SELECTED ABSTRACTS

ORAL

PRESENTATIONS

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AMERICAN NEUROTOLOGY SOCIETY

Saturday, April 10, 2021

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±0.78yr vs. 3.13±0.66yr, p=.007) and those from low-income areas (8.58±7.6y vs. 2.35±3.00y, p=0.007). Time between identification as a CI candidate and implantation was longer in publicly insured patients (721±107d vs. 291±64d, p=.001) and in bilingual children (888±160d) compared to those who spoke solely Spanish (473±101d, p=0.036) or English (400± 95d, 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±132d vs. 197±67d, p=.007), developmental evaluation, (517±106d vs. 150±56d, p=.003), speech evaluation (482±107dvs. 163±65d, p=.013), and Children's Implant Profile (ChIP) assessment (572±107d vs. 184±59d, 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 implanation continue to affect timing of implantation.

REQUIRED:
Define Professional Practice Gap & Educational Need: 1. Lack of understanding regarding persistent disparities in timing of pediatric cochlear implanation 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 implanation. 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±18.7 years, 59.6% male). The cohort group comprised 23 ears with preoperative AzBio scores ≥40% in quiet and ≤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 (≥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 co-efficient 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 co-efficients 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 co-efficients 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.

REQUIRED:
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 ≥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 (≥65years), n=26 younger (<65years)). 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 (21.5vs31.3; p=0.105), and was drastically worse in AzBio +5dBSNR (CI alone 6.7vs22.1, p=0.0014; best aided 9.5vs21.5; 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 disproportionally 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 to 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 (≥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 LPFTA 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 LFTA 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 establish 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 ≥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: ß=0.471[0.298, 0.644]; AzBio: ß=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.

REQUIRED:
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 ≥2mm of growth) following initial growth of ≥2mm 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 (0-3.0μM) 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 on 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

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

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 ≥ 6 and OTC medications for pain scores ≤ 5. Compared to TC approach, the PA approach was associated with significantly higher average pain scores on POD1 (TC: 2.7 ± 0.5 vs. PA: 5.1 ± 0.5; $p = 0.0018$) and POD5 (TC: 0.4 ± 0.2 vs. PA: 2.2 ± 0.5; $p = 0.0015$), and a higher average milligram morphine equivalent (MME) use on POD5 (TC: 0 vs. PA: 3.4 ± 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.

REQUIRED:
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; and 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±117.8 mg of morphine equivalents (MME). Twenty-two (20.9%) required additional prescriptions of 163.2±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^2, 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.