

***SELECTED ABSTRACTS***

***ORAL  
PRESENTATIONS***



***56<sup>th</sup> Annual Virtual Spring Meeting  
AMERICAN NEUROTOLOGY SOCIETY***

***LIVE!  
Saturday, April 10, 2021***

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## Exploring Factors Responsible for Delay in Pediatric Cochlear Implantation

*Jacquelyn DeVries, BS, Yin Ren, MD, PhD*

*Julie Purdy, PhD, CCC-A, Daniela Carvalho, MD, MMM, Elina Kari, MD*

**Objective:** To identify and characterize demographic and socioeconomic factors associated with delays in cochlear implantation (CI) in children

**Study Design:** Retrospective

**Setting:** Tertiary pediatric CI referral center

**Patients:** All CI recipients under 18 years of age receiving CI between March 2018 and February 2020.

**Interventions:** CI

**Main Outcome Measures:** Primary outcome measures included age at implantation and time from candidacy evaluation to CI.

**Results:** Seventy-two patients were identified (44% female, average age at implantation 4.87 years). Age at implantation was later in patients with public, rather than private, insurance ( $5.98 \pm 0.78$ yr vs.  $3.13 \pm 0.66$ yr,  $p=.007$ ) and those from low-income areas ( $8.58 \pm 7.6$ y vs.  $2.35 \pm 3.00$ y,  $p=0.007$ ). Time between identification as a CI candidate and implantation was longer in publicly insured patients ( $721 \pm 107$ d vs.  $291 \pm 64$ d,  $p=.001$ ) and in bilingual children ( $888 \pm 160$ d) compared to those who spoke solely Spanish ( $473 \pm 101$ d,  $p=0.036$ ) or English ( $400 \pm 95$ d,  $p=.022$ ). Latinx children were more often publicly insured whereas white children were more often privately insured, ( $p<.05$ ). Publicly insured patients had delays in each step of the pre-CI workup, including vestibular evaluation ( $621 \pm 132$ d vs.  $197 \pm 67$ d,  $p=.007$ ), developmental evaluation, ( $517 \pm 106$ d vs.  $150 \pm 56$ d,  $p=.003$ ), speech evaluation ( $482 \pm 107$ d vs.  $163 \pm 65$ d,  $p=.013$ ), and Children's Implant Profile (ChIP) assessment ( $572 \pm 107$ d vs.  $184 \pm 59$ d,  $p=.002$ ). On ChIP evaluation, concerns regarding education were higher in Spanish-speaking children ( $p=0.024$ ;  $p=2.6 \times 10^{-4}$ ) and children with public insurance ( $p=0.016$ ;  $p=.002$ ). Income and language spoken were found to predict age at implantation ( $p=0.006$ ;  $p=0.019$ ) while race and language spoken predicted delay from candidacy identification to implantation ( $p=0.18$ ;  $p=0.007$ ).

**Conclusions:** Disparities in access to cochlear implantation continue to affect timing of implantation.

**Define Professional Practice Gap & Educational Need:** 1. Lack of understanding regarding persistent disparities in timing of pediatric cochlear implantation as based on type of insurance, ethnicity, and language(s) spoken in the home.

**Learning Objective:** 1. To identify determine factors associated with delay in pediatric cochlear implantation

**Desired Result:** 1. Attendees will have a better understanding of demographic factors associated with delays in pediatric cochlear implantation. 2. Attendees will have knowledge when in the pre-implantation process delays are likely to occur in order to target areas of improvement.

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

**Indicate IRB or IACUC :** Rady Children's Hospital IRB # 190779. Approved 12/11/2019. All data was collected after IRB approval.

## **Outcomes in Patients Meeting Cochlear Implant Criteria in Noise but not in Quiet**

*Anthony Thai, BA; Emma Tran, BS; Austin Swanson, AuD; Matthew B. Fitzgerald, PhD  
Nikolas H. Blevins, MD; Jennifer C. Alyono, MD*

**Objective:** Evaluate outcomes in cochlear implant (CI) recipients qualifying based on AzBio in noise but not in quiet

**Study Design:** Retrospective cohort study

**Setting:** Tertiary otology/neurotology clinic

**Patients:** After excluding device failures, this study included 216 implanted ears (mean age  $65.0 \pm 18.7$  years, 59.6% male). The cohort group comprised 23 ears with preoperative AzBio scores  $\geq 40\%$  in quiet and  $\leq 40\%$  in either +10 or +5 speech-to-noise ratio (SNR). The control group included 193 ears with preoperative AzBio scores  $< 40\%$  in quiet. Age and gender were similar between the two groups.

**Interventions:** Cochlear implantation

**Main Outcome Measures:** 1-year post-operative AzBio score in quiet and noise

**Results:** Cohort group AzBio scores improved in +10 SNR (pre-operative: 25.4%, post-operative: 51.4%,  $p < 0.001$ ) but not quiet (pre-operative: 62.0%, post-operative: 71.0%,  $p = 0.16$ ). In contrast, controls improved in AzBio +10 SNR (preoperative: 8.0%, postoperative: 55.7%,  $p < 0.001$ ) and quiet (preoperative: 11.8%, postoperative: 66.8%,  $p < 0.001$ ). Both groups had similar postoperative AzBio quiet ( $p = 0.47$ ) and +10 SNR ( $p = 0.50$ ). Compared to controls, the cohort had fewer ears with significant within-subject improvement in AzBio quiet ( $\geq 15\%$  improvement; control: 89.9%, cohort: 41.1%,  $p < 0.001$ ). Ears displaying within-subject improvements in AzBio quiet were more likely to have lower baseline scores in AzBio quiet ( $p < 0.001$ ) and CNC words ( $p = 0.004$ ), but not baseline AzBio +10 SNR, aided pure tone average and unaided word recognition scores ( $p > 0.05$ ).

**Conclusions:** Patients qualifying for CI candidacy because of performance in noise display significant post-implantation benefit in noise. However, these patients are less likely to show significant individual improvement in quiet.

**\*Define Professional Practice Gap & Educational Need:** Major insurance companies define CI criteria based on sentence recognition scores without specifying whether such testing should be performed in quiet or in noise. Our study presents a larger group of patients with longer follow-up than exists in prior literature, and confirms that patients meeting CI candidacy solely in noise still benefit from implantation, although to a lower extent than patients qualifying in quiet.

### **\*Learning Objective:**

Cochlear implant candidacy criteria do not specify the level of background noise that should be employed for sentence recognition testing.

Patients meeting CI criteria in noise but not in quiet display significantly improved AzBio scores in noise post-implantation. Patients with low baseline AzBio scores in quiet and/or in noise are most likely to have clinical benefit from CI.

### **\*Desired Result:**

Cochlear implantation should be considered in patients meeting cochlear implant criteria solely in noise. Patients with lower baseline scores are more likely to derive significant objective benefit.

**Level of Evidence - IV**

**Indicate IRB:** IRB 50573, Stanford University

## ANS TRAINEE AWARD

### Zwitterionic Coating of Cochlear Implants Reduces Friction and Force of Insertion

*Douglas M. Bennion, MD, PhD; Ryan Horne; Adreann Peel  
C. Allan Guymon, PhD; Marlan Hansen, MD*

**Background:** Strategies to minimize intracochlear trauma during implantation of an electrode array are critical to optimize outcomes including hearing preservation. To this end, bioengineering advances in application of thin-film zwitterionic hydrogels to relevant biomaterials provide a promising avenue.

**Methods:** Using a recently designed one-step process, thin-film coatings containing zwitterionic sulfobetaine methacrylate (SBMA) were polymerized and photografted to the surface of polydimethylsiloxane (PDMS, silastic) samples and also to cochlear implant (CI) arrays from two manufacturers. Methylene and fluorescein staining and scanning electron microscopy with energy-dispersive X-ray spectroscopy verified and characterized the coatings. Tribometry was used to measure the coefficient of friction between uncoated and coated PDMS and biologic tissues. Force transducer measurements were obtained during manual insertion and robotic motorized insertion of uncoated (n=9) and coated CI electrode arrays (n=9) into human cadaveric cochleae.

**Results:** Image analysis confirmed uniform coating of the PDMS samples and the CI electrode arrays with SBMA polymer films. SBMA thin-film coating of PDMS resulted in >90% reduction in frictional coefficients across various biologic tissues (subdermis, trachea, aorta, bladder, dura,  $p < 0.001$ ). During insertion of electrode arrays into human cadaveric cochleae, SBMA coatings reduced maximum force by more than 40% during both manual insertion ( $p < 0.005$ ) and micromotorized insertion ( $p < 0.005$ ).

**Conclusion:** Thin-film SBMA coatings of PDMS and electrode arrays significantly reduce frictional coefficients and insertional forces in cadaveric cochleae. These encouraging findings support thin-film zwitterionic coatings of CI electrode arrays as a method for reducing insertional trauma and thereby promoting hearing preservation.

**Define Professional Practice Gap & Educational Need:** Hearing preservation in cochlear implantation has become an important priority in cochlear implantation and bioengineering strategies designed to prevent intracochlear trauma by decreasing friction and insertional forces are discussed.

**Learning Objective:** - Become familiar with the biochemistry of photografting of zwitterionic hydrogels

- Understand the effect of zwitterionic coating in reducing the coefficient of friction between various biomaterials and biologic surfaces
- Appreciate the impact of thin-film coating on human cochlear implant arrays in reducing insertional forces in a cochlear implant in explanted human cadaveric cochleae.

**Desired Result:** Improved understanding of the potential for zwitterionic thin-film coatings at reducing friction and force of cochlear implant insertion

**Level of Evidence:** N/A

**Indicate IRB or IACUC:** Exempt.

# NEUROTOLOGY FELLOW AWARD

## The Impact of Age on Noise Sensitivity in Cochlear Implant Recipients

*Matthew Shew, MD; Craig Buchman, MD; Dorina Kallogjeri, MD; Stephanie Chen, MD  
Cameron Wick, MD; Nedim Durakovic, MD; Jacques Herzog, MD  
and CI532 Study Group*

**Objective:** To evaluate the impact of noise on speech perception testing in adult cochlear implant (CI) recipients above and below 65 years.

**Study Design and Setting:** Multi-institution, prospective, non-randomized, single-subject repeated measures design.

**Patients:** 96 adults  $\geq 18$  years old with post-lingual bilateral sensorineural hearing loss.

**Intervention(s):** Participants received a CI532 in one ear. Speech perception measures were evaluated before and 6-months after activation.

**Main outcome measure(s):** Subjects completed consonant-nucleus-constant (CNC) words in quiet and AzBio sentences in noise using +10dB and +5dBSNR, and Montreal Cognitive Assessment (MOCA).

