Learning Objectives

• To review the anatomy of the anterior and central skull base and associated foramina and soft tissues on CT and MR
• To demonstrate selected anatomic variants of these regions
• To illustrate some of the common and less common “don’t touch” lesions of the region

Disclosures

• None

ANATOMY

Anterior Skull Base

• Frontal bone
  − Squama (vertical portion)
  − Orbital plate (horizontal portion)
    • Floor of anterior cranial fossa
    • Also ethmoid roof
  − Frontal sinus

• Ethmoid bone
  − Cribriform plate
  − Ethmoid sinuses

• Articulation
  − Posteriorly w/ sphenoid bone, superiorly w/ parietal bone

Ethmoid Bone

• Four parts
  − Horizontal or cribriform plate
    • Perforated by foramina for olfactory nerves
  − Perpendicular plate
    • Part of nasal septum
  − Paired lateral masses
    • Air cell labyrinths

Ethmoid roof (fovea ethmoidalis) is formed by orbital process of frontal bone

Ethmoid roof

- Gyrus rectus
- Cribiform level
- Kallmann Syndrome
**Anterior Skull Base: Changes over Time**

- At birth, ASB largely cartilaginous
- Ossification begins in roof of ethmoid labyrinth laterally and spreads to midline
  - Crista galli, perpendicular plate of ethmoid begin ~2 months, steady increase to ~14 months (Belden et al, AJNR 1997)

**Other developmental lesions may occur ...**

1 day old male w difficulty breathing; also mild hypertelorism

**Frontonasal cephalocele**
31 F found down in apartment, dx’d w bacterial meningitis.

**Frontoethmoidal cephalocele**
- B frontoorbital cephaloceles

Developmental defects/lesions may affect the anterior skull base. At all ages, be alert for meningoencephaloceles.

**Central Skull Base**

- Sphenoid bone
  - Body; greater wings; lesser wings; pterygoid processes
  - Multiple skull base foramina and fissures for vessels and nerves
- Occipital bone
  - Basiocciput contributes to clivus

**CT Anatomy of Central Skull Base and Foramina**
Central Skull Base: Changes Over Time, CT
- Pneumatization of sphenoid sinus
- Fusion of the sphenoid-occipital synchondrosis
- Clival marrow: red to yellow

Central Skull Base: Changes Over Time, MR

16 mo: Minimal sphenoid sinus pneumatization
Prominent sphenoid-occipital synchondrosis
10 yrs: Larger sinus
Synchondrosis obliterating

14 mo: 16 F
3 yrs: 6 F
8 yrs: 67 F

Adult hood:
Large fully pneumatized sphenoid sinus
Complete obliteration of sphenoid-occipital synchondrosis

Some clival heterogeneity can be normal

Initial MR
Correlative CT
7 yrs later

50 yr old male
Same patient, age 57

ANATOMICAL VARIANTS/“DON’T TOUCH” LESIONS
- Developmental variants or anatomical aberrations in bone, vessels, soft tissues
- We don’t want to biopsy them or treat them with stereotactic radiosurgery
- There are enough to fill entire textbooks! A few are selected
**Notochord**
- Flexible rod-shaped body in embryos of all chordates
  - Composed of mesoderm-derived cells
  - Defines primitive axis of the embryo
  - Located ventral to neural tube
- In most vertebrates, persists only as nucleus pulposus of intervertebral disc

**Ecchordosis Physaliphora**
- Ectopic notochordal remnant
  - Soft tissue mass associated with scalloping of posterior clivus
  - T2 bright, non-enhancing
- Typically incidental: asymptomatic, indolent
  - Follow-up imaging if unsure of dx

**Persistent Canals and Divots**
- Persistent Craniopharyngeal Canal
- Fossa Navicularis Magna
  - Type 3A, with cephalocele
  - Type 3B, with tumor (teratoma)

**Absent Canals**
- 39 M with R pulsatile tinnitus and vascular retrotympanic mass.
  - Absent foramen spinosum with aberrant ICA, persistent stapedial artery
  - Congenital Absence of ICA/Carotid Canal

**Petrus Apex Variations: Many**
- Asymmetrical marrow
- Petrus Apex Cephalocele
  - May coexist with empty sella, arachnoid pitting, osseous-dural dysplasia – Do consider possible association with IIH (idiopathic intracranial hypertension)

**Brain may herniate into arachnoid pits**
- 27 M with epilepsy. L temporal origin of seizures.
  - Dx: focal brain herniation into arachnoid granulation/pit. Patient did not have IIH.
  - Patient referred for bx.
  - Dx: prominent arachnoid granulation vs cephalocele of greater wing of sphenoid
Another variant to recognize …

43 F referred to our sinus center for biopsy of a skull base lesion.

- Benign developmental variant
- Nonexpansile lesion w/ osteosclerotic borders, internal fat, curvilinear calcifications in basisphenoid or adjacent skull base
- Fatty marrow conversion, but then failure of pneumatization

Welker et al, AJR June 2008

DON’T BIOPSY

- These may be actual lesions, but they can often be identified specifically enough that they do not require biopsy, or biopsy can be dangerous, though they may require some form of treatment
- And in some cases biopsy may be indicated, but one can still redirect from a plan to resect to a plan to biopsy

Focal lesion of R basisphenoid. Benign or aggressive?

Dx: arrested pneumatization of the skull base

CT and MR are often complementary at the skull base. We are not just trying to get the clinicians to order more studies!

"Your CT scan looks fine, your PET scan looks fine, your MRI looks fine, but your insurance reimbursement doesn't look fine."

56 F w HA, R CN VI palsy

Soft tissue lesion involving sella, central skull base. Met? Macroadenoma? Should we plan for biopsy?

Let’s do an MR first … a CTA/CECT would also be reasonable

Dx: partially thrombosed giant aneurysm of R cavernous ICA. Patient was subsequently rx’d w flow diverting stents.

21 F w new onset R CN XII palsy and HA during pregnancy.
Dx: presumed "cavernous hemangioma" [low flow venous vascular malformation] of bone. These can enlarge during pregnancy. Post-partum, symptoms resolved, and the patient is being followed.

How about this case? 39 M w HA, diplopia.

Dx: metastatic spindle cell sarcoma

48 year old M w 3 year h/o R sided rhinorrhea.

Dx: spontaneous lateral sphenoid cephalocele c/b CSF leak.

Summary
- Anterior and central skull base anatomy
- Anatomical variants
- Don’t touch lesions