

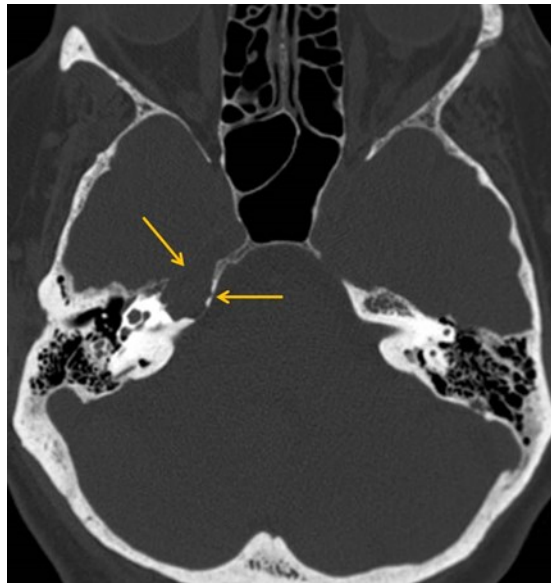
## Expansile Lesion of the Petrous Apex

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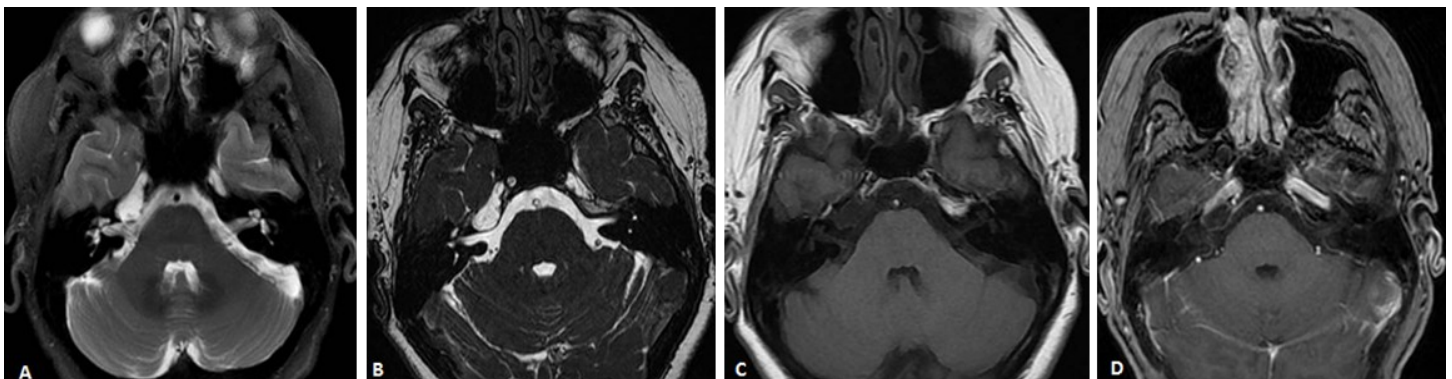
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### Case Presentation

A 58-year-old woman underwent a noncontrast head CT after trauma. Past medical history was non-contributory. An incidental finding is discovered (**Fig. 1**) and further evaluated by MRI (**Fig. 2**).



**Figure 1.** Axial CT in bone algorithm shows a lucent, expansile lesion in the right petrous apex (arrows) with smooth, scalloped margins.



**Figure 2.** Axial T2 weighted (A), axial high-resolution heavily T2 weighted FIESTA sequence (B), axial T1 weighted (C), and axial T1 post-contrast (D) MR images demonstrate a homogenous T2 hyperintense, T1 hypointense non-enhancing lesion that follows CSF signal and is continuous with right Meckel cave. Although not shown, the lesion completely suppressed on FLAIR and did not restrict diffusion.

## Key imaging finding

Expansile lesion of the petrous apex

## Differential diagnoses

Cholesterol granuloma  
 Meningocele  
 Epidermoid cyst  
 Mucocele  
 Chondrosarcoma (and other neoplasms)  
 Petrous apicitis  
 Petrous carotid aneurysm

## Discussion

The differential diagnosis for petrous apex lesions is broad, but careful attention to certain imaging features can often help distinguish between the various entities. The radiologist plays a key role in the evaluation of lesions of the petrous apex, since this area is beyond direct inspection by the clinician and surgical access is difficult. Therefore, the radiologist's role should go beyond detection, localization, and characterization and make every effort to arrive at the most specific diagnosis – when possible – to appropriately direct patient care.