**Results:** 96 adult patients were enrolled (n=70 older ( $\geq 65$  years), n=26 younger ( $< 65$  years)). There was no significant difference in CNC scores (CI alone 58.4 vs 67.5,  $p=0.0857$ ; best aided 66.7 vs 76.1,  $p=0.3357$ ). Older adults performed worse on AzBio+10dBSNR compared to younger patients (CI alone 37.4 vs 56.9,  $p=0.0006$ ; best aided 51.4 vs 68.2;  $p=0.01$ ), and in AzBio+5dBSNR (CI alone 7.7 vs 11.2,  $p=0.0002$ ; best aided 15.3 vs 22.3,  $p=0.0005$ ). The magnitude of change in AzBio+10dBSNR was significantly less in older adults in CI alone (15.3 vs 22.3;  $p=0.0005$ ) but not best aided (21.5 vs 31.3;  $p=0.105$ ), and was drastically worse in AzBio +5dBSNR (CI alone 6.7 vs 22.1,  $p=0.0014$ ; best aided 9.5 vs 21.5;  $p=0.0142$ ). There was no significant difference in MOCA between the two age groups.

**Conclusions:** While both older and younger patients have similar outcomes with respect to CNC word scores, the addition of noise disproportionately impacts older patients. Caution should be exercised when adding noise to candidacy testing in the elderly.

### \*Define Professional Practice Gap & Educational Need:

- There are varying CI candidacy criteria used by Medicare and third-party payers. Additionally, the use of sentence recognition test to be utilized and the addition of background noise is not specified. The current study prospectively evaluates the impact of different open set sentence speech recognition tests in quiet, +10dB SNR, +5dB SNR in older adults ( $\geq 65$  years) compared to their younger counterparts.
- With an increasing number of older adults impacted by hearing loss, understanding the role of CI candidacy testing in quiet and noise in the elderly is an essential component as we move forward with creating consensus guidelines for CI candidacy.

### \*Learning Objective:

- Evaluate baseline and change in different speech recognition tests between younger and older adult CI recipients
- Understand the impact of background noise to CI candidacy testing and performance in younger and older adult CI recipients.

### \*Desired Result: I

- Similar magnitude of improvement in speech recognition scores between younger and older CI recipients
- The addition of background noise to speech recognition testing affects both younger and older CI recipients equally.

### \*Level of Evidence – Level III

**Indicate IRB or IACUC :** Registered on clinicaltrials.gov (NCT03007472), approved by each institutions' respective IRB.

## **The Influence of Cochlear Implant Electrode Type and Position on Hearing Preservation**

*Elizabeth L. Perkins, MD; Matthew O'Malley, MD; Marc Bennett, MD; David S. Haynes, MD  
Jack H. Noble, PhD; Robert F. Labadie, MD, PhD; René Gifford, PhD*

**Objective:** : To analyze the influence of electrode type and position on hearing preservation longevity following cochlear implantation

**Study Design:** Retrospective chart review

**Setting:** Tertiary referral center

**Patients:** Adult cochlear implant recipients between 2013-2019 with hearing preserved post-operatively and post-operative CT scans

**Interventions:** CT scan analysis of electrode position. Stepwise regression to determine influence of electrode position, electrode type, and patient demographics on post-operative low frequency hearing.

**Main Outcome Measures:** Low frequency pure tone average (LFPTA), LFPTA shift, angular insertion depth (AID), base insertion depth (BID), scalar position, mean perimodiolar distance

**Results:** Sixty (49.6%) were implanted with straight versus 32 (26.4%) implanted with a pre-curved electrode, and 29 patients (24.0%) with a pre-curved, nonstyletted electrode. Mean length of surgery date to last follow up was 28.6 months (range 1-103). There was no significant difference in activation, 6- and 12-month, and last follow up LFPTA shift when the cohort was separated by electrode type (straight  $p=0.3020$ , pre-curved, styletted  $p=0.5226$ , pre-curved, non styletted  $p=0.7651$ ). Pre-operative LFPTA and age of implantation was a significant predictor of LFPTA shift at activation, accounting for 30.8% of variance ( $F(2, 113) = 26.603$ ,  $p < 0.0001$ ). LFPTA shift at activation, scalar position, and base insertion depth were significant predictors of variability and accounted for 39.1% of variance in LFPTA shift at 6 months ( $F(3,87) = 20.269$ ,  $p < 0.0001$ ).

**Conclusions:** Patients had excellent long-term residual hearing regardless of electrode type. Age, pre-operative acoustic hearing, and BID may influence short and long-term hearing preservation.

**\*Define Professional Practice Gap & Educational Need:** The relationship of electrode type and position with speech outcomes has been established for conventional cochlear implantation, yet the impact and stability of residual low frequency hearing remains to be investigated.

**\*Learning Objective:** To understand the potential influence of cochlear implant electrode type and position on short and long-term hearing preservation

**\*Desired Result:** For practitioners to gain knowledge of the potential influences of patient demographics (age, residual low-frequency hearing) and electrode type on hearing preservation.

**Level of Evidence - IV**

**Indicate IRB or IACUC :** Exempt

## Role of Pre-Implant Patient Expectations in Adult Cochlear Implant Outcomes

*Theodore R. McRackan, MD, MSCR, Mark S. Costello, MD  
Priyanka Reddy, BS; Judy R. Dubno, PhD*

**Objective:** Pre-operative expectations affect patient outcomes in many health conditions, but expectations are rarely assessed in adult cochlear implant (CI) users. This study is a first step in assessing the contribution of pre-operative expectations to post-operative CI outcomes, including speech recognition, CI quality of life (CIQOL), and CI satisfaction.

**Study Design:** Cross-sectional study

**Setting:** Tertiary medical center

**Patients:** 41 adult CI patients

**Interventions/Main Outcome Measures:** Pre-operative expectation questionnaire results, pre-and post-operative speech recognition (CNC and AzBio) scores, post-operative CIQOL domain and global scores and CI satisfaction scores using a visual analog scale (VAS). Cohen's  $d$  was used to express effect size.

**Results:** Overall, patients with lower pre-operative CI performance expectations showed higher post-operative QOL. This effect was large for the emotional, entertainment, and social domains ( $d=0.85-1.02$ ) of the CIQOL-35 and medium for the communication, listening effort domains, and the Global score ( $d=0.55-0.63$ ). Pre-operative performance expectations showed minimal associations with pre-operative vs. post-operative change in CNC ( $d=-0.26$ ;  $-0.69-0.18$ ) or AzBio scores ( $d=-0.28$ ;  $-0.72-0.15$ ). Determining the extent to which pre-operative expectations played in role in post-operative satisfaction with CIs was limited by the clustering of satisfaction scores in the upper range of the scale (VAS mean 81.1).

**Conclusions:** This study provides preliminary evidence that patients' expectations prior to cochlear implantation may influence their post-operative quality of life and other outcomes, but not speech recognition. This suggests that an increased emphasis should be placed on measuring and counseling expectations in CI candidates. This assumption needs to be confirmed with additional research with larger sample sizes, more sensitive satisfaction measures, and a prospective design.

**Define Professional Practice Gap & Educational Need:** Despite being extensively investigated, the patient and audiological factors that are routinely evaluated account for only a small degree of variation in CI outcomes (QOL and speech recognition ability). Patient expectation has been shown to have a substantial impact on outcomes and directly contribute to patient satisfaction in many health conditions. However, understanding patient pre-CI expectation and its impact on patient outcomes remains a major research gap in adult cochlear implantation.

**Learning Objective:** Determine the potential impact of patient pre-CI expectations on QOL, speech recognition and satisfaction outcomes

**Desired Result:** Practitioners and researchers will understand that pre-CI expectations may have a substantial impact on post-operative CIQOL. As such, this area may be a modifiable factor that could be addressed more completely in the pre-operative setting and investigated in controlled prospective trials.

**Level of Evidence – Level IV**

**Indicate IRB or IACUC :** Medical University of South Carolina; Pro00073019

## **Time-to-Peak Speech Perception Score after Cochlear Implantation in Single-sided Deafness**

*Ashley M. Nassiri, MD, MBA; John P. Marinelli, MD; Katherine P. Wallerius, MD  
Christine M. Lohse, MS; Colin L. W. Driscoll, MD; Brian A. Neff, MD  
Aniket A. Saoji, PhD; Matthew L. Carlson, MD*

**Objectives:** 1) Characterize speech perception scores over time and 2) determine time-to-peak speech perception scores in patients with single-sided deafness (SSD) who underwent cochlear implantation (CI).

**Study Design:** Retrospective case review

**Setting:** Tertiary academic medical center

**Patients:** Adult patients with SSD who underwent CI from 2014-2019

**Interventions:** CI, speech perception testing

**Main Outcome Measure:** Time-to-peak speech perception score

**Results:** Thirty-six patients met inclusion criteria. Median age at implantation was 52.5 years (IQR 38-60.5), while median duration of deafness was 2.0 years (IQR (0.9-4.4)). Median CNC scores at 1, 3, 6, and 12 months postoperatively were 54%, 46%, 50% and 55% respectively, while AzBio sentences in quiet scores were 77.5%, 78%, 68.5% and 72%, respectively. A study participant was considered to reach peak scores when CNC reached 48% and AzBio reached 56%, defined as 80% of mean peak scores of 60% CNC and 70% AzBio for SSD patients reported in prior studies. In total, 24 patients reached peak CNC score at a median of 3 months (IQR 1-6) and 32 reached peak AzBio score at a median of 3 months (IQR 1-12). Duration of deafness was negatively correlated with CNC scores (correlation coefficient -0.13;  $p=0.51$ ) and AzBio scores (correlation coefficient -0.14;  $p=0.46$ ) at last follow-up, but these associations were not statistically significant.

**Conclusions:** Patients with SSD who undergo CI may experience a shorter time-to-peak speech perception score when compared to previously reported rates in traditional CI candidates. This may reflect the benefit of auditory input from a normal hearing contralateral ear.

**\*Define Professional Practice Gap & Educational Need:** Single-sided deafness is a relatively new indication for cochlear implantation. Consequently, outcomes data for this population is limited compared to those of traditional cochlear implant candidates. Outcomes data is important both for postoperative care guidelines and expectations and for patient counseling.

**\*Learning Objective:** For the single-sided deafness with cochlear implant population: 1) understand median speech perception scores over time postoperatively, and 2) understand trends in time-to-peak speech perception scores.

**\*Desired Result:** Physicians and audiologists will have additional knowledge about the postoperative speech perception outcomes and trends for cochlear implantation in the single-sided deafness population. This can potentially be used in patient counseling.

**Level of Evidence** - Level V

**Indicate IRB or IACUC:** Mayo Clinic IRB Approved #16-006130



## Identification of Factors Associated with Second-Side Cochlear Implant Speech Recognition Outcomes in Adults

*James R. Dornhoffer, MD\*; Yuan F. Liu, MD\*; Elise E. Zhao BS; Elizabeth L. Camposeo, AuD  
Ted A. Meyer, MD, PhD; Theodore R. McRackan, MD, MSCR*

*\*Authors contributed equally to this work*

**Objective:** Assess the relationship between patient, hearing, and cochlear implant (CI)-related factors and second sided CI speech recognition outcomes in bilaterally implanted adults.

