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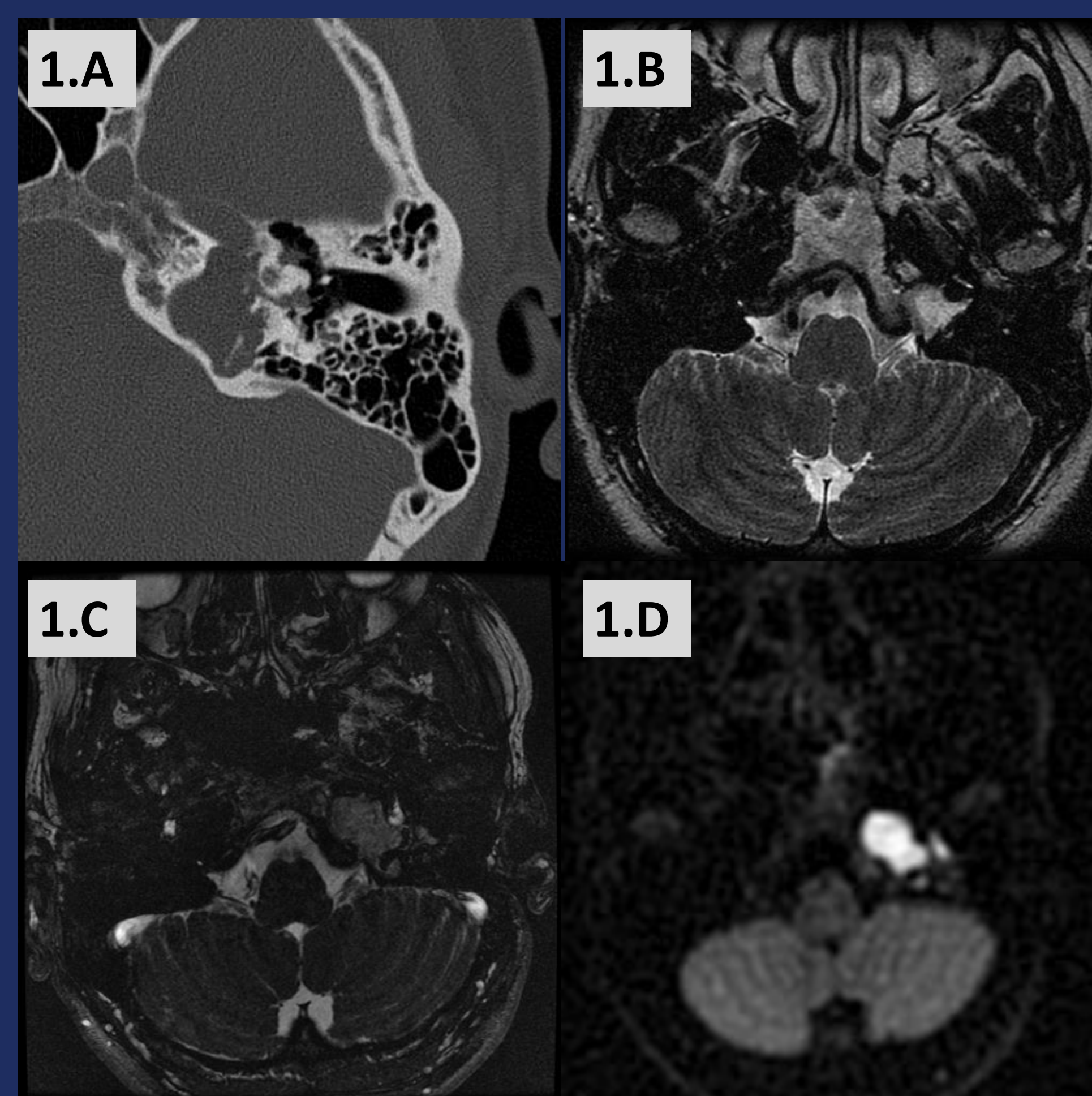
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INTRODUCTION

- **Petrous Apex Cholesteatomas (PACs)** constitute 4-9% of all petrous apex lesions. Given that the petrous apex is one of the least accessible areas of the skull, and its proximity of several vascular and neural structures, management approaches are controversial. Choice of surgical approach depends on the extent and location of disease, its relationship to the carotid artery, and the patients symptoms.
- Symptoms occur late in the disease process. Hearing loss and tinnitus are the most common initial symptoms. Frequently the facial nerve is involved at presentation.
- PACs have a high recidivism rate due to the inability to clear all the disease at primary surgery, which is often times intended to minimize morbidity.
- Recent advances in endoscopy have added new routes of access to the petrous apex. Herein, we report long-term outcomes on 2 patients with PAC who were managed with endoscopic-assisted surgery but by two different routes: endonasal vs. infracochlear.