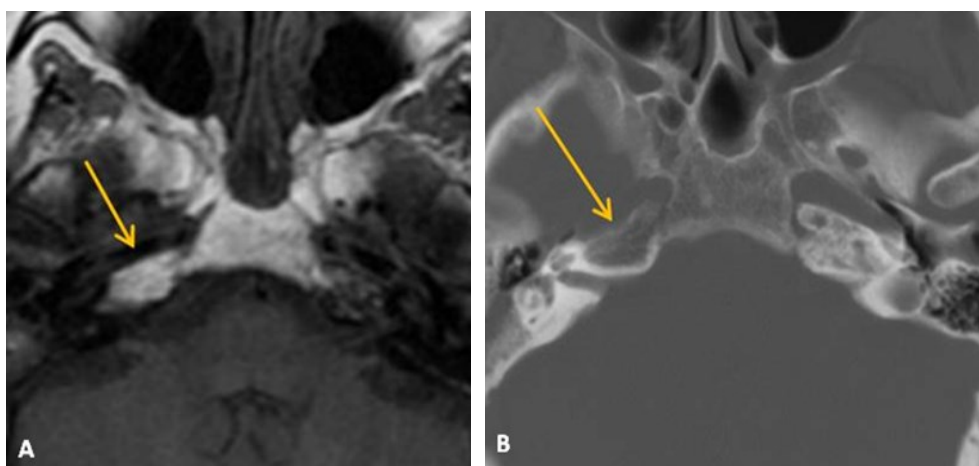
When evaluating petrous apex lesions, imaging findings are often nonspecific by CT or MRI alone. However, CT and MRI are complementary and both

studies are typically required for more definitive characterization. On CT, the osteolytic component and margins are better evaluated. If the margins are smooth and scalloped, this suggests a slow-growing benign process with pressure erosion or remodeling of adjacent bone. This is more typical of cholesterol granuloma, meningocele, mucocele, schwannoma, and other benign lesions, while ill-defined margins or a permeative moth-eaten pattern are worrisome for aggressive neoplasm or infection. The presence of internal matrix/calcification is also an important feature to assess, and – if present – suggests a chondroid lesion such as chondrosarcoma. MR imaging, to include post-contrast sequences, is essential to narrow the differential diagnosis; it is superior to CT in assessing the lesion's relationship to adjacent soft tissue structures.

While solid lesions often require biopsy to determine appropriate treatment, if resection is necessary, and the extent of surgery, cysts may be treated with simple drainage and fistulization if proper preoperative diagnosis is made and treatment is necessary.<sup>1</sup> Potential pitfalls to be aware of, primarily on MR imaging, are asymmetric pneumatization of the petrous apex and unilateral retention of secretions in apical air cells. With the former, there is unilateral T1 hyperintensity from marrow of non-pneumatized petrous apex (**Fig. 3**). Fat suppression techniques can usually resolve this issue, as this area will follow suppression of marrow signal elsewhere. In the latter instance, unilateral T2 hyperintensity is seen in the petrous apex from retained secretions, which is usually

T1 hypointense, similar to sinus secretions. CT imaging in both of these circumstances will show absence of an expansile lesion or bony erosion, and therefore usually resolves the question.

Petrous apex lesions are often incidentally seen and usually attain considerable size before causing cranial nerve symptoms that lead to their clinical presentation.<sup>1</sup> Most of the lesions that may be encountered in clinical practice are specifically discussed below.