**Study Design:** Retrospective review of a prospectively maintained CI database.

**Setting:** Tertiary academic center

**Patients:** 102 adults receiving bilateral sequential or simultaneous CIs

**Interventions/Main Outcome Measures:** Post-implantation Consonant-Nucleus-Consonant (CNC) word and AzBio sentence scores at  $\geq 12$  months.

**Results:** Of patient, hearing, and CI-specific factors examined, only post-implantation speech recognition scores of the first CI were independently associated with speech recognition performance of the second CI on multivariable regression analysis (CNC:  $\beta=0.471[0.298, 0.644]$ ; AzBio:  $\beta=0.602[0.417, 0.769]$ ). First-side postoperative CNC scores explained 24.3% of variation in second CI postoperative CNC scores, while improvement in first CI AzBio scores explained 40.3% of variation in second CI AzBio scores. Based on established 95% confidence intervals, 75.2%(CNC) and 65.9%(AzBio) of patients score equivalent or better with their second CI compared to first CI performance. Age at implantation, duration of hearing loss, receiving simultaneous vs. sequential CIs, and pre-operative residual hearing (measured by pure-tone average and aided speech recognition scores) were not associated with 12-month speech recognition scores.

**Conclusions:** The degree of improvement in speech recognition from first CI may predict speech recognition with a second CI. This provides preliminary evidence-based expectations for patients considering a second CI. Counseling should be guarded given the remaining unexplained variability in outcomes. Nonetheless, these data may assist decision making when considering a second CI versus continued use of a hearing aid for an unimplanted ear.

**Define Professional Practice Gap & Educational Need:** There is little evidence to help guide the decision between second CI and bimodal amplification (CI in one ear with hearing aid in the other) in patients with bilateral SNHL who have undergone initial unilateral CI.

**Learning Objective:** To explore demographic and audiologic factors that may be associated with second CI speech recognition performance.

**Desired Result:** Practitioners and researchers will recognize that the postoperative performance in speech recognition with one CI significantly correlated with performance on the second CI for patient undergoing bilateral implantation. As such, clinicians may offer limited evidenced-based guidance for patients pursuing a second CI vs. bimodal amplification with a hearing aid.

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

**Indicate IRB or IACUC :** Pro00071518

## **Characterizing Cochlear Implant Magnet-Related MRI Artifact and Visualization of Indicated Structures**

*Nathan D. Cass MD; Douglas J. Totten, BA; Elizabeth L. Perkins, MD  
John D. Ross MD; Matthew R. O'Malley, MD*

**Objective:** Characterize the magnetic resonance imaging (MRI) artifact from cochlear implant (CI) magnets and assess ability to identify and monitor indicated structures.

**Study Design:** Retrospective case series.

**Setting:** Tertiary referral center.

**Patients:** Patients undergoing MRI following CI placement from 2010-2019.

**Main Outcome Measures:** CI magnet-related artifact size and ability to visualize the indicated structure of interest on MRI.

**Results:** 20 cochlear implantees underwent 54 MRIs with retained magnet between 2010 and 2019. Median age at implantation of the patients was 58.8 (IQR: 50.4-66.7). MED-EL devices were implanted in 17 patients (85%) and Cochlear devices in 3 patients (15%). One patient was diagnosed with neurofibromatosis type 2 (NF2). Non-NF2 vestibular schwannoma was the most common indication for MRI (33%) followed by NF2 (19%). Magnet-related artifact size ranged from 4.6–5.9 cm, measured in radii at image level of maximum signal loss, with differences between spin and gradient echo pulse sequences, and additional ring artifacts in fat saturated sequences. Structure of interest was visualized in 33 (61%) of 54 MRIs; 9 (100%) with Cochlear devices and 24 (53%) with MED-EL devices.

**Conclusions:** While MRI-compatible CIs enable radiological follow-up of important structures after implantation, artifact from the implant can severely limit the ability to visualize and monitor these structures. Devices create varying levels of MRI artifact, which should be considered by the surgeon and patient prior to implantation, particularly in the setting of known intracranial disease. When possible, CI receiver-stimulator placement may also be altered to facilitate visualization of structures of interest.

**Define Professional Practice Gap & Educational Need:** New MRI-compatible CIs herald increased head and neck imaging in implantees; currently there is a lack of characterization and reporting of CI magnet-related artifact and the situations in which it limits ability to visualize and monitor structures of interest on MRI.

**Learning Objective:** Characterize CI magnet-related MRI artifact and determine how often structures of interest were able to be visualized and monitored on MRI following CI placement.

**Desired Result:** This study can provide context for discussion regarding artifact-related decisions including implant choice and device location placement in patients with high likelihood of needing post-implantation MRIs.

**Level of Evidence - IV**

**Indicate IRB or IACUC:** IRB Approved (192331, Vanderbilt University Medical Center)

**Natural History of Growing Vestibular Schwannomas During Observation:  
An International Multi-Institutional Study of 593 Growing Tumors**

*John P. Marinelli, MD; Matthew L. Carlson, MD; Jacob B. Hunter, MD; Ashley M. Nassiri, MD, MBA  
Martin Reznitsky, MD; Sven-Eric Stangerup, MD, DMSc; Per Caye-Thomasen, MD, DMSc*

**Objective:** To characterize the natural history of growing sporadic vestibular schwannoma (VS) during observation in an international multi-institutional cohort.

**Study Design:** Cohort study.

**Setting:** Four tertiary referral centers across the United States and Denmark.

**Patients:** Patients with two prior MRI scans demonstrating growth that continued observational management.

**Intervention:** Observation with serial imaging.

**Main Outcome Measure:** Subsequent linear growth-free survival (i.e., an additional  $\geq 2$ mm of growth) following initial growth of  $\geq 2$ mm from tumor size at diagnosis.

**Results:** Five hundred ninety-three patients met inclusion criteria. Median age at initial growth was 66 years (IQR 59-73) for intracanalicular tumors (N=65) and 62 years (IQR 54-70) for tumors with cerebellopontine angle extension (N=528). The median number of MRIs from diagnosis to last follow up was 5 (IQR 4-7) for intracanalicular tumors and 5 (IQR 3-6) for cerebellopontine angle tumors. The median duration of MRI surveillance following initial detection of tumor growth was 5.2 years (IQR 2.4-6.9) for intracanalicular tumors and 1.0 year (IQR 1.0-3.3) for cerebellopontine angle tumors. For intracanalicular tumors, subsequent growth-free survival rates (95% CI; number still at risk) at 1, 2, 3, 4, and 5 years following the initial MRI that demonstrated growth were 77% (67-88; 49), 53% (42-67; 31), 46% (35-60; 23), 34% (24-49; 17), and 32% (22-47; 13), respectively. For cerebellopontine angle tumors, subsequent growth-free survival rates were 72% (68-76; 451), 47% (42-52; 259), 33% (28-38; 140), 26% (22-31; 82), and 23% (18-28; 57), respectively.

**Conclusions:** Growth detected during observation does not necessarily portend future growth. Toleration of some growth during observation is justifiable in appropriately selected cases.

**Define Professional Practice Gap & Educational Need:** Tumor growth during observation is often assumed to foreshadow future growth. In this setting, patients are typically recommended to undergo definitive treatment with either microsurgery or radiosurgery. However, if not all tumors continue to grow after detection of initial growth, then continued observation with serial imaging may be appropriate in select cases (e.g., vestibular schwannoma in an only-hearing ear, advanced age with a slowly growing tumor, significant medical comorbidities). Given the widespread existing treatment paradigm surrounding treatment of growing tumors during observation, little data currently characterizes the natural history of growing vestibular schwannoma.

**Learning Objective:** Describe the natural history of sporadic vestibular schwannoma that has already met criteria for tumor growth during observation.

**Desired Result:** Physicians would consider toleration of some growth during observation in appropriately selected cases.

**Level of Evidence:** III

**Indicate IRB or IACUC:** We performed this research with approval from the required Institutional Review Boards (IRB 15-008224, 112016-040, 181440).

## Effect of AR42 on Tumor Growth and Hearing Loss In Vivo and on Primary Vestibular Schwannoma Cells

*Carly Misztal, BS; Olena Bracho, BS; Michael Estivill, BS; Cristina Fernandez Valle, PhD  
Fred F. Telischi, MD; Xue-Zhong Liu, MD, PhD; Christine T. Dinh, MD*

**Hypothesis:** AR42, a histone deacetylase (HDAC) inhibitor, reduces the viability of primary vestibular schwannoma (VS) cells and delays the progression of tumor growth and hearing loss (HL) in a xenograft model of VS.

**Background:** AR42 showed promising results when treating meningiomas and schwannomas *in vivo*; however, the effectiveness of AR42 in preventing tumor progression and HL with VS is unknown.

**Methods:** Pharmacokinetic studies for AR42 were performed in Fischer rats using mass spectrometry. Merlin-deficient Schwann cells were grafted onto cochleovestibular nerves of immunodeficient rats and treated with vehicle (n=7) or AR42 (25mg/kg/day for 4 weeks; n=12). Auditory brainstem response, rotarod, and tumor bioluminescence imaging were performed to 6 weeks. At the study endpoint, tumor weight and toxicities were measured. Primary human VS cells from 7 patients were cultured with AR42 (0-3.0 $\mu$ M) for 72 hours and viability assays were performed. Immunohistochemistry for HDAC was also conducted.

**Results:** AR42 reached peak concentrations in nerve ~24 hours after oral administration. AR42 delayed the progression of HL from 2 to 4 weeks at 4 and 32 kHz. When compared to control, AR42 did not affect tumor weight, auditory hair viability, and histology of liver and kidney. Overall, AR42 caused dose-dependent reductions in viability of VS cell-lines (p<0.05); however, some cell-lines responded better than others.

**Conclusions:** AR42 delayed the progression of HL temporarily but did not prevent tumor growth in an animal model of VS. A subset of VS cell lines demonstrated good response to AR42. Further investigations are warranted to evaluate whether AR42 would be effective in NF2 patients.

**Define Professional Practice Gap & Educational Need:** AR42 is a HDAC inhibitor that has shown benefit *in vivo* for meningiomas and schwannomas and may be beneficial in treating vestibular schwannomas in patients with Neurofibromatosis Type 2; however, the effectiveness of AR42 in controlling tumor growth in vestibular schwannoma is not well studied.

**Learning Objective:** Understand the effects of AR42 on tumor growth and hearing loss in an *in vivo* model of vestibular schwannoma and on viability of primary human vestibular schwannoma cells *in vitro*.