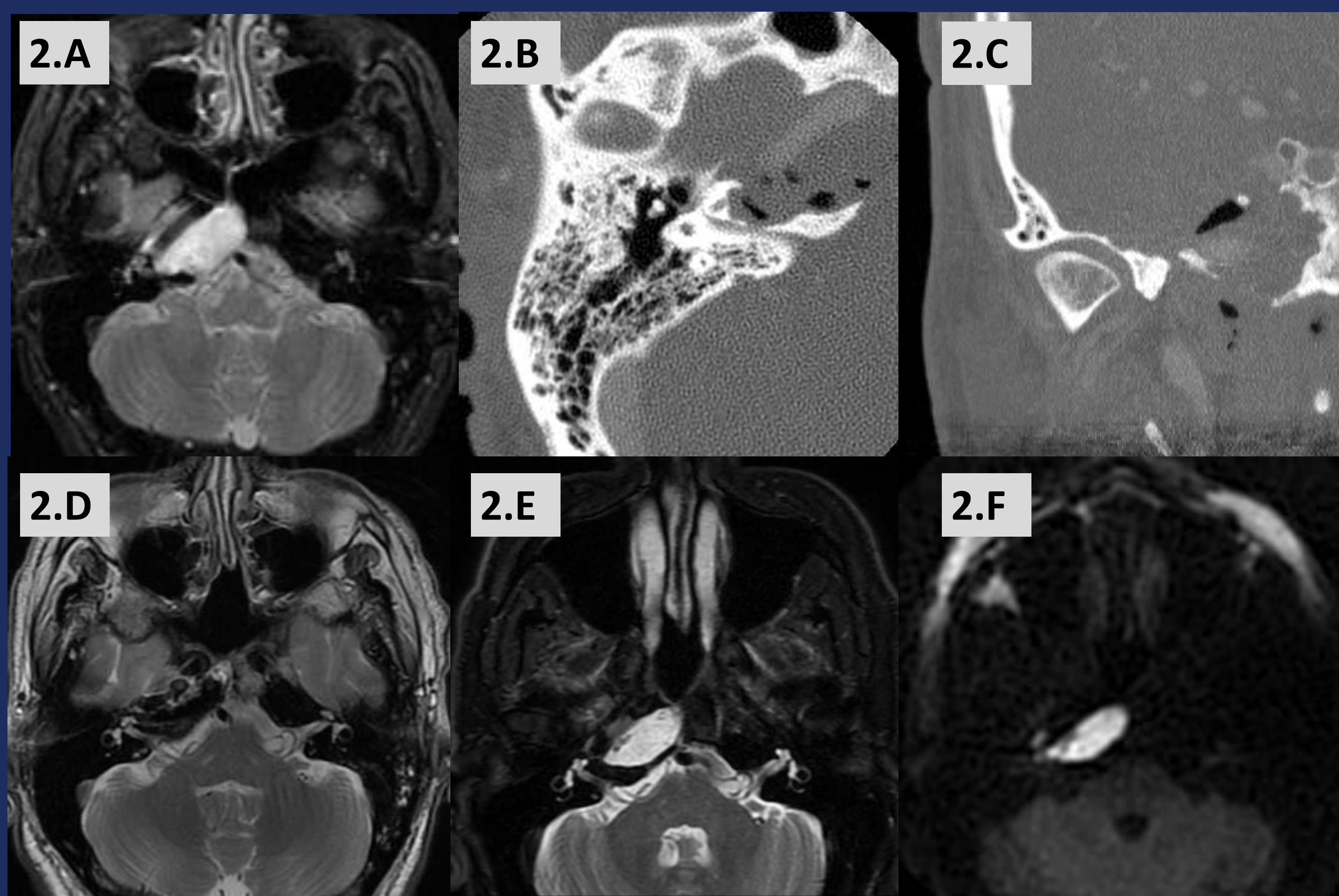
CASE #1 - Infracochlear Approach

A 24-year-old female presented with left-sided facial weakness (House-Brackmann IV), sensorineural hearing loss, and decreased vestibular function due to a PAC that grew to involve the geniculate ganglion and labyrinth. CT demonstrated expansion of the left petrous apex (**Figure 1A**) and T2-weighted MRI demonstrates hyperintense lesion (**Figure 1B**) with diffusion restriction consistent with a cholesteatoma. Her initial operation was performed via a combined transcanal-infratemporal and middle fossa approach using the conventional operating microscope. During follow-up 8 years later, she was noted to have a recurrent expanding mass in the left petrous apex (**Figure 1C**) and diffusion-weighted imaging confirmed this to be recurrent cholesteatoma (**Figure 1D**). A left transtemporal-infracochlear approach was taken to re-expose the petrous apex. Bone was removed between the cochlea superiorly, the carotid artery anteriorly, and the jugular bulb inferiorly. This allowed access to the inferior aspect of the petrous apex (below the IAC). The ossicular chain was not manipulated. Endoscopic removal of cholesteatoma was then performed using 0° and 30° 3-mm endoscopes. Improved access to the posterior and inferior aspects of the petrous apex were noted with the endoscope versus microscope. Computerized image guidance was helpful in delineating the limits of debridement as well as noting the position of the internal carotid artery in the vertical and horizontal petrous segments. Portions of the cholesteatoma matrix shared a common wall with the middle fossa and posterior fossa dura and the carotid artery. Therefore, the goal of surgery was to remove as much cholesteatoma debris as possible with minimal removal of cholesteatoma matrix. Approximately 2 years after this procedure, the patient elected to undergo another debridement via an endoscopic infracochlear approach. She continues to do well and follows up with yearly MRI scans. Her facial function remains a HB IV. A BAHA was placed due to a significant conductive hearing loss she developed from fibrosis around the ossicles. This BAHA was placed more superiorly and posteriorly than typical so to not affect radiological surveillance of recurrent cholesteatoma.



CASE #2 – Endonasal Approach

A 52-year-old male initially presented with double vision and found to have right-sided lateral rectus palsy due to a cholesteatoma expanding the petrous apex and clivus and compressing the dura in the region of Dorello's canal (**Figure 2A**). A large combined lateral skull-based approach was discussed with him but given the significant morbidity with this and the likelihood of recurrence, a decision was made to perform a less morbid