporal bone CSF leak repair

**Desired Result:** To determine is surgeon choice of approach for repair or choice to perform OCR at time of surgery changes patient hearing outcomes

**Level of Evidence:** *Level V*

**Indicate IRB or IACUC:** *Exempt*

## Degree of Hearing Loss is Associated with Subjective Tinnitus Severity

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Howard S. Moskowitz, MD, PhD; Sarah Bracker, PA; Rachel F. Held, PhD; Joshua J. Sturm, MD, PhD

**Objective:** To explore the relationship between degree of hearing loss and subjective tinnitus severity.

**Study Design:** Survey study and retrospective chart review.

**Setting:** Academic medical center.

**Patients:** 24 adult patients (>18 years old) with chronic (>3 months) subjective tinnitus.

**Interventions:** Questionnaires collected included the Tinnitus Handicap Inventory (THI) and the Tinnitus Functional Index (TFI). Hearing loss was quantified with pure tone audiometry.

**Main Outcome Measures:** Correlation coefficients between subjective tinnitus severity (THI, TFI) and pure tone averages (PTA) calculated for the right and left ears across 500Hz to 4000Hz. Correlation analyses were performed separately for PTA in the ear experiencing the most significant tinnitus (PTA-tin) and PTA in the contralateral ear (PTA-contralateral).

**Results:** Positive correlations were found between both TFI and THI scores and PTA in the ear experiencing the most significant tinnitus (TFI x PTA-tin;  $r = 0.47$ ,  $p = 0.03$ , 95% CI: 0.07 to 0.74, THI x PTA-tin;  $r = 0.49$ ,  $p = 0.02$ , 95% CI: 0.11 to 0.75). No significant correlations were found between THI/TFI scores and PTA in the contralateral ear (TFI x PTA-contralateral;  $p = 0.22$ , TFI x PTA-contralateral;  $p = 0.31$ ). A subscale analysis of the THI questionnaire subdomains revealed that PTA-tin was more strongly correlated with *Functional* domain scores ( $r = 0.54$ ,  $p = 0.007$ , 95% CI: 0.17 to 0.77) than *Emotional* ( $r = 0.47$ ,  $p = 0.02$ , 95% CI: 0.08 to 0.74) or *Catastrophic* ( $r = 0.17$ ,  $p = 0.42$ , 95% CI: -0.25 to 0.54) scores.

**Conclusions:** Higher levels of tinnitus handicap were associated with higher degrees of hearing loss in the ear most affected by tinnitus. This was particularly the case for tinnitus handicap in the functional domain, which relates to areas of mental, social and physical functioning.

**Professional Practice Gap & Educational Need:** Degree of hearing loss may be an underappreciated contributor to subjective tinnitus severity, thereby supporting the dual utility of amplification in managing hearing loss and tinnitus.

**Learning Objective:** To explore the relationship between subjective tinnitus distress and degree of hearing loss.

**Desired Result:** To improve physician knowledge of the interplay between hearing impairment and tinnitus handicap.

**Level of Evidence - III**

**Indicate IRB or IACUC:** This study is IRB approved under protocol 2025-16851 at Montefiore Einstein

## **Predictive Value of Intraoperative Electromyography Parameters for Postoperative Facial Nerve Function: A Systematic Review**

*Sonaal Verma, BS; Sriprachodaya Gaddam, BS; Paritosh Coomar, BS  
Zachary Schwam, MD; George Wanna, MD; Enrique Perez, MD*

**Objective:** To identify intraoperative electromyography (EMG) parameters most frequently associated with postoperative facial nerve outcomes in otologic and skull base surgeries

**Study Design:** Systematic review.

**Setting:** Systematic review of studies indexed in PubMed, Web of Science, and Embase from 2000 through 2025.

**Patients:** Not applicable (systematic review).

**Interventions:** Not applicable (systematic review).

**Main Outcome Measures:** Intraoperative EMG parameters associated with or predictive of postoperative facial nerve function.

**Results:** Forty studies met inclusion criteria. Thirty-nine focused on skull base procedures, and one addressed middle ear surgery. The House-Brackmann scale was the most used outcome measure. Stimulation threshold was the parameter most frequently reported and correlated with post-op facial nerve outcomes (n = 32), followed by free-run train time (n = 13) and amplitude ratio (n = 12). Medtronic NIM was the most used device. All studies were rated as low risk of bias.