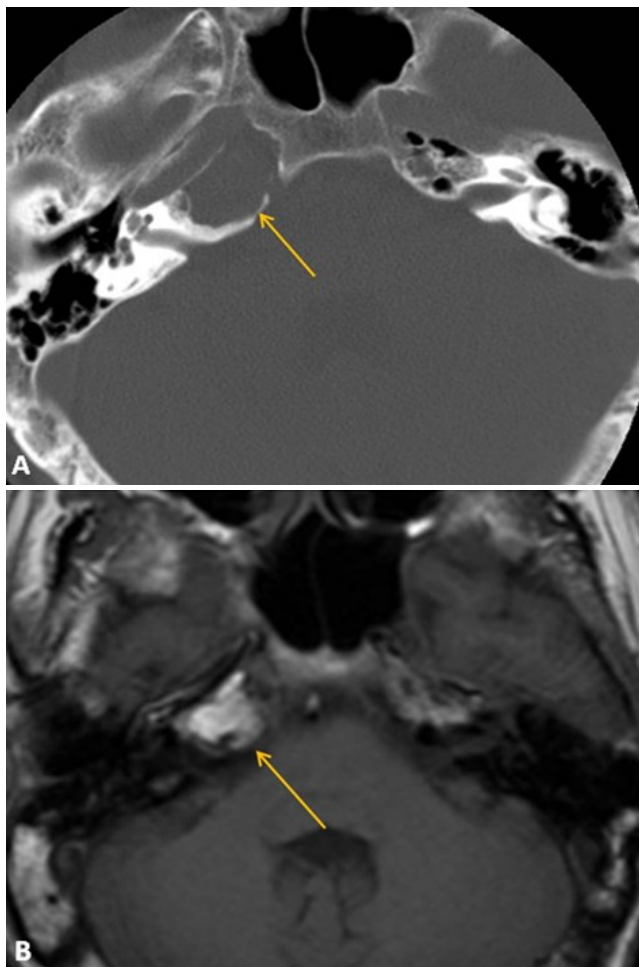


**Figure 3.** Normal Marrow as Possible Pitfall on MRI.

Axial T1 weighted MR image (A) shows asymmetric T1 hyperintensity in the right petrous apex due to normal marrow in a non-aerated apex, confirmed to have no lesion by CT (B).

### Cholesterol Granuloma.

Cholesterol granuloma (also known as cholesterol cyst or giant cholesterol cyst) is the most common primary petrous apex lesion.<sup>1</sup> A theorized mechanism for its development is obstruction of ventilation outlet by thickened mucosa, leading to repeated cycles of hemorrhage and granulomatous reaction. When gas is trapped in the pneumatized space and absorbed over time, negative pressure in the enclosed space leads to tissue edema, breakdown of blood vessels in the region, and subsequent accumulation of blood degradation products, including cholesterol.<sup>1</sup> These lesions typically occur in young and middle-aged adults of both sexes. If symptomatic, hearing loss, tinnitus, and hemifacial spasm are the most common associated clinical findings.<sup>1</sup> On CT, they are homogenous lucent expansile lesions with smooth,



**Figure 4. Cholesterol Granuloma.**

Axial CT in bone algorithm (A) shows an expansile lucent lesion of the right petrous apex with smooth, sharply defined margins. Corresponding T1 hyperintensity on MRI (B) is typical of cholesterol granuloma.

sharply defined margins, and no internal calcification (Fig. 4A). Overlying bone may be thinned or even absent and one may see dehiscence of the carotid canal. On MRI, the characteristic feature of this lesion is strong T1 hyperintensity (Fig. 4B). They are also typically bright on T2 weighted images and frequently contain non-homogenous hypointense internal areas that probably represent hemosiderin from previous hemorrhage. Note that normal unilateral T1 hyperintensity from marrow of non-pneumatized petrous apex can be a pitfall, and CT can usually sort this out if there is a question based on the MRI (Fig. 3).

### Meningocele.

A petrous apex meningocele is an uncommon lesion that represents a protrusion of meninges and CSF from the posterolateral aspect of Meckel cave.<sup>2</sup> On CT, these lesions mimic cholesterol granulomas with an expansile homogenous lesion of the petrous apex. MRI is key to demonstrating that the lesion follows CSF signal on all sequences and directly communicates with Meckel cave. These are usually asymptomatic and incidental but rarely have been associated with symptoms such as cranial nerve palsy.<sup>2</sup>

### Epidermoid Cyst.

Epidermoid cysts contain desquamated keratin, which appears grossly as whitish friable material. For this reason, they are also referred to as primary cholesteatomas.<sup>1</sup> As the keratin accumulates, the mass slowly enlarges. On CT, epidermoid cysts appear similar to cholesterol granulomas with a homogenous, nonenhancing, sharply defined, expansile lesion. On MR imaging, they are strongly T2 hyperintense; the presence of restricted diffusion will help differentiate these from mucocèles (see below). Although these are often referred to as “cysts,” they often contain solid or semi-solid material and are usually treated with complete surgical resection to prevent recurrence.