**Desired Result:** Understand that there is a need for novel therapies for Neurofibromatosis Type 2 (NF2) and that AR42, a HDAC inhibitor, may be a potential candidate in the treatment of patients with NF2-associated vestibular schwannoma.

**Level of Evidence:** N/A

**Indicate IRB or IACUC:** University of Miami IRB #20150637, approved 03/04/2019

## **Cost-effectiveness of Microsurgery, Radiosurgery, and Observation in the Management of Small-and Medium-sized Sporadic Vestibular Schwannoma**

*Robert J. Macielak, MD; Viengneesee Thao, PhD, MS; Bijan J. Borah, PhD  
James P. Moriarty, MS; Jamie J. Van Gompel, MD; Matthew L. Carlson, MD*

**Background:** The management of small- and medium-sized sporadic vestibular schwannoma (VS) remains controversial. Despite increasing emphasis on costs within healthcare, literature on this subject in the realm of VS care remains sparse.

**Objective:** To determine the most cost-effective VS management strategy.

**Methods:** A Markov model was created to determine the most cost-effective management algorithm for patients diagnosed with a sporadic <1.5 cm VS in both lifetime cost and quality-adjusted life-years (QALY). Treatment regimens included upfront microsurgery (MS), upfront radiosurgery (RS), observation with microsurgery strictly reserved for observed tumor growth (OMS), and observation with radiosurgery strictly reserved for observed tumor growth (ORS). Tumor growth and recurrence rates, MRI surveillance schedule, treatment outcomes, and health-related quality of life (HRQoL) values were derived from previously published data. Cost estimates were based on CMS Fee Schedule reimbursement rates.

**Results:** Across all ages, ORS was the most cost-effective management algorithm while upfront MS was the least cost-effective. When presented with a hypothetical 50-year-old patient, the most cost-effective strategy was ORS (\$18,889, 14.17 QALY), followed by OMS (\$21,189, 14.14 QALY), RS (\$32,456, 14.03 QALY), and MS (\$44,552, 13.58 QALY). Sensitivity analyses varying mortality rates, estimated costs, and HRQoL values noted largely similar results.

**Conclusions:** When diagnosed with a small- to medium-sized sporadic VS, observation provides the most cost-effective management at any age, with RS being the most cost-effective adjunct if growth is noted. Upfront MS is the least-cost effective management strategy.

**\*Define Professional Practice Gap & Educational Need:** Despite the increasing emphasis on health-care costs, few studies have compared the cost and cost-effectiveness of the available VS management strategies.

**\*Learning Objective:** Learners should be able to identify the most cost-effective management strategy when presented with a small- to medium-sized VS to allow for cost-conscious decision making.

**\*Desired Result:** To provide practitioners with an additional factor to consider when determining the best course of management when all management strategies are available.

**Level of Evidence – N/A**

**Indicate IRB or IACUC:** Exempt

## NEUROTOLOGY FELLOW AWARD

### Complications after Surgical Salvage for Vestibular Schwannoma following Failed Stereotactic Radiosurgery

*Alexander L. Luryi, MD; Seilesh Babu, MD; John F. Kveton, MD  
Dennis I. Bojrab, MD; Elias M. Michaelides, MD; Christopher A. Schutt, MD*

**Objective:** To assess complication rates following surgery for vestibular schwannoma after failed stereotactic radiosurgery (SRS).

**Study Design:** Retrospective chart review.

**Setting:** Two tertiary otology and neurotology centers.

**Patients and Interventions:** Patients undergoing their first surgery for vestibular schwannoma between 2007 and 2018.

**Main Outcome Measures:** Post-operative complications.

**Results:** Five hundred seventy patients met inclusion criteria, 16 of whom (2.8%) had undergone previous SRS. Patients who had previously undergone SRS were older (average age 59.6 vs. 52.7,  $p = 0.04$ ) but were otherwise similar to those who had not. Patients who had previously undergone SRS had a higher likelihood of post-operative cerebrospinal fluid (CSF) leak (25.0% vs. 8.1%,  $p = 0.05$ ), any post-operative complication (43.8% vs. 17.5%,  $p = 0.007$ ), and need for unplanned revision surgery (31.3% vs. 8.1%,  $p = 0.001$ ). Multivariate analysis confirmed an association between previous SRS and CSF leak (OR 4.20,  $p = 0.02$ ), any post-operative complication (OR 3.42,  $p = 0.02$ ), and need for unplanned revision surgery (OR 4.63,  $p = 0.009$ ), independent of age, tumor volume, body mass index, gender, and surgical approach. There were no significant associations between previous SRS and facial nerve functional outcomes ( $p > 0.05$ ).

**Conclusions:** Lateral skull base surgery for vestibular schwannoma in the setting of previous SRS is associated with an increased risk of complications. Patients undergoing such surgeries or deciding between SRS and alternative management should be counseled of this increased risk.

**\*Define Professional Practice Gap & Educational Need:** Prior reports on outcome after surgical salvage for vestibular schwannoma are lacking and conflicting. Further data on this important topic are needed.

**\*Learning Objective:** To establish the complication profile of salvage surgery for vestibular schwannoma and review existing literature on the topic.

**\*Desired Result:** Participants will understand the increased risk of complications associated with salvage surgery for vestibular schwannoma when compared with primary surgery.

**Level of Evidence - IV**

**Indicate IRB or IACUC :** IRB approved; Yale University School of Medicine #2000023466

## **Delayed Facial Nerve Palsy following Resection of Vestibular Schwannoma: Clinical and Surgical Characteristics**

*Bridget MacDonald, BA; Yin Ren, MD, PhD; Bitu Shahrivini, BS; Kareem Tawfik, MD  
Omid Moshtaghi, MD; Marc Schwartz, MD\*; Rick Friedman, MD, PhD\*  
(\*Equal senior authorship)*

**Objective:** Analyze delayed facial nerve palsy (DFNP) following resection of vestibular schwannoma (VS) to describe distinct characteristics and facial nerve (FN) functional course.

**Study Design:** Prospective cohort with retrospective review.

**Setting:** Academic medical center.

**Patients:** Consecutive patients undergoing VS resection 11/2017-08/2020. Exclusion criteria: preoperative House-Brackmann (HB)  $\geq$ III, postoperative HB  $\geq$ III without delayed palsy, <30 days follow-up.

**Interventions:** VS resection with intraoperative electromyographic (EMG) monitoring.

**Main Outcome Measures:** FN outcomes utilizing the HB scale; comparison between patients with DFNP (deterioration greater than one HB grade 24 hours to 30 days postoperatively) vs. those with HBI-II throughout.

**Results:** 288 patients met criteria: mean age 47.6 years, 36.1% male; 24.0% middle cranial fossa, 28.5% retrosigmoid, 47.6% translabyrinthine. DFNP occurred in 31 (10.8%) patients with average time to onset of 8.1 days. Of these, 22 (71.0%) recovered HBI-II and 3 (9.7%) recovered HBIII. Patients who experienced DFNP, on average, had larger maximum tumor diameter (23.4 vs. 18.7mm,  $p=0.014$ ), lower rate of retrosigmoid approach (9.7% vs. 30.7%,  $p=0.014$ ), higher rate of translabyrinthine approach (67.7% vs. 45.1%,  $p=0.017$ ), lower rate of gross-total resection (54.8% vs. 75.5%,  $p=0.014$ ), and lower rate of  $\geq 100\mu\text{V}$  FN response to 0.05mA stimulus intraoperatively (80.6% vs. 94.9%,  $p=0.002$ ). In multivariable logistic regression, patients with FN response  $\geq 100\mu\text{V}$  to 0.05mA stimulus were 72.0% less likely to develop DFNP ( $p=0.021$ ).

**Conclusions:** Intraoperative EMG facial nerve response, tumor size, surgical approach, and extent of resection may play a role in development of DFNP following resection of VS. Most patients who develop DFNP recover near-normal function.

### **Define Professional Practice Gap & Educational Need:**

There exists a need to understand the nature of delayed facial nerve palsy following resection for vestibular schwannoma such that appropriate pre- and postoperative prognostication can take place and best practices can be instituted to avoid this morbidity.

**Learning Objective:** To describe the prevalence and clinical course of delayed facial nerve palsy and to identify clinical and surgical characteristics that may be associated with its development.

**Desired Result:** Attendees will be better able to understand the risk of DFNP following resection of vestibular schwannoma, identify clinical and surgical factors that may play a role in its development, and finally, gain a better understanding of the functional course for these patients.

**Level of Evidence:** III – Cohort and case-control studies

**Indicate IRB or IACUC:** Approval was obtained from the UCSD Institutional Review Board, #180978XL.

## **Subset of Intracanalicular Vestibular Schwannomas Demonstrate Minimal Growth over a 10 Year Period**

*Matthew J. Wu, BS; Renata M. Knoll, MD Michael J. McKenna, MD  
Elliott D. Kozin, MD; David H. Jung, MD, PhD*

**Objective:** Characterize growth rates of intracanalicular vestibular schwannomas (VS) over a 10-year period.

**Study Design:** Retrospective chart review.

**Setting:** Tertiary care referral center.

**Patients:** Patients diagnosed with tumors earlier than 2012 with VS originating in the internal auditory canal (IAC) without neurofibromatosis 2 and available magnetic resonance imaging (MRI).

**Main Outcome Measures:** Primary outcomes included tumor growth rate (GR) and tertile location within the IAC (fundus, midpoint, porus) of untreated tumors. GR was evaluated at 5- and 10-years following diagnosis. Tumors arising from a single tertile were defined as Group A and those encompassing multiple tertiles were defined as Group B.

**Results:** We identified 57 intracanalicular VS (25 received treatment and 32 were untreated within 5 years of diagnosis). For untreated tumors, 14 were in Group A and 18 in Group B. The mean age of diagnosis and follow-up time were 52.0  $\pm$  14.1 and 6.4  $\pm$  2.4 years, respectively. Mean tumor size at the baseline MRI for Groups A and B was 4.3  $\pm$  1.7 and 10.8  $\pm$  3.8 mm, respectively. Overall, untreated intracanalicular VS exhibited little growth at 10-year follow-up (0.05mm/year). GR between Groups A and B at 5-year and 10-year follow-up periods were similar ( $p=0.40$  and  $p=0.57$ , respectively). VS that originated in the fundus had no growth at 10-year follow-up whereas those that originated at the IAC midpoint grew 0.22mm/year ( $p=0.03$ ).

**Conclusions:** In this longitudinal study examining intracanalicular VS over a 10-year period, over 50% of tumors required no treatment and exhibited no significant growth. Tumors originating in the fundus demonstrated the least rate of growth.

### **\*Define Professional Practice Gap & Educational Need:**

The management of vestibular schwannomas (VS) has changed over the past few decades. Tumors are increasingly being observed prior to treatment with radiation or surgery. Few studies have examined the long-term rate of growth of intracanalicular VS.

