Good News

- PAs tend to be symmetric
- A quick glance at axial MRI or CT is usually all that is required to evaluate
- Isolated PA lesions are relatively rare
- Many abnormalities are incidental or “don’t touch me lesions”

Bad News

- Obvious asymmetry creates an automatic dilemma
- Once you see a possible lesion you have to answer bunch of questions in order to narrow down differential
- It seems that additional study is always necessary
- It’s our responsibility to determine the significance of a lesion and narrow the differential

The petrous apex is a pyramidal shaped, variably pneumatized structure of the temporal bone that has unique anatomic relationships to:

- central skull base
- intracranial compartments
- suprahoid neck
Petrous Apex Anatomic Relationships:
- PA is intimately related to several important anatomic structures
  - Cavernous sinus & CNS
  - POF
  - Clivus
  - Meckel’s cave and trigeminal nerve
  - Carotid Artery
  - Jugular foramen
  - Sphenoid Sinus
  - Nasopharynx

Petrous Apex: Anatomic Relationships

Tentorium cerebelli
- Fixed edge with superior petrosal sinus
- Free edge

PETROUS APEX
- Interclinoid fold
- Anterior Petroclinoid fold
- Posterior Petroclinoid fold
- Ductomotor Triangle

AXIAL CT PETROUS APEX
- Arcuate Eminence & SCC

AXIAL CT PETROUS APEX
- Superior Petrosal Sinus
Dorello’s Canal

CN VII

Petroclival Junction

Lacerum segment

Trabecular bone

Trigeminal Impression

Geniculate Ganglion

Greater Superficial Petrosal Nerve

Trigeminal Impression

Notice how thin the bone is here

Parasympathetics / lacrimation

Greater Superficial Petrosal Nerve

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Greater Superficial Petrosal Nerve

Greater Superficial Petrosal Nerve

Surgical Landmark for geniculate ganglion

Greater Superficial Petrosal Nerve

Facial Nerve Schwannoma

PNTS involving GSPN

Greater Superficial Petrosal Nerve
Most commonly, PA is composed of rim of cortical bone and intrinsic trabecular bone containing bone marrow.

- Pneumatization of the petrous apex occurs in 9–30% of patients.
- Normal imaging appearance on CT or MR is highly dependent on presence of marrow space vs. pneumatized air cells within PA.
• Is there a lesion or process that replaces normal bone marrow?
• Is there a lesion/process that replaces normal air density/hypointensity related to pneumatized air cells?
• Is the lesion enhancing?
• Is there associated bone expansion, erosion, or destruction?
Pathology of Petrous Apex

**Intrinsic Lesions**
- Bone/Bone Marrow/Cartilage
- Petrous apex air cells
- Internal Carotid Artery

**Extrinsic Lesions/Extracranial**
- Nasopharyngeal carcinoma
- Sinonasal carcinoma
- Sarcoma
- Lymphoma
- Invasive infection
- Glomus
- Endolymphatic Sac Tumor

**Extrinsic Lesions/Intracranial**
- Invasive Meningioma
- PA Cephalocele
- Dural Mets

44 year old patient with left 6th nerve palsy

Text:

Pathology of Petrous Apex

- Chondrosarcoma of PDF
- Metastatic disease
- Myeloma
- Lymphoma/Leukemia
- Sarcoma
- Osteomyelitis
- Effusion
- Petrous apicitis
- Cholesterol granuloma
- Cholesteatoma
- Aneurysm
- Thrombosis

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The least likely diagnosis for this destructive, enhancing lesion of the petrous apex is:
1. Metastatic disease
2. Myeloma
3. Chondrosarcoma
4. Chordoma
5. PA cephalocele
POF (or PA) Chondrosarcoma

- Enhancement is diffuse
- Usually markedly hyperintense on T2
- Fingerlike or polypoid extensions (cauliflower)
- CT appearance: Typically lytic expansile lesion with peripheral irregular calcification
- 50% ?? contain chondroid calcifications
Chordoma vs. Chondrosarcoma

- Both are rare skull base tumors
- Both are typically hyperintense on T2
- Both are typically slow growing
- At light microscopy, chordomas were thought to have "chondroid" features (ex: chondroid chordoma)

Chordoma vs. Chondrosarcoma

- These tumors are immunohistochemically distinct.
- Chordoma actually has no chondroid elements.
- Chordomas tend to occur in midline: Clivus
- Chondrosarcomas tend to occur off midline: Petro-occipital Fissure
None of the MRI or CT features appear to be useful for differentiating chordomas from chondrosarcomas.
57 year old female followed for bilateral cavernous carotid aneurysms. Also with history of lung cancer. Presents with headache.