### Mucocele.

Mucocèles have very similar imaging features compared to epidermoid cysts on routine MR sequences but are less common. They are hyperintense on T2, hypointense on T1, and there may be a thin enhancing rim. In contrast to epidermoid

cysts, they do not restrict diffusion, which is an important distinguishing feature.<sup>1</sup>

#### Petrous Apicitis.

Petrous apicitis refers to overt infection of the petrous apex, usually as a complication of otomastoiditis.<sup>3</sup> This is thought to develop only in individuals that have a pneumatized apex, because if aerated (as is the case in approximately 30% of individuals), the petrous apex communicates with mastoid air cells and middle ear.<sup>4</sup> On CT, there is debris and fluid in the petrous apex with destruction of bony septa (analogous to coalescent mastoiditis).<sup>4</sup> Destruction of bony cortex can result in intracranial complications, which can be better evaluated by MRI. This can cause the classic Gradenigo triad of otomastoiditis, sixth nerve palsy, and pain in the distribution of the fifth nerve, although patients rarely have all of these symptoms.<sup>4</sup> Trapped fluid, or "petrous apex effusion," occurs commonly as an incidental finding on both CT and MRI and should not be confused with clinically significant disease. There should not be bony destruction or expansion with an effusion. Also, MRI typically shows enhancement with petrous apicitis, but that would not be the case with retained secretions.

#### Chondrosarcoma.

Petroclival chondrosarcoma is a rare tumor, yet probably the most common primary malignant neoplasm in the region of the petrous apex.<sup>1</sup> These tend to occur off midline along synchondroses, centered along the petrosphenoidal and petrooccipital fissures within the petrous apex. On CT, they cause bone destruction, enhance, and may contain chondroid-like matrix (**Fig. 5**). On MR imaging, they are characteristically hyperintense on T2, iso to hypointense on T1, and usually enhance avidly. Occasionally, their location may overlap with chordomas which arise from notochord remnants, typically occur in midline, and may contain calcifications.<sup>1</sup>

#### Other Neoplasms.

A trigeminal schwannoma may occasionally attain such size that it straddles the petrous apex, extending

into the anterior and middle cranial fossae. The petrous apex may also be invaded by direct extension from nasopharyngeal squamous cell carcinoma or glomus jugulare paragangliomas. On CT, these have permeative margins and associated soft tissue components seen as enhancing masses on post-contrast imaging. Squamous cell carcinoma will be associated with an infiltrative nasopharyngeal mass. Paraganglioma will characteristically have osseous destruction with a "moth-eaten" appearance on CT; on MRI, the soft tissue mass may have a "salt and pepper" appearance. Myeloma, lymphoma, metastases, and giant cell tumors are additional tumors that may occasionally involve the petrous temporal bone and typically have aggressive imaging features. Endolymphatic sac tumors are rare papillary cystadenomatous tumors that can cause facial palsy and sensorineural hearing loss.<sup>1</sup> These are associated with Von-Hippel-Lindau disease but may also occur sporadically; involvement tends to occur within the retrolabyrinthine petrous bone, although extension towards the apex may be seen.

#### Petrous Carotid Aneurysms.

Aneurysms of the petrous portion of the internal carotid artery are extremely rare,<sup>1</sup> but are an important part of the differential diagnosis to consider given the serious implications of misdiagnosing this



**Figure 5. Chondrosarcoma.**

Axial CT in bone algorithm demonstrates an expansile lytic lesion of left petrous apex with internal "arc-like" calcification of chondroid matrix.

entity. On CT, you would expect to see a lobulated soft tissue mass expanding the carotid canal with smooth, scalloped bony margins.<sup>1</sup> On MR imaging, laminated mural thrombus may be apparent, showing varying signal intensity; the patent lumen appears as a flow void.<sup>1</sup>

## Diagnosis

Petrous apex meningocele

## Summary

Petrous apex meningocele is typically an incidental finding, but is important to recognize as a potential mimicker of other lesions on CT. MRI confirms the diagnosis by demonstrating a CSF signal lesion that communicates with Meckel cave. As in this scenario, it is often possible to make a specific imaging diagnosis of a lesion involving the petrous apex. Every attempt should be made to do so, particularly because this area is not amenable to direct inspection and surgical access is difficult. Therefore, radiologists play a key role in diagnosis and determining if further management is necessary.

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