**Conclusions:** Stimulation threshold and free-run EMG train time were the parameters most frequently associated with postoperative facial nerve outcomes. However, wide variability in intraoperative EMG techniques limits standardization and cross-study comparison. The single middle ear study underscores a gap in understanding EMG use in this surgical context. Given that Medtronic NIM was the most frequently reported system, and concerns have been raised by the AAO-HNS regarding its reliability, future studies should assess device validity. Future investigations should aim to establish standardized EMG protocols, expand research in middle ear surgery, and compare monitoring systems to optimize clinical utility.

**Professional Practice Gap & Educational Need:** There is a lack of standardized intraoperative EMG practices and techniques, underrepresentation in the literature of facial nerve EMG monitoring in middle ear surgery, and limited comparative data on facial nerve monitoring systems.

**Learning Objective:** Describe the EMG parameters most associated with facial nerve outcomes, recognize the limited data in middle ear surgeries, and understand the need for validation of facial nerve monitoring systems.

**Desired Result:** To improve clinical decision making by encouraging standardized EMG practices, expanding investigation of facial nerve monitoring in middle ear surgery, and studying the validity of monitoring systems.

**Level of Evidence:** Level V

**Indicate IRB or IACUC:** Exempt



**From Residency to Fellowship: Gender and Race in Neurotology  
Fellowship Compared with Otolaryngology Residency**

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Theodore Huang, MS; Justin R. Shinn, MD; Eric R. Oliver, MD*

**Objective:** Quantify gender and race trends in neurotology fellowships, using otolaryngology residency as a benchmark.

**Study Design:** Retrospective, cross-sectional study.

**Setting:** Accreditation Council for Graduate Medical Education (ACGME) trainee counts across academic years 2011-2012 to 2023-2024 for race and 2007-2008 to 2023-2024 for gender.

**Participants:** All Neurotology and Otolaryngology trainees reported to ACGME.

**Interventions:** None.

**Main Outcome Measures:** Annual proportions by gender and race (White; Asian/Pacific Islander; Hispanic; African American; American Indian/Alaska Native; Unknown/Other). Race trends tested with Cochran–Armitage; gender compared between 2007–2008 and 2023–2024 by  $\chi^2$ .

**Results:** Among neurotology fellows, female representation increased from 13.0% to 41.0% ( $\chi^2=5.33$ ,  $p=0.021$ ), and a significant increase in Hispanic fellows was observed ( $p=0.026$ ); changes in White, Asian/Pacific Islander, African American, and American Indian/Alaska Native were not significant ( $p>0.05$ ). For comparison, otolaryngology residency showed broader diversification: females rose from 27.8% to 44.3% ( $\chi^2=89.5$ ,  $p<0.001$ ) and proportions of Asian/Pacific Islander, Hispanic, and African American trainees increased (all  $p<0.001$ ), with a small decrease in American Indian/Alaska Native ( $p<0.01$ ).

**Conclusions:** Neurotology fellowships demonstrate meaningful gains in female representation, but more limited race shifts relative to otolaryngology residency. Because fellowships feed the future academic and leadership pipeline, stagnation at the subspecialty stage may blunt upstream residency gains. Focused outreach, mentorship, and holistic selection in neurotology could help align fellowship demographics with the evolving resident pool.

**Learning Objective:** Identify where diversity gains are and are not occurring within neurotology and interpret simple trend and comparison tests to guide program strategy.

**Desired Result:** Provide actionable data for the Neurotology Society to inform recruitment and mentorship.

**Level of Evidence:** Level IV.

**Indicate IRB or IACUC:** Exempt

**Barriers to Increasing Cochlear Implant Surgical Volume –  
A Survey-Based Study**

*Mana Espahbodi, MD; Rebecca Rosenzweig, BS; Terry Zwolan, AuD; Weston Adkins, AuD  
Karl Doerfer, MD; Richard Gurgel, MD, MSCI; Maura Cosetti, MD*

**Objective:** This study surveyed surgeons regarding cochlear implant (CI) surgical volume to determine factors that impact CI surgical caseload in order to identify barriers that may be impacting access to care.

