Pediatric Neuroradiology and Neuroanatomy for the Audiologist

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Why study radiology and anatomy?

• Understand the anatomy, understand the disease, and understand the patient
• Correlation with disease processes and radiology – if you can’t see it or touch it you may need to image it
• Improve communication among disciplines
• Knowledge can improve patient care
Temporal Bone Anatomy

Bony Divisions: 1) Squamous, 2) Tympanic, 3) Mastoid, 4) Styloid, 5) Petrous

Temporal Bone - Squamous

- Forms lateral wall of middle cranial fossa
- Floor of temporal fossa (temporalis muscle)
- Groove for middle meningeal artery
<table>
<thead>
<tr>
<th>Temporal Bone - Tympanic</th>
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<tbody>
<tr>
<td><img src="image" alt="Temporal Bone - Tympanic" /></td>
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<tr>
<td>• U-shaped bone that forms the majority of the external auditory canal</td>
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<table>
<thead>
<tr>
<th>Temporal Bone - Mastoid</th>
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<tbody>
<tr>
<td><img src="image" alt="Temporal Bone - Mastoid" /></td>
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<tr>
<td>• 3 components:</td>
</tr>
<tr>
<td>1. Antrum</td>
</tr>
<tr>
<td>2. Aditus ad antrum</td>
</tr>
<tr>
<td>3. Köerner’s septum (remnant of petrosquamous suture)</td>
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<tr>
<td>• Aeration continues in early childhood</td>
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<table>
<thead>
<tr>
<th>Temporal Bone - Styloid</th>
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<td><img src="image" alt="Temporal Bone - Styloid" /></td>
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<tr>
<td>• Develops after birth</td>
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<tr>
<td>• Attachment of several muscles within the neck</td>
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<tr>
<td>• Elongated styloid (&gt;30mm) can cause dysphagia and otalgia,</td>
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[http://a-s.clayton.edu/biology/biol1151L/lab05/skull_diassembled.htm](http://a-s.clayton.edu/biology/biol1151L/lab05/skull_diassembled.htm)
Temporal Bone Radiology

Computed Tomography (CT)

- Noninvasive imaging modality which utilizes X-rays (ionizing radiation) to produce a diagnostic image
- Images utilized to delineate anatomy and function

CT - Process

- Radiodensity differs for different material (Hounsfield units)
- Serial axial images are used to reconstruct coronal images
- Iodine-based contrast defines vascular or luminal anatomy/function
### CT – Pros & Cons

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<td>– Fast, noninvasive, sensitive imaging modality</td>
<td>– Poor soft tissue definition</td>
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<tr>
<td>– Excellent detail of bony anatomy (trauma, malformation, pre-op)</td>
<td>– Contrast allergy (iodine)</td>
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<tr>
<td>– Used in screening and in children</td>
<td>– Poor sensitivity of IAC lesions</td>
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<td></td>
<td>– Ionizing radiation can be harmful (esp children and pregnant women)</td>
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### CT - Indications

- Bony disease of temporal bone (trauma, neoplasms, SSC dehiscence, osteodystrophic disease)
- Cochleovestibular malformations
- Preoperative evaluation (CI, Chronic ear disease)
- Complications of otitis media (Labyrinthine fistula, Mastoiditis, Intracranial abscess)
- Evaluation of IAC when MRI contraindicated

Noncontrast