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# Radiomorphometric Comparison of Endoscopic Presigmoid Hearing-Preserving Approaches to the Internal Auditory Canal

Aaron Tucker, BA[1]*; Sammy Gao, BA[1]; Arman Saeedi, MD, MPH[1]; Brendon Warner, MD[1]; Lawrance Lee, MD[1]; Nauman F. Manzoor, MD[1]

[1]Department of Otolaryngology - Head and Neck Surgery, Virginia Commonwealth University, Richmond, VA; * **Presenter**

## Background

Vestibular schwannomas (VS) are slow-growing benign tumors of the vestibular nerve that can cause significant morbidity if untreated due to cochleovestibular symptoms such as progressive tinnitus, imbalance, and sensorineural hearing loss.[1,2] Traditional hearing preservation surgical approaches to the internal auditory canal (IAC) provide excellent exposure, although due to prolonged intracranial retraction, they carry risk of edema, hematoma, seizures, and meningitis.[3,4]

The retrolabyrinthine (RL) approach to the IAC entails the removal of the mastoid and the posterior petrous bone up to the vestibular labyrinth, preserving the integrity of all 3 semicircular canals and hearing function.[5] The approach has traditionally been limited in VS surgery due to challenges in lateral IAC and cerebellopontine angle visualization.

The transcrural (TC) approach is a similar presigmoid transpetrosal approach that offers greater access by partially removing and sealing the posterior semicircular canal,[6] with hearing preservation rates ranging from 58-90%.[7,8] Finally, the translabyrinthine (TL) approach provides complete access to the IAC, but at the cost of hearing sacrifice.

Feasibility studies have described the benefits of endoscopic assistance in overcoming the anatomical constraints of presigmoid approaches.[9] Using three-dimensional imaging software, we compared post-mastoidectomy IAC exposure in simulated RL, TC, and TL approaches, and quantified the relationship between anatomic covariates with and IAC exposure.

## Methods

**Imaging:** High-resolution computed tomography scans were performed on thirteen cadaveric temporal bones (7 left, 6 right) before and after completion mastoidectomy. Three-dimensional segmentation was performed with 3D Slicer (Slicer Community™).

**Main Outcome:** Total IAC volume was first calculated. The RL, TC, and TL approaches were recreated with defined surgical landmarks (**Figure 1**), and exposure was estimated by the percent of the post-dissection IAC accessible in each approach (TL was assigned 100%).[10] 0° and 30° angles at the level of the semicircular canals were employed to simulate endoscopic assistance.

**Covariates:** Pre-dissection anatomic covariates were measured, which included RL corridor width, surgical freedom, and angle of attack (**Figure 2**). RL corridor width was defined as the distance between the posterior fossa plate and posterior semicircular canal.

**Analysis:** Measurements were compared across the 3 approaches using Mann-Whitney U testing (Bonferroni-corrected significance, $p<.017$). Pearson correlations were used to measure linear association between anatomic predictors and logarithmically transformed IAC exposure ($p<.05$).

## Results

Post-dissection mean IAC volume was 232.8 ± 85.1 mm³

**Volumetric Comparisons by Approach**

TC provided greater IAC exposure than RL but less than TL in both 0° and 30° views (**Figure 3**). Compared with 0° views, 30° endoscopy improved median IAC exposure (RL: 75.6% vs 65.1%, p=.019; TC: 95.6% vs 79.3%, p<.0001). Exposure of RL with 30° assistance approximated TC at 0° (median difference 3.8%, p=.282).

**Comparison of Anatomic Covariates by Approach**

Across RL, TC and TL approaches, stepwise increases were seen for median surgical freedom (182.9 mm², 245.0 mm², 330.3 mm², p<.0001) and angle of attack (19.9°, 29.9°, 56.5°, p<.0001), respectively (**Figure 3**).

**Correlation of Covariates with Approach Volume**

Pre-dissection corridor width ranged 1.14-7.11 mm (median 4.36 mm).

Corridor width did not correlate with RL or TC exposures. Surgical freedom correlated with RL exposure for 0° (r=.63, p=.022) and 30° views (r=.59, p=.033); angle of attack was not associated with exposure volumes (**Figure 4**).