**\*Learning Objective:** Understand the rate of growth of intracanalicular vestibular schwannomas based on location within the internal auditory canal.

**\*Desired Result:** For intracanalicular VS, initial presentation within the IAC (near fundus, midpoint, or porus) may help guide decision making regarding treatment and prolonged surveillance.

**Level of Evidence – Level IV**

**Indicate IRB or IACUC:** Exempt.



## **Evaluating the Impact of Frailty and Advanced Age on Morbidity following Vestibular Schwannoma Surgery**

*Alvin DeTorres, MD; Gentry Carter, BS; Alvin Kwok, MD, MPH  
Christian Bowers, MD; Neil S. Patel, MD; Richard Gurgel, MD, MSCI*

**Objective:** Correlate frailty and advanced age with morbidity in vestibular schwannoma surgery.

**Study Design:** Retrospective cohort study using a national database.

**Setting:** The National Surgical Quality Improvement Program (NSQIP) datasets 2008-2018.

**Patients:** All patients in the NSQIP database during 2008-2018 diagnosed with benign neoplasm of cranial nerves, 225.1 (ICD-9) or D33.3 (ICD-10), who underwent surgical resection determined by current procedural terminology codes 61520, 61526, 61590, 61591, 61595, or 61569.

**Interventions:** Surgical resection

**Main Outcome Measures:** Frailty, using the five-factor modified frailty index (mFI-5), was correlated with 30-day post-operative morbidity using linear regression models. Morbidity rates and frailty were compared in age groups 65-69, 70-74, 75-79, 80+.

**Results:** Data from 1856 patients was captured from the database. Univariate linear model showed mFI-5 to be a statistically significant predictor of morbidity ( $p=0.0005$ ). Multivariate linear regression identified age as a predictor of morbidity ( $p=0.025$ ) while mFI-5 was not ( $p=0.069$ ). Patients age 65 years and older who underwent surgery ( $n=292$ ) were generally robust with a mean mFI-5 of  $0.83\pm0.72$  and had a morbidity rate of 26.7%. When categorized by age (65-69, 70-74, 75-79, and 80+), there was no statistically significant difference in morbidity among the different groups ( $p=0.47$ ). In these older patients, morbidity did not correlate with either increasing age ( $p=0.46$ ) or frailty ( $p=0.69$ ).

**Conclusions:** Using a multivariate model, both age and frailty are important predictors of morbidity after vestibular schwannoma surgery. Advanced age alone should not be considered a contraindication for surgery without also considering frailty. The NSQIP demonstrates that older but robust patients have similar complication rates to their younger cohorts.

**\*Define Professional Practice Gap & Educational Need:** Frailty has been used as a predictor of morbidity after surgery in other surgical specialties, however, the impact of frailty and advanced age on vestibular schwannoma surgery has only recently been studied and is not well understood.

**\*Learning Objective:** To understand how frailty and age over 65 affects vestibular schwannoma post-surgical morbidity.

**\*Desired Result:** Attendees can use this data to counsel patients on how age or comorbid conditions may impact their post-operative course. Attendees may consider how frailty and/or advanced age may affect complications in other surgeries. Interest in additional research on these factors and their impact on outcomes for other otologic, neurotologic, or neurosurgical procedures will be generated.

**Level of Evidence - III**

**Indicate IRB or IACUC :** Exempt

## **The Influence of Extent of Resection and Tumor Morphology on Facial Nerve Outcomes following Acoustic Neuroma Surgery**

*Elizabeth L. Perkins, MD; Nauman F. Manzoor, MD; Douglas J. Totten, BA  
Alexander D. Sherry, MD; Matthew O' Malley, MD  
Marc Bennett, MD, MHCC; David S. Haynes, MD, MHCC*

**Objective:** To determine the influence extent of resection (EOR), patient demographics, and tumor characteristics on facial nerve (FN) outcomes following microsurgical resection of acoustic neuromas (AN).

**Study Design:** Retrospective chart review

**Setting:** Tertiary referral center

**Patients:** 385 patients who underwent AN microsurgical resection

**Interventions:** microsurgical resection of AN, post-operative evaluation of FN function

**Main Outcome Measures:** House-Brackmann (HB) scores post-operatively. Poor FN function was defined as HB score 3-6 and good FN function was defined as HB score 1-2. Propensity-score matching was used in subset analysis to balance tumor volume between the surgical cohorts followed by multivariable analysis.

**Results:** Seventy-one patients (18%) underwent STR while 314 patients (82%) underwent GTR. 214 patients (63%) had good FN function at 2-3 weeks post-operatively, while 80% had good FN function at 1 year. In single predictor analysis, STR didn't influence FN function at 2-3 weeks (OR 0.88, 95% CI 0.49-1.55,  $p=0.65$ ). In propensity-score matched subset analysis (N=178), patients with STR were less likely to have poor FN function at 2-3 weeks (OR 0.43, 95% CI 0.21-0.88,  $p=0.02$ ) independent of tumor volume (OR 1.07, 95% CI 1.02-1.11,  $p=0.004$ ), while there was no correlation between STR and FN function at 1 year ( $p=0.09$ ). Ventral extension of tumor to IAC line was associated with poor FN outcomes at 2-3 weeks (OR 1.20, 95% CI 1.11-1.30,  $P=0.0001$ ) and 1 year post-op (OR 1.16 95% CI 1.05-1.27,  $p=0.002$ ).

**Conclusions:** When accounting for tumor volume, STR is protective in immediate pre-operative FN function compared to GTR. Ventral extension of the tumor correlated with long-term FN outcomes, but not extent of resection.

**\*Define Professional Practice Gap & Educational Need:** Over the last decade there has been a trend towards subtotal (STR) versus gross total (GTR) acoustic neuroma resection in favor of preserving facial nerve (FN) function. Beyond the approach, other tumor related factors, such as size, ventral extension, and cystic appearance, can potentially influence FN outcomes.

**\*Learning Objective:** To understand the potential influence of tumor morphology and extent of resection on short and long-term facial nerve function.

**\*Desired Result:** For practitioners to consider that sub-total resection may be protective in the short-term recovery, while ventral extension is associated with worse short and long term facial nerve outcomes.

**Level of Evidence - IV**

**Indicate IRB or IACUC :**181440

## **Diagnostic Yield and Utility of Radiographic Imaging in the Evaluation of Pulsatile Tinnitus: A Systematic Review**

*Austin C. Cao, BA; Caitlin Cavarocchi, BA; Tiffany P. Hwa, MD; Steven J. Eliades, MD PhD  
Michael J. Ruckenstein, MD; Douglas C. Bigelow, MD; Jason A. Brant, MD*

**Objective:** Assess diagnostic yield of imaging modalities used to evaluate patients presenting with pulsatile tinnitus(PT).

**Data sources:** PubMed, Embase, and Scopus was queried using the search terms “pulsatile tinnitus,” “pulse-synchronous tinnitus,” and “pulse synchronous tinnitus” with no date or language limitations.

**Study selection:** Studies that reported diagnostic imaging for patients presenting with pulsatile tinnitus were included.

**Data extraction:** Sample size, gender, age, imaging study, indications, and diagnoses. The primary outcome measure from aggregated data was the yield of positive diagnoses made with each imaging modality. The quality of evidence was assessed using the Cochrane risk-of-bias tool.

**Data synthesis:** From an initial search of 412 articles, 18 manuscripts met inclusion criteria, of which 14 studies evaluated individual imaging modalities. 950 patients were included, of which 73.2% were female and mean age was 56.5. 40.6% of patients received CT temporal bone, primarily for suspected venous pathology. 24.1% of patients received carotid duplex sonography (CDS), primarily for suspected arterial pathology. The diagnostic yield varied between modalities: CDS (21.0%, range: 18.1-30%, n=229), CT temporal bone (64.0%, range: 21.4-81.1%, n=386), CTA (85.5%, range: 43.8-97.2%, n=152), MRI (71.8%, 68.5-79.2%, n=78), MRA (58.4%, range: 40.7-81.2%, n=137), and multimodal (78.4%, range: 67.6-91.0%, n=464).

**Conclusions:** We present an evidence-based diagnostic algorithm for the workup of undifferentiated PT. Clinical findings that distinguish between arterial and venous origin should be used to determine the appropriate imaging modality. Studies varied widely on inclusion criteria, demonstrating that positive diagnostic yield for imaging can approach 90% if strict judicious indications are followed.

**Define Professional Practice Gap & Educational Need:** No widely accepted guidelines exist for the diagnostic workup of pulsatile tinnitus. Due to a lack of familiarity with navigating the wide differential diagnosis that exists for this symptom, providers often order a multitude of imaging studies to capture all possible pathologies. This likely leads to an inefficient utilization of facility resources, without demonstrated marginal benefits for each individual study. The lack of large-scale studies comparing imaging modalities limits the clinical applicability of published studies.

### **Learning Objective:**

- 1) Review the differential diagnosis for pulsatile tinnitus.
- 2) Determine the clinical indications and the diagnostic value for different imaging studies.
- 3) Describe a diagnostic algorithm for evaluating undifferentiated pulsatile tinnitus.

**Desired Result:** Attendees should be able to determine the appropriate imaging modality for different clinical presentations of pulsatile tinnitus.

**Level of Evidence – Level II**

**Indicate IRB or IACUC:** This project was exempt from IRB approval.

**A Phase 1/2 Study of OTO-313 Given as a Single Intratympanic Injection in Patients with Moderate to Severe, Persistent Tinnitus**

*James M. Robinson, MS; Kenneth S. Maxwell, MD, (presenter) Ines Hoffman, PhD  
Gordon T. McMurry, MD; Grant D. Searchfield, PhD  
David M. Baguley, PhD, Jeffery J. Anderson, PhD*

**Objective:** To evaluate the safety and exploratory efficacy of intratympanic OTO-313 in patients with tinnitus.

**Study Design:** Randomized, double-blind, placebo-controlled study.

**Setting:** Tertiary referral centers.

**Patients:** Patients with unilateral tinnitus of moderate to severe intensity (score of  $\geq 25$  on the Tinnitus Functional Index [TFI]) and a duration of tinnitus of 1 to 6 months.

**Interventions:** A single intratympanic injection of OTO-313 (0.32 mg/0.2 mL) or placebo (0.2 mL vehicle).

**Main Outcome Measures:** Change from baseline in the TFI, daily ratings of tinnitus loudness and annoyance, and PGIC.

**Results:** OTO-313 was well-tolerated with a lower incidence of adverse events than placebo. The mean TFI reduction from baseline trended in favor of OTO-313 at Day 15, 29, and 57. A clinically meaningful, 13-point improvement on the TFI was observed in 43% (6/14) of OTO-313 patients at both Day 29 and Day 57 versus 13% (2/16) of placebo patients (ad hoc  $p$ -value  $< 0.05$ ). The higher responder rate for OTO-313 was maintained for all TFI improvement levels of 15, 20, 25 and 30 points. Treatment with OTO-313 led to reduction in the daily ratings of tinnitus loudness and annoyance as well as improved PGIC scores.