**Study Design:** The survey included demographic questions (i.e. age, years in practice, etc.), number of CI surgeries performed the past year, factors that impact CI surgery caseload, surgical confidence, if they train residents and fellows, and patient wait times for CI surgery.

**Setting:** The survey was emailed to 1500 physicians using a manufacturer “opt-in” email list and was posted on social media networks. It was open for completion from August 23 – October 3, 2025.

**Patients:** N/A

**Interventions:** Participation in the IRB-approved survey was voluntary.

**Main Outcome Measures:** Responses provided by participants about their CI practice.

**Results:** 228 attending physicians completed the survey. Most report that they perform CI surgeries (96%, 204/212) and most (47%, 108/228) perform 10–25 CIs each month. The average number of CIs per month per surgeon is 3.6 with adults accounting for 81%. 47% (107/228) indicate they would like to perform more CIs, with the greatest limiter to performing more CIs cited as low patient demand (i.e. low referrals, 34%, 78/228) and institutional barriers (28%, 64/228). Surgeons who do not perform CI (4%, 8/212) indicated that other surgeons in their practice perform CIs (63%, 5/8). Most report patients wait 4–8 weeks for surgery.

**Conclusions:** Barriers to increase CI surgical volume require continued effort to overcome in order to increase the number of patients who are able to benefit from this life-changing technology.

**Professional Practice Gap & Educational Need:** Factors that impact CI surgical caseload are unknown.

**Learning Objective:** To determine factors that impact CI surgical volume.

**Desired Result:** To address areas for intervention on to increase CI surgical volume and CI utilization.

**Level of Evidence** – N/A

**Indicate IRB or IACUC:** Mount Sinai (IRB Protocol #: STUDY-25-00413)

## **Dynamic Intraoperative Interpretation of TIM Heatmaps: Fluoroscopic Correlation of Skip and Central Heat TIM Patterns in Cochlear Malformation**

*Jacob Mabey, MD; Natasha Tillett, MD; Sam Schild, MD; Justin Cottrell, MD*

**Objective:** To describe intraoperative fluoroscopic and trans-impedance matrix (TIM) findings during cochlear implantation in a patient with bilateral cochlear malformations, highlighting the dynamic relationship between electrode position and evolving TIM heatmap patterns.

**Study Design:** Case report

**Setting:** Tertiary academic center.

**Patients:** A patient with a right Incomplete Partition type I malformation and a left common cavity malformation undergoing cochlear implantation.

**Interventions:** Real-time intraoperative fluoroscopy was used to guide electrode placement. TIM analysis was performed following complete electrode insertion, and after adjustments to optimize final electrode positioning.

**Main Outcome Measures:** TIM heatmap morphology, fluoroscopic electrode position, and correlation between electrode position and subsequent TIM heatmap patterns.

**Results:** Initial insertion produced a previously characterized TIM skip heat pattern seen in patients with Incomplete Partition Type II and deficient interscalar septal width. This prompted partial electrode withdrawal under fluoroscopy, which subsequently resulted in a TIM central heat pattern, representing a symmetric voltage concentration around the mid-array region. Advancing the array slightly resulted in a skip heat pattern with more defined current delineation and more favorable x-ray profile. Interestingly, SmartNav analysis interpreted the TIM data as a tip foldover, despite good positioning.

**Conclusions:** This case visually demonstrates which small positional changes of electrodes within malformed cochleae can transform TIM morphology, helping to elucidate why certain patterns occur, and next steps to study clinical relevance.

**Professional Practice Gap & Educational Need:** Understanding current behavior within the cochlea can help elucidate better ways of stimulating neural elements and placing electrodes. Different current spread patterns utilizing TIM have been identified in patients with cochlear malformations, however why patterns occur is not well understood.

**Learning Objective:** To better understand why TIM heatmap patterns occur, highlighted by a case in which real-time fluoroscopic guidance was utilized in a patient with cochlear malformations.

**Desired Result:** A deeper understanding of TIM technology, and potential critical angles of electrode proximity that translate to current spread between electrodes that can undergo future study to evaluate physiologic correlate.

**Level of Evidence** - Level V

**Indicate IRB or IACUC:** Exempt.