Multifocal Lymphoma

Right petrous apex plasmacytoma

Fibrous Dysplasia
**Petrous Apex: Benign Intrinsic Lesions**

- **Paget’s**
- **Osteopetrosis**

**Petrous Apex: Endocranial Lesions**

- **Meningioma**
- **Large Petroclival Meningioma**
- **Invasive Meningioma**

*Most meningiomas invasive to skull base are WHO grade I or II, and not “malignant”*
Companion case: Invasive Meningioma

11 year old female with headache and facial pain

Trigeminal Schwannoma

70 year old with vertigo
• Pseudomeningoceles, meningoceles
• Rarely associated with symptoms
• Tracks like CSF on all sequences!!
• Subset may be related to Intracranial hypertension

Petrous Apex Cephaloceles
43 yo with right 6th nerve palsy and HA

Petrous Apex: Intrinsic Expansile

Cholesterol Granuloma

- Hyperintense on T1- "smoky" appearance
- T2-Can be markedly hyperintense or heterogeneous
- NOT fat signal
- No internal enhancement
- Well circumscribed bony margins
- May be lobulated or cauliflower-like

MRI:
- Hyperintense on T1- "smoky" appearance
- T2- Can be hyperintense or markedly heterogeneous and rim of hypointensity
- NOT fat signal
- No internal enhancement
- May be lobulated or cauliflower-like

CT:
- Expansile, lytic lesion
- Well circumscribed bony margins

Cholesterol crystals can be formed in any location where there has been cellular degeneration
- prior hemorrhage
- degenerating inflammatory cells
- necrotic inflammatory tissue
- Cholesterol crystals act as foreign bodies, and they incite a strong granulomatous reaction from the tissue in which they form.
60 year old patient with history of Nasopharyngeal Carcinoma

Now with right facial pain and neck nodes
Exocranial Lesions

Nasopharyngeal Carcinoma

Petrous Apex Mass

Teaching Point:
Vascular Lesions in the skull base may have:
- slow flow
- complex flow
- mixed signal thrombus
- partial thrombosis

Always consider CTA to fully evaluate the ICAs and the cavernous sinuses for a lesion in central skull base seen on MRI.

55 year old with Type 2 Diabetes, congenital deafness and inability to communicate verbally presents with low grade fever, severe pain and drainage from left ear.

Had been treated for several weeks for otomastoiditis, but symptoms progressed.

Infection

Erosion of bone at the central skull base

Infiltrating process of the central skull base region and nasopharyngeal soft tissues
Otomastoiditis and Central Skull Base Osteomyelitis

**Staphylococcus aureus**

**Typical Skull Base Osteomyelitis**
- Elderly diabetic or immunocompromised pts
- Typically complication of Malignant Otitis Externa
- Process originates as a soft-tissue infection of the EAC, then spreads to the skull base through the fissures of Santorini along the floor of cartilaginous EAC
- Pseudomonas, Aspergillosis
- It causes bone destruction of the skull base
- Affects the skull base foramina and cavernous sinuses, causing cranial neuropathies

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75yM Asian, with DM
- Had ear discharge, admitted to OSH where multiple biopsies obtained searching for NPC
- All negative
- Increasing ear pain and fevers – then Dx of skull base osteomyelitis
- Not responding to pseudocovering AB
- Clinical and MRI findings progressed until final biopsy demonstrated Aspergillosis

Skull Base Osteomyelitis Secondary to Fungal MOE

Skull Base Osteomyelitis Secondary to Fungal MOE
Skull Base Osteomyelitis

Petrous apex marrow space
Occipital Bone marrow space
Streptococcus pneumoniae

Endolymphatic Sac Tumor

Giant Jugulotympanicum Paraganglioma

73 yo female with multiple right sided lower cranial neuropathies, including right vocal cord paralysis and hearing loss.