**Conclusions:** OTO-313 was well-tolerated and demonstrated a higher proportion of responders than placebo based on a clinically meaningful reduction in TFI scores across consecutive study visits (Day 29 and 57). Reductions in TFI scores strongly correlated with improvements in tinnitus loudness and annoyance, and PGIC. These findings support further clinical development of OTO-313 for the treatment of tinnitus.

**\*Define Professional Practice Gap & Educational Need:** There are no approved pharmacological treatments for tinnitus and current management focuses on sound therapy and behavioral approaches to modify the patient's attention and response to the sensation.

**\*Learning Objective:** To learn about the early clinical results of OTO-313 in the treatment of tinnitus.

**\*Desired Result:** Increase the physician's knowledge of the safety and exploratory efficacy of OTO-313 in the treatment of tinnitus.

**Level of Evidence - Level II**

**Indicate IRB or IACUC:** IRB approved on March 18, 2019 by IntegReview #4007596

# **Transtemporal Sigmoid Sinus Decompression: A Novel Surgical Procedure for the Treatment of Idiopathic Pulsatile Tinnitus**

*Patrick W. Slater, MD; Bailey H. Duhon, BS; Neha Korla, MDS*

**Objective:** Idiopathic pulsatile tinnitus (IPT) is associated with high patient morbidity although treatment methods remain unsatisfactory. In the present study, the novel transtemporal sigmoid sinus decompression is used in the treatment of idiopathic pulsatile tinnitus.

**Study Design:** Retrospective case study

**Setting:** Tertiary referral center

**Patients:** From 2005 to 2020, 287 patients presented with a complaint of pulsatile tinnitus. After exclusion criteria, 25 patients were diagnosed with IPT. Those patients underwent treatment and were included in a retrospective study.

**Interventions:** Following failed conservative therapies, the primary author performed a transtemporal sigmoid sinus decompression surgery on the patients under general anesthesia.

**Main Outcome Measures:** Long-term resolution of IPT was measured using the Tinnitus Handicap Inventory (THI). Outcome measurements were taken preoperatively, immediately postoperatively, three months postoperatively, and the status of all 25 patients is known at the time of this study.

**Results:** Transtemporal sigmoid sinus decompression was performed on 25 patients (mean age: 51.7 years, 80.0% female). Out of the 25 patients, 23 (92.0%) patients experienced complete resolution of their IPT. Statistically significant differences based on preoperative THI (mean THI: 4.19) were evident immediately after surgery (mean THI: 1.31;  $p < 0.001$ ), at three months postoperatively (mean THI: 1.19;  $p < 0.001$ ), and over a mean follow-up time of 68.7 months (range, 3-168 months)(mean THI: 1.38;  $p < 0.001$ ). Out of the two patients considered unsuccessful, one patient (case 21) experienced a partial resolution. No major postoperative complications occurred.

**Conclusions:** Transtemporal sigmoid sinus decompression is a safe and effective surgical procedure demonstrated to significantly decrease pulsatile tinnitus and provide long-term relief in patients diagnosed with IPT.

**\*Define Professional Practice Gap & Educational Need:** Treatment modalities for patients diagnosed with IPT are often ineffective. Part of the difficulty in the treatment of IPT is the lack of a differential diagnosis strategy. Medical therapies are often inadequate, and the surgical treatments to this point have primarily focused on treating anatomical anomalies found in and around the sigmoid sinus. There is little research concerning the use of sigmoid sinus decompression alone as a treatment for IPT. This study intends to bridge that gap.

**\*Learning Objective:** To better understand the clinical presentation, exclusion criteria for diagnosis, and the surgical treatment using transtemporal sigmoid sinus decompression of patients with IPT.

**\*Desired Result:** We seek to increase clinician's ability to identify and treat patients with IPT.

**Level of Evidence:** Level V

**IRB Approval:** IntegReview IRB 02-003657, 10/13/2020.

## Supervised Machine Learning Models for Predicting Common Causes of Dizziness

*Eric J. Formeister MD, MS; Jeffrey D. Sharon, MD*

**Background:** Machine learning (ML) is a type of artificial intelligence in which a computer learns patterns between variables in order to correctly predict outcomes in large datasets. Its previously demonstrated utility in numerous other industries shows promise for use in the field of otolaryngology.

**Objective:** The objective of this study was to use a ML platform and a national population-based dataset to identify factors important in predicting vestibular migraine (VM) and other common types of dizziness.

**Methods:** Based on established clinical criteria and available subject responses from the 2008 National Health Interview Survey (n=21,781), we generated case definitions for VM, benign paroxysmal positional vertigo, Ménière's disease, persistent postural-perceptual dizziness, superior canal dehiscence, and bilateral vestibular hypofunction. Fifty-seven variables consisting of sociodemographic characteristics and medical comorbidities were used to develop supervised ML decision tree models to predict these common types of dizziness.

**Results:** The one-year prevalence of dizziness in the U.S. was 11.9% (2,490 respondents). VM was highly prevalent, with 2.7% (584 respondents) classified as having VM. ML decision tree models were able to correctly predict VM with high accuracy (sensitivity=86%; specificity=83%). The most important factors identified by the model included age, alcohol use, amount of sleep, and the number of healthcare encounters.

**Conclusions:** In a large population-based dataset of U.S. adults, supervised ML models accurately predicted dizziness subtypes based on responses to questions that do not pertain to dizziness symptoms alone. Additional analyses using ML models will further explore the complex interaction between comorbid medical conditions, lifestyle behaviors, and dizziness.

**\*Define Professional Practice Gap & Educational Need:** Machine learning, a type of artificial intelligence, shows great promise for investigating better ways to diagnose and treat neurologic disease, especially in the setting of large databases. Correctly classifying patients into dizziness subtypes is crucial for organizing efficient care delivery to improve quality of life, and this classification could become more efficient through the use of machine learning models.

**\*Learning Objective:** The objective of this presentation is to describe a supervised machine learning model to help correctly predict (classify) dizziness subtypes based on presenting sociodemographic characteristics and medical comorbidities in a large, nationwide database.

**\*Desired Result:** The participant will learn about a common method of artificial intelligence/machine learning called decision trees to help correctly identify dizziness subtypes. Additionally, they will appreciate the relative prevalence of the most common types of dizziness in the U.S. adult population.

**Level of Evidence – III.**

**Indicate IRB or IACUC :** Exempt due to the lack of protected health information or identifying respondent data in the publicly available dataset.

## Head Roll-Tilt Subjective Visual Vertical Test in the Diagnosis of Persistent Postural-Perceptual Dizziness (PPPD)

*Chihiro Yagi, MD; Yuka Morita, MD, PhD; Meiko Kitazawa, MD; Kuniyuki Takahashi, MD, PhD  
Yoshiro Wada, MD, PhD; Tadashi Kitahara, MD, PhD; Arata Horii, MD, PhD*

**Objective:** To examine a role of head roll-tilt subjective visual vertical (HT-SVV) test in the diagnosis of persistent postural-perceptual dizziness (PPPD).

**Study Design:** Retrospective chart review.

**Setting:** Tertiary referral center.

**Patients:** 75 PPPD, 21 unilateral vestibular hypofunction (UVH), and 37 psychogenic dizziness (PD) patients showing chronic vestibular symptoms (> 3 months).

**Main Outcome Measures:** In addition to the conventional vestibular tests, upright SVV and mean perceptual gain during head roll-tilt (perceived/actual head tilt angle) were measured, which was termed the head-tilt perception gain (HTPG). One-sample t-tests against previously reported mean values in healthy subjects and multiple comparison analysis for comparison between the disease groups were performed. Receiver operating characteristic (ROC) curve to predict PPPD by HTPG was created.

**Results:** In patients with PPPD, SVV, HTPG and the Romberg ratio on foam, a marker for visual dependency of postural control, were significantly higher than normals ( $p < 0.01$ ), while bithermal caloric test, cervical- and ocular-vestibular evoked myogenic potentials, and video head impulse test were normal. HTPG was significantly higher in the PPPD group than the PD group. There was no significant difference in posturography between the disease groups. The area under the curve of the ROC curve was 0.712 and the HTPG value of 1.202 had sensitivity and specificity of 44.3% and 90.5%, respectively for diagnosing PPPD.

**Conclusions:** While PPPD showed no obvious abnormalities of the semicircular canal and otolith functions, high HTPG, an excessive perception of head tilt, can be a specific marker in discriminating PPPD from other chronic vestibular diseases.

**\*Define Professional Practice Gap & Educational Need:** 1. Lack of coherent findings regarding the conventional vestibular tests in patients with PPPD. 2. Lack of objective tests to diagnose patients with PPPD.

**\*Learning Objective:** 1. To increase knowledge of findings regarding the conventional vestibular tests in patients with PPPD. 2. To understand the usefulness of head roll-tilt subjective visual vertical test in the diagnosis of PPPD.

**\*Desired Result:** A better understanding of the pathogenesis of PPPD and the ability to accurately diagnose patients with PPPD in a group of patients with chronic vertigo.

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

**Indicate IRB or IACUC :** This study was approved by the IRB of Niigata University Medical and Dental Hospital on January 21, 2019. (#2018-0345)

## ANS TRAINEE AWARD

### Intraoperative Electrocochleography Predicts Outcomes in Transmastoid and Middle Cranial Fossa SSCD Repair

*Susan Ellsperman, MD; Steven A. Telian, MD; Paul Kileny, PhD; Christopher Welch, MD, PhD*

**Objective:** To determine whether electrocochleography (ECoG) predicts audiologic and vestibular outcomes after repair of superior semicircular canal dehiscence (SSCD) via transmastoid (TM) and middle cranial fossa (MCF) approaches

**Study Design:** Retrospective review

**Setting:** Academic tertiary referral center

**Patients:** Adults with SSCD who underwent repair between 2005 and 2019.

**Hypothesis:** Intraoperative ECoG will predict SSCD repair outcomes, which may differ between TM and MCF approaches

**Main Outcome Measures:** Patient-reported vestibular and audiologic symptoms; pre-, intra-, and post-operative ECoG measures, dizziness handicap index (DHI) scores

**Results:** Forty-seven patients underwent SSCD repair (40 unilateral, 7 bilateral) between 2005 and 2019, including 25 MCF and 29 TM approaches. There were no differences in preoperative, intraoperative, or post-repair ECoG SP/AP values between the MCF and TM groups ( $p$  0.16, 0.56, 0.58). Patients had subjective improvement in vestibular symptoms (or stable symptoms in patients who underwent the procedure for predominately audiologic manifestations) with both approaches (MCF: 88%; TM: 90%;  $p$  0.65) which was predicted by intraoperative SP/AP ratio normalization ( $p$  0.0005). Similarly, DHI scores returned to baseline postoperatively with both approaches in those with the most significant preoperative vestibular dysfunction ( $p$  0.58,  $p$  0.52). Reported vestibular symptoms persisted more often in patients with migraine (56% vs. 31%,  $p$  0.04), with more persistently elevated ECoG measures, though not significant (38% vs. 15%,  $p$  0.09). Patients had subjective improvement or stability in audiologic symptoms with both approaches (MCF: 96%; TM: 100%;  $p$  0.62) predicted by SP/AP ratio normalization ( $p$  0.0004).