## Figures

**Figure 1. Right Ear 3-D Representation of Hearing Preservation Presigmoid Approaches**

*S, Superior; L, Lateral. *Green represents the surgical approach through the RL corridor*

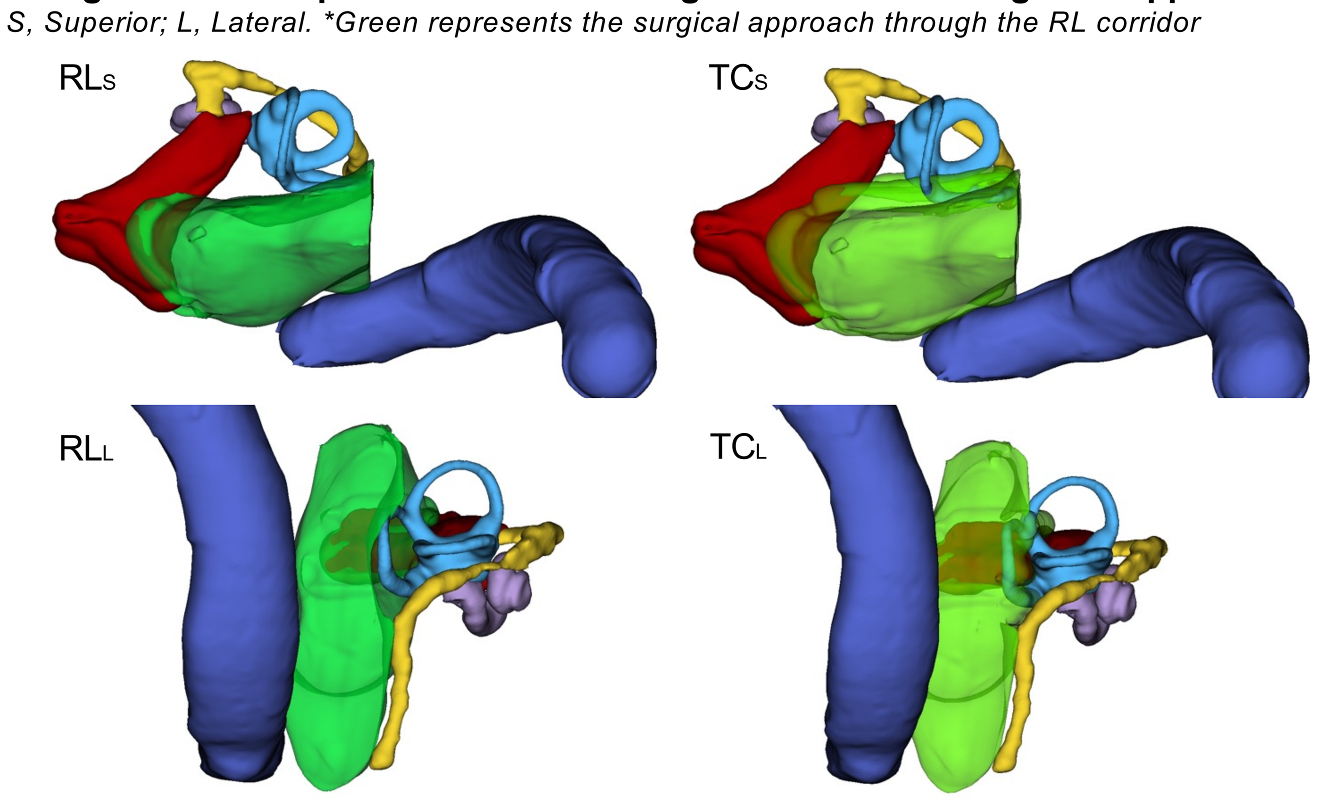



**Figure 2. Right Ear, Pre-Dissection Measurements of Surgical Freedom (A) and Angle of Attack (B)**

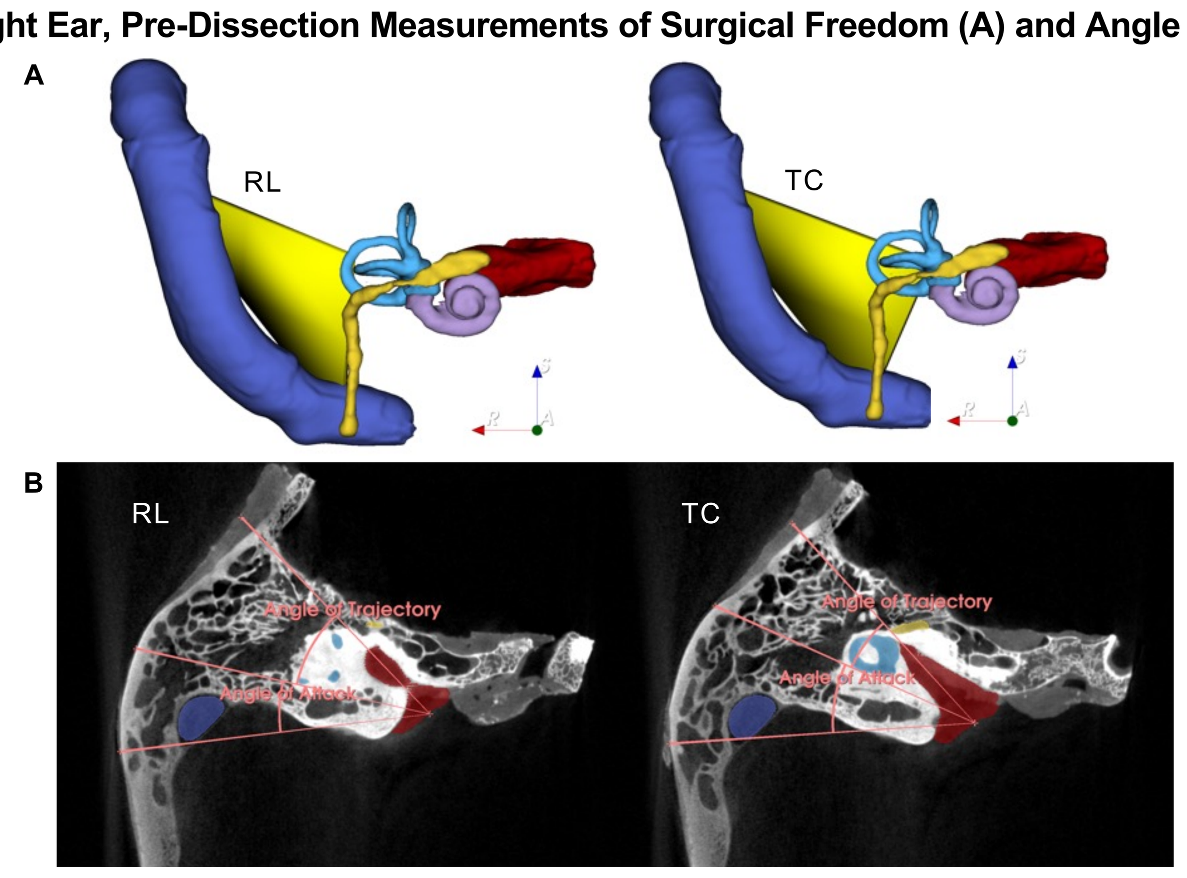