procedure via an endoscopic transsphenoidal approach. A large portion of the cholesteatoma was removed successfully with exception of the area where the cyst surrounded the carotid artery, and portions of tumor were likely left in the lateral to the carotid artery in its horizontal petrous segment. He was then followed with scans every 1-2 years and did well for 8 years at which time he developed deterioration in right-sided hearing in the high frequencies and imaging revealed erosion into his cochlea by an expansile lesion of his right petrous apex (**Figure 2B-C**). In addition there is erosion into the clivus, the petrous segment of the carotid canal, and the occipital condyle (**Figure 2C**). He then underwent an endoscopic transsphenoidal transclival approach to resect the recurrent tumor (**Figure 2D**). Biliary T-tubes were placed to allow for ventilation and drainage. He did well initially and his 6-mo post-op scan demonstrated near total removal of the cholesteatoma (**Figure 2D**). However, at his 3 year follow-up, he was found to have re-growth as demonstrated by his T2-weighted MRI (**Figure 2E**) and diffusion weighted sequence (**Figure 2F**). He has since undergone another transsphenoidal debridement. His symptoms have remained stable, with no further hearing loss, and continues to be followed with annual MRI's for surveillance.



CONCLUSIONS

- Recidivism is common in PAC and repeat debridement procedures are often required in patients in whom hearing and balance are attempting to be preserved.
- Endoscopes provide a less invasive way to access this problematic region where enhanced visualization may lead to improved gross total resection and a greater period of time between debridement procedures.
- Both approaches provided access for near-total resection of the PAC with preservation of hearing, vestibular and pre-operative facial nerve function. Over a 12-year follow-up on each patient, both required 2 additional operations for recurrent disease.
- Diffusion-weighted imaging is helpful to obtain during surveillance MRI's for PAC to determine when significant regrowth of cholesteatoma has occurred.
- The **Endoscopic Transtemporal Infracochlear Approach** may provide greater access to the posterior and inferior aspects of the petrous apex. However, a poorly pneumatized temporal bone makes this approach more difficult.
- The **Endoscopic Endonasal Approach** may be more suitable for superior or anterior-inferior petrous apex disease. This approach reduces risk to hearing and facial nerve. It also may improve the ability to maintain continuous drainage and aeration with stents. A narrow window between the carotid artery and the brainstem makes this route more difficult.

REFERENCES

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