**Conclusions:** Abnormal preoperative ECoG reliably predicts the presence of a physiologically significant SSCD and normalization correlates with patient symptom improvement after SSCD repair; no significant differences in post-operative outcomes were noted between patients undergoing TM versus MCF repair. Circumspection regarding the likelihood of an ideal outcome after SSCD repair should be exercised when counseling patients with concomitant migraine.

**\*Define Professional Practice Gap & Educational Need:** It is not certain whether outcomes differ between the two adopted approaches for SSCD repair

**\*Learning Objective:** To highlight the reliability and utility of intraoperative ECoG and demonstrate its use in predicting symptom improvement for TM and MCF approaches to SSCD repair

**\*Desired Result:** To report subjective and objective outcomes following SSCD repair and encourage adoption of intraoperative ECoG monitoring

**Level of Evidence** - Level V

**Indicate IRB or IACUC:** IRB review considers this study exempt (HUM00169949)



## Comparison of Outcomes of Surgical Repair of Spontaneous Temporal Bone CSF Leaks and Encephaloceles Using Bone Cement and Autologous Material

*Vir Patel, MD; Tiffany Peng Hwa, MD; Steven Eliades, MD PhD  
Jason Brant, MD; Douglas Bigelow, MD; Michael Ruckenstein, MD*

**Objective:** To compare success rates of transmastoid repair of spontaneous temporal bone cerebrospinal fluid(CSF) leak and encephalocele using only bone cement(BC) versus only autologous material(AM) versus combined repair(CR) with both bone cement and autologous material.

**Study Design:** Retrospective Chart Review

**Setting:** Tertiary Care Hospital

**Patients:** 43 adult patients undergoing transmastoid repair of spontaneous temporal CSF leak and/or encephalocele between 2014 and 2020(BC:12, AM:15, CR:16).

**Interventions:** Cortical mastoidectomy with identification of defect and repair with either BC (Cranios® hydroxyapatite), AM (local bone, fascia, fat, and/or cartilage), or CR (Cranios® combined with autologous materials).

**Main Outcome Measures:** Successful repair sustained without recurrent CSF leak or encephalocele throughout follow up.

**Results:** Of patients undergoing repair, 51% were female (BC:42%, AM:60%, CR:50%). Mean age at repair was 58.6 years (SD 10.9; BC:57.3, AM:57.6, CR:60.5). Mean BMI at repair was 35.4 (SD 7.6; BC:36.3, AM:36.5, CR:33.6). Forty-one (95.3%) patients had successful repair without known recurrent CSF leak or encephalocele since surgery (BC:11, 91.6%; AM:14, 93.3%; CR:16, 100%;  $p=0.49$ ). Mean length of follow up was 41.6 months (BC: 29.9, AM: 51.2, CR: 41.5). The difference in mean operative time amongst the groups was statistically significant (BC: 100.2 minutes, AM: 182.8, CR: 133.2;  $P<.00001$ ).

**Conclusions:** BC, AM, and CR techniques each demonstrate effective and sustained means of repair for temporal CSF leak and encephalocele. Use of isolated BC offers a significant decrease in operative time with a noninferior outcome.

**\*Define Professional Practice Gap & Educational Need:** Spontaneous CSF leaks and encephaloceles are an important cause of hearing loss and middle ear effusion and can also lead to more serious complications like meningitis. Reported surgical techniques encompass an array of approaches and use of varying materials for repair. However, no study to date has specifically compared success rates of repair using bone cement to repair with autologous material. Thus, further elucidation of the success rates of these surgical techniques can clarify which repair approaches can serve as effective and durable options for patients with this pathology.

**\*Learning Objective:** After participation in this poster or oral presentation, learners will be able to:

- 1) Discern the signs and symptoms of spontaneous temporal bone CSF leak and encephalocele
- 2) Understand the initial work up and testing for suspected temporal bone CSF leak or encephalocele
- 3) Appreciate temporal bone anatomy in its relation to potential locations of CSF leaks and encephaloceles
- 4) Identify patient comorbidities that may be associated with spontaneous temporal bone CSF leak and encephaloceles
- 5) Describe multiple methods of surgical intervention for temporal bone CSF leak and encephalocele, along with potential advantages and disadvantages of using varying repair materials

**\*Desired Result:** Learners will improve competency in initial evaluation, diagnostic work up, and surgical management of spontaneous temporal bone CSF leak and encephalocele, including an expanded understanding of the various repair materials available and how this may affect success rate and operative time.

**Level of Evidence – Level III**

**Indicate IRB or IACUC:** Hospital of the University of Pennsylvania IRB, protocol number 843735.

## **Perineural Invasion of the Intratemporal Facial Nerve: How Far Proximally Do We Chase the Positive Margin?**

*Joshua Cody Page, MD, Marc-Elie Nader, MD, FRCSC, Diana Bell, MD, Paul W. Gidley, MD*

**Objective:** To determine recurrence patterns in patients with head and neck cancers requiring facial nerve sacrifice and to determine optimal management of the proximal positive facial nerve margin.

**Study Design:** Case series with chart review.

**Setting:** Tertiary Care Center

**Patients:** 65 patients with head and neck malignancies who underwent sacrifice of the intratemporal facial nerve (ITFN) between August 1, 2002, and November 30, 2015. Demographics, preoperative facial nerve function, prior oncologic treatment, histology, operative details and recurrence patterns were reviewed.

**Main Outcome Measures:** Recurrence rates and recurrence location were of primary interest.

**Results:** Histopathologic evidence of perineural invasion (PNI) was found in 33.8% (n=22) of cases. Of these, 5 had positive proximal margins on final pathology. Three of the 5 (60%) experienced recurrence of disease following initial treatment which included radiation in each case. None of the disease recurrence occurred proximally along the facial nerve. Segments of the facial nerve biopsied included: at the stylomastoid foramen (n=45), mastoid segment (37), tympanic (6), geniculate (2) and labyrinthine (2). Patient follow-up was greater than 5 years.

**Conclusions:** The data suggests that a conservative approach to chasing the proximal facial nerve margin may be optimal with respect to operative planning, patient morbidity and recurrence pattern. Recurrence proximally along the facial nerve is an exceedingly rare event and the necessity of biopsy proximal to the geniculate ganglion is called into question.

**\*Define Professional Practice Gap & Educational Need:** 1) Lack of understanding how to best manage positive proximal margins of the facial nerve. 2) Lack of understanding of recurrence patterns in tumors involving the facial nerve with positive proximal margins.

**\*Learning Objective:** 1) To demonstrate that conservative resection may be best for managing positive proximal margins of the facial nerve. 2) To discuss recurrence patterns in patients with tumors involving or in close proximity to the facial nerve.

**\*Desired Result:** 1) Attendees will better understand arguments for conservative management with respect to facial nerve margins that are positive proximally. 2) Attendees will be able to more effectively establish preoperative surgical planning when the facial nerve is presumed to be involved with tumor.

**Level of Evidence** - Level IV

**Indicate IRB or IACUC :** UT MD Anderson Cancer Center, IRB# DR08-0802

## **The Laterality of Early Age-Related Hearing Loss and Brain Beta-Amyloid**

*Alexandria L. Irace, BA; Brady Q. Rippon, MS; Adam M. Brickman, PhD  
José A. Luchsinger, MD, MPH; Justin S. Golub, MD, MS*

**Objective:** We previously noted an association between hearing and brain Beta-amyloid, a marker of Alzheimer's pathology. The objective was to determine if a stronger association exists in the left versus right ear.

**Study Design:** Cross-sectional analysis of a prospective study

**Setting:** Community-based cohort in New York City

**Patients:** n=98

**Interventions:** None

**Main Outcome Measures:** The outcome was brain Beta-amyloid standardized uptake value ratio (SUVR) on positron emission tomography. Linear regression was performed to analyze the association between Beta-amyloid and hearing in each ear, adjusting for age, sex, education, cardiovascular disease, and hearing aid use.

**Results:** Mean age was  $64.3 \pm 3.5$  years. Mean pure-tone average was  $24.0 \pm 10.5$  dB in the right ear and  $22.9 \pm 11.6$  dB in the left ear. Adjusting for confounders, a 10 dB worsening in pure-tone average in the left ear was associated with a significant increase of Beta-amyloid SUVR in the left frontal lobe (coefficient=0.028, 95% confidence interval=0.006-0.049), left cingulate (0.029, 0.003-0.055), right cingulate (0.029, 0.003-0.054), right temporal (0.019, 0.002-0.037), and right frontal lobe (0.024, 0.002-0.047). For every 10% decrease in word recognition score for the left ear, significantly increased Beta-amyloid SUVR was observed in these same regions-of-interest, the whole brain, and both parietal lobes. No significant associations were observed between Beta-amyloid SUVR and hearing in the right ear.

**Conclusions:** Worsening hearing in the left, but not right ear was associated with higher Beta-amyloid levels. Understanding lateralized differences in central auditory pathways and related neural networks may offer new insight into the relationship between hearing loss and dementia.

**Define Professional Practice Gap & Educational Need:** Age-related hearing loss is severely undertreated, as only a minority of patients regularly wear hearing aids. The relationship between age-related hearing loss and cognitive decline requires further characterization to facilitate effective counseling and management of this condition. Additionally, understanding the effects of lateralized differences in central auditory pathways may provide key insight into the mechanistic underpinnings of this relationship.

**Learning Objective:** After this presentation, the learner will be able to describe the relationship between age-related hearing loss and Beta-amyloid, summarize how these findings may be related to clinical dementia, and hypothesize about why the left versus right ear may contribute differently to this relationship.

**Desired Result:** Hearing specialists will better understand the complex relationship between age-related hearing loss and cognitive decline and the role of Beta-amyloid as a possible mediator. They will utilize this knowledge to counsel patients on the potential long-term sequelae of untreated age-related hearing loss.

**Level of Evidence – Level III**

**Indicate IRB or IACUC:** New York-Presbyterian Hospital/Columbia University Irving Medical Center, New York, NY; IRB # AAAR5012; Approved 8/9/2017

## NICHOLAS TOROK VESTIBULAR AWARD

### Higher Readmission Rates after Hip Fracture among Patients with Vestibular Disorders

*Steven D. Curry, MD, MPH; Alessandro Carotenuto, MD; Devin A. DeLuna, BS  
Dennis J. Maar II, BA; Ye Huang, BA; Justin C. Siebler, MD; Jonathan L. Hatch, MD*

**Objective:** Falls in older adults are associated with high injury severity and mortality. Patients with vestibular disorders may have increased risk. The purpose of this study was to examine the outcomes among patients with underlying vestibular disorders who have hip fractures and identify predictors of increased morbidity and mortality.