**Figure 3. Comparison of IAC Exposure, Surgical Freedom, and Angle of Attack of Approaches**

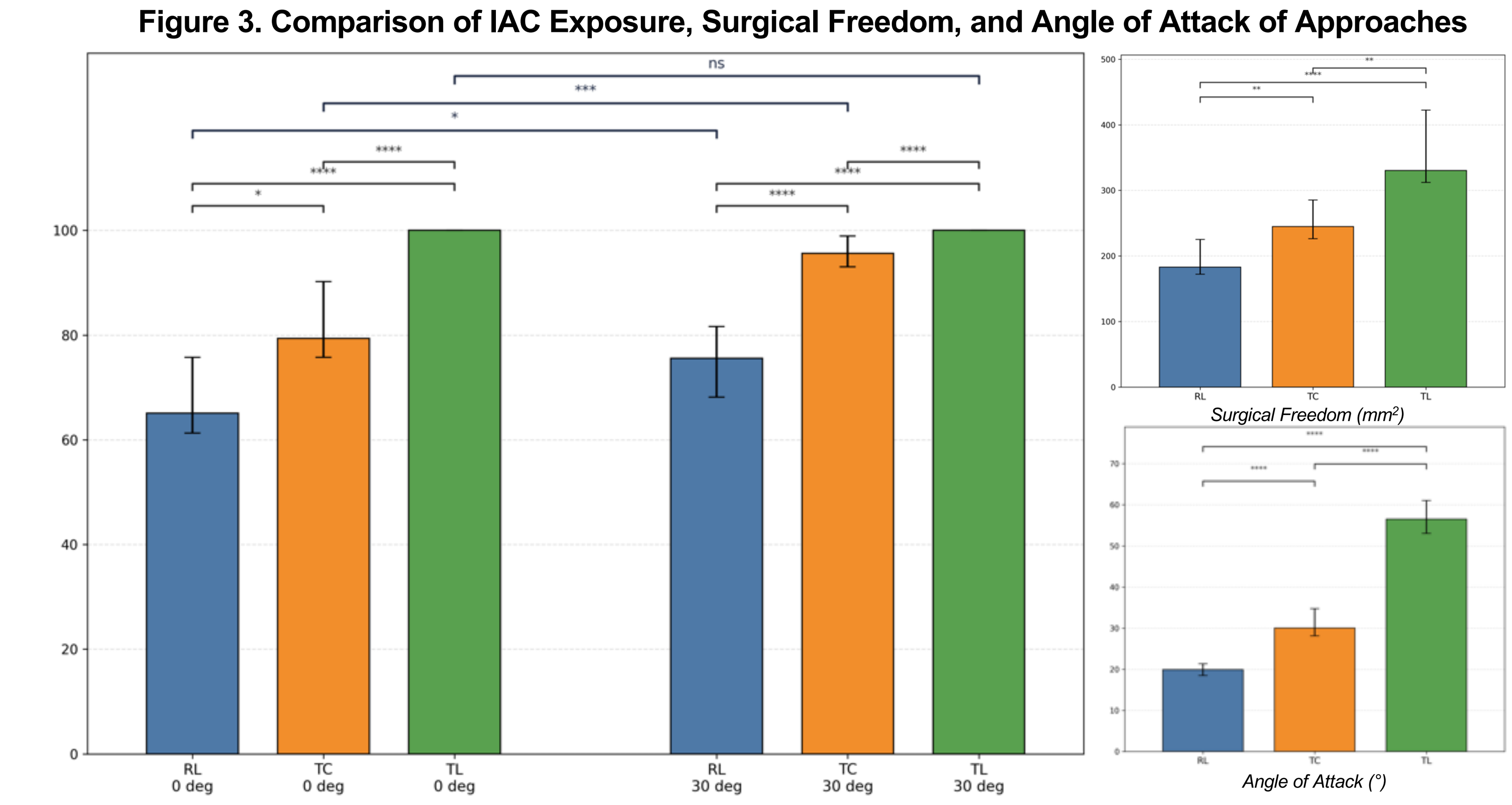
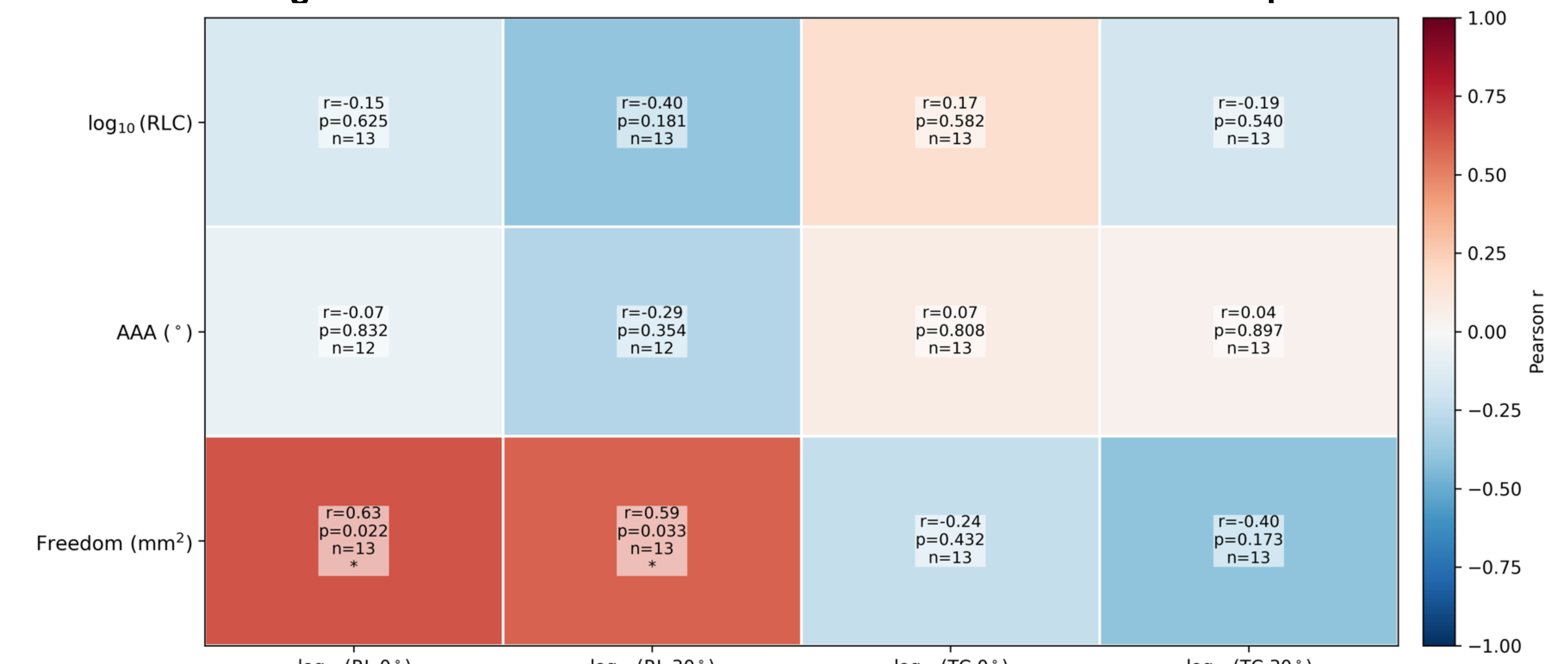