**Study Design:** Retrospective cohort study.

**Setting:** Tertiary care academic medical center.

**Patients:** 201 adults diagnosed with a vestibular disorder prior to treatment for hip fracture due to a ground-level fall, compared to 327 age- and sex-matched controls who had hip fracture due to a ground-level fall without a vestibular diagnosis. Patients were treated between 2013-2019.

**Main Outcome Measures:** Length of hospital stay during admission for hip fracture, 30-day readmission rate, and 30-day mortality rate.

**Results:** 30-day readmission rate after hip fracture was significantly increased in patients with vestibular disorders compared to matched controls ( $p < 0.0001$ ), odds ratio 3.12 (95% CI 1.84-5.39). No significant difference was found for length of hospital stay ( $p = 0.507$ ) or 30-day mortality rate ( $p = 0.986$ ). Reasons for readmission in the vestibular patient group included higher rates of repeat fall, infection, and recurrent vestibular symptoms. Use of medication classes associated with falls or hip fractures was not significantly different between groups, except for higher rates of antihypertensive use at the time of fracture in the control group ( $p = 0.002$ ). No significant differences were found between groups for age, sex, race, rate of surgical treatment for hip fracture, or disposition at discharge.

**Conclusions:** Patients with vestibular disorders are at a significantly higher risk of hospital re-admission within 30 days after discharge for treatment for hip fracture.

**Define Professional Practice Gap & Educational Need:** While falls and hip fractures are common in the elderly, less is known about the increased risk in patients with underlying vestibular disorders.

**Learning Objective:** To understand the heightened risk in the care after hip fracture among patients with vestibular disorders and reasons for readmission within 30 days after discharge.

**Desired Result:** Better understanding of the increased morbidity of hip fracture in patients with underlying vestibular disorders.

**Level of Evidence - III.**

**Indicate IRB or IACUC:** Approved 8/19/2019, IRB #412-19-EX.

## **Diameter-Based Volumetric Models May Inaccurately Calculate Jugular Paraganglioma Volume following Sub-Total Resection**

*Douglas J. Totten, BA; Nauman F. Manzoor, MD; Elizabeth L. Perkins, MD  
Nathan D. Cass, MD; Mohamed H. Khattab, MD  
David S. Haynes, MD, MMHC; Joseph M. Aulino, MD*

**Objective:** To assess validity of commonly used diameter-based models to measure postoperative jugular paraganglioma (JP) tumor volume after subtotal resection (STR) in determining residual tumor growth as compared to gold-standard slice-by-slice segmentation.

**Study Design:** Retrospective case series.

**Setting:** Tertiary referral center.

**Patients:** Patients with jugular paragangliomas who underwent STR from 2007-2019.

**Main Outcome Measures:** Pre- and postoperative tumor volumes as measured by three commonly used diameter-based models (cuboidal, ellipsoidal, and spherical) were compared to slice-by-slice segmentation volume as measured manually by a senior neuroradiologist. Models with absolute percent error (APE) > 20% compared to segmentation were considered unsatisfactory based on published criteria.

**Results:** 21 patients were included. Median postoperative APE exceeded the established 20% threshold for each of the volumetric models as cuboidal, ellipsoidal, and spherical model APE were 63%, 28%, and 27%, respectively. The postoperative cuboidal model had significant systematic bias overestimating volume ( $p=0.002$ ) whereas the postoperative ellipsoidal and spherical models lacked systematic bias ( $p=0.11$  and  $p=0.82$ ). The postoperative cuboidal, ellipsoidal, and spherical model biases were, respectively, 39% (95% Limits of Agreement [LOA] -47% to 125%), -22% (95% LOA -107% to 62%), and -7% (95% LOA -75% to 62%).

**Conclusions:** Cuboidal, ellipsoidal, and spherical models do not provide accurate assessments of postoperative JP tumor volume and may result in salvage therapies that are unnecessary or inappropriately withheld due to inaccurate assessment of residual tumor growth. While more time-consuming, contouring by an experienced neuroradiologist provides a substantially more accurate and precise measurement of tumor volume that may optimize clinical management.

**Define Professional Practice Gap & Educational Need:** Lack of reliability between measurements may result in over- and undertreatment of jugular paraganglioma patients following subtotal resection.

**Learning Objective:** Assess accuracy of commonly used diameter-based models in measuring jugular paraganglioma tumor volume following subtotal resection in order to determine reliability of models in identifying residual tumor growth.

**Desired Result:** This study can guide postoperative patient management and may prompt further investigation into how to more effectively measure tumor volume postoperatively.

**Level of Evidence - IV**

**Indicate IRB or IACUC:** IRB Approved (201632, Vanderbilt University Medical Center)

## Opioid and Non-Opioid Usage in the Post-operative Period following Otologic Surgery

*Neal R. Godse, MD; Rahilla A. Tarfa, PhD; Philip Perez, MD  
Barry E. Hirsch, MD; Andrew A. McCall, MD*

**Objective:** To prospectively analyze post-operative pain and medical management following otologic surgery stratified by surgical approach.

**Study Design:** Cohort study using prospective data logs tracking pain level and pain management following otologic surgery.

**Setting:** Tertiary academic hospital.

**Patients:** 48 adults undergoing outpatient otologic surgeries.

**Interventions:** Surveys detailing post-operative pain levels and treatment with prescription opioid and over the counter (OTC) analgesics.

**Main Outcome Measures:** Self-reported pain scores, use of OTC medications, and use of opioid medications. Outcomes were compared to potential predictive independent factors including surgical approach, age, gender, alcohol use, tobacco use, and comorbid anxiety/depression.

**Results:** 56.3% of patients had surgery with a postauricular (PA) approach while 43.7% had surgery with a transcanal (TC) approach. Patients used opioids a majority of the time for pain scores were  $\geq 6$  and OTC medications for pain scores  $\leq 5$ . Compared to TC approach, the PA approach was associated with significantly higher average pain scores on POD1 (TC:  $2.7 \pm 0.5$  vs. PA:  $5.1 \pm 0.5$ ;  $p = 0.0018$ ) and POD5 (TC:  $0.4 \pm 0.2$  vs. PA:  $2.2 \pm 0.5$ ;  $p = 0.0015$ ), and a higher average milligram morphine equivalent (MME) use on POD5 (TC: 0 vs. PA:  $3.4 \pm 1.2$ ;  $p = 0.01$ ). Multivariate linear regression demonstrated a significant negative correlation between age and total MME use, and a significant positive correlation between the PA approach and total MME use.

**Conclusions:** Postauricular approach is associated with increased pain levels and opioid use following otologic surgery. Patient- and approach-specific opioid prescribing is feasible following otologic surgery.

**Define Professional Practice Gap & Educational Need:** I. There are no set guidelines on opioid prescription following otologic surgeries. II. There is also a lack of understanding of the pain levels associated with various otologic surgical approaches, duration and intensity of post-operative pain, and the necessary amount of opioid and OTCs needed to control post-operative pain following surgery.

**Learning Objective:** Attendees will get a better appreciation of the pain levels associated with various otologic surgical approaches, the duration of this pain, and noted trends of opioid and OTC use following surgery among this cohort of patients.

**Desired Result:** Attendees will be able to discuss steps towards creating a patient- and surgery- specific opioid prescription regimen for otologic surgery.

**Level of Evidence** – Level III – Cohort and case-control studies

**Indicate IRB or IACUC:** Approved through the University of Pittsburgh Medical Center Quality Improvement Center, project 2129.

## Opioid Prescribing Patterns after Skull Base Surgery for Vestibular Schwannoma

*Yin Ren, MD, PhD; Pasha Mehranpour, BS; Omid Moshtaghi, MD  
Marc S. Schwartz, MD; Rick A. Friedman, MD, PhD*

**Objective:** Excessive opioid prescription is a source of prescription diversion and could contribute to chronic opioid abuse. This study describes the opioid prescribing patterns and risk factors for additional opioid prescription after surgical resection of vestibular schwannoma (VS).

**Study Design:** Retrospective chart review

**Setting:** A single tertiary referral center

**Patients:** Adult patients undergoing surgical resection of VS between May 2019 and March 2020.

**Interventions:** Opioid use postoperatively and up to one year following surgery were characterized from medical records and by querying the state-wide Controlled Substance Utilization Review and Evaluation System.

**Main Outcome Measures:** The presence of additional opioid prescriptions within 60 days of surgery.

**Results:** A total of 109 patients (mean age 50 years, 65.5% female) were prescribed an average of  $138.2 \pm 117.8$  mg of morphine equivalents (MME). Twenty-two (20.9%) required additional prescriptions of  $163.2 \pm 103.2$  MME. Age, gender, tumor size, or the choice of surgical approach (translabyrinthine, retrosigmoid, versus middle fossa) were not associated with additional prescriptions. Patients with additional prescriptions had higher body-mass index (BMI 28.8 vs. 25.8 kg/m<sup>2</sup>,  $p=0.015$ ) and required more opioid medications during the hospital stay (51.8 vs. 29.1 MME,  $p=0.002$ ). On multivariate logistic regression, higher BMI (odds ratio [OR]=1.32;  $p=0.001$ ), history of headaches (OR=11.9,  $p=0.011$ ) or opioid use (OR=29.3,  $p=0.008$ ) were associated with additional prescription.

**Conclusions:** Additional opioid prescriptions may be necessary in a portion of VS patients undergoing surgery. The choice of surgical approach is not associated with excess opioid requirements. Patients with higher BMI, pre-existing headaches or opioid use may require additional prescriptions.

**\*Define Professional Practice Gap & Educational Need:** Excessive opioid prescription practices after otologic and neurotologic surgery could contribute to the ongoing national opioid crisis. While recent reports have attempted to characterize the opioid use patterns after otologic surgery, there is a vastly unmet need to understand the prescription patterns and identify patient risk factors for excess opioid requirements after resection of vestibular schwannomas via various surgical approaches.

**\*Learning Objective:** To characterize and understand the opioid prescription patterns for patients up to one year after undergoing craniotomy (including translabyrinthine, middle fossa, and retrosigmoid approaches) for resection of vestibular schwannomas.

**\*Desired Result:** Healthcare providers including neurotologists and skull-base neurosurgeons will understand factors associated with excess opioid requirements, better counsel patients regarding postoperative pain, provide appropriate amounts of opioid medications after surgery.

**Level of Evidence – Level IV**

**Indicate IRB or IACUC :** IRB approved - University of California San Diego IRB # 180978XL, 10/25/2018.