**Figure 4. Correlation Between Anatomic Covariates and IAC Exposure**




## Conclusion

In this cadaveric series, both the RL and TC hearing-preserving approaches exposed less IAC volume than the TL approach; however, simulated 30-degree endoscopic assistance substantially improved visualization for both RL and TC. Since TC carries a higher risk of hearing loss due to partial labyrinthectomy, the RL approach remains a feasible, comparatively safer hearing-preserving option for VS of the medial IAC.

Additionally, surgical freedom correlated with IAC accessibility in the RL approach. Given the limited sample of 13 temporal bones, larger feasibility studies are needed to better define the prognostic value of anatomic covariates in surgical candidate selection.

## References

1. Cioffi G, Yeboa DN, Kelly M, et al. Epidemiology of vestibular schwannoma in the United States, 2004–2016. *Neuro-Oncol Adv*. 2020;2(1):vdaa135. doi:10.1093/noajnl/vdaa135
2. Kadri H, Agha MS, Abouharb R, Mackieh R, Kadri T. The outcome of the retrosigmoid approach in the decompression of vestibular schwannomas - a retrospective cohort study of 60 consecutive cases. *J Med Life*. 2024;17(4):426-431. doi:10.25122/jml-2024-0055
3. Ansari SF, Terry C, Cohen-Gadol AA. Surgery for vestibular schwannomas: a systematic review of complications by approach. Neurosurg Focus 2012;33:E14.
4. Irving RM, Jackler RK, Pitts LH. Hearing preservation in patients undergoing vestibular schwannoma surgery: comparison of middle fossa and retrosigmoid approaches. J Neurosurg 1998;88:840–5.
5. Vaz-Guimaraes F, Sarteschi C, Roesler EH, et al. Morphometric Analysis of the Retrolabyrinthine Approach to the Posterior Fossa. World Neurosurg. 2024 Aug;188:e441-e451. doi: 10.1016/j.wneu.2024.05.134.
6. Sincoff EH, McMenomey SO, Delashaw JB Jr. Posterior transpetrosal approach: less is more. Neurosurgery. 2007 Feb;60(2 Suppl 1):ONS53-8; discussion ONS58-9. doi: 10.1227/01.NEU.0000249232.12860.A5.
7. Brandt MG, Poirier J, Hughes B, Lownie SP, Parnes LS. The transcrusal approach: a 10-year experience at one Canadian center. Neurosurgery. 2010 May;66(5):1017-22. doi: 10.1227/01.neu.0000368102.22612.47.
8. Kaylie DM, Horgan MA, Delashaw JB, McMenomey SO. Hearing preservation with the transcrusal approach to the petroclival region. Otol Neurotol. 2004 Jul;25(4):594-8; discussion 598. doi: 10.1097/00129492-200407000-00029.
9. Irwin LA, Lee L, Mitchell J, Corwin FD, Coelho DH, Manzoor NF. Endoscopic-Assisted Presigmoid Approach to the Internal Auditory Canal. A Feasibility Study. Otol Neurotol. 2024 Aug 1;45(7):806-809. doi: 10.1097/MAO.0000000000004248.
10. Zador Z, de Carpentier J. Comparative Analysis of Transpetrosal Approaches to the Internal Acoustic Meatus Using Three-Dimensional Radio-Anatomical Models. J Neurol Surg B Skull Base. 2015 Aug;76(4):310-5. doi: 10.1055/s-0035-1549000.

Aaron Tucker, BA
VCU Department of Otolaryngology – Head & Neck Surgery
1200 East Broad Street, West Hospital, Richmond, VA, 23298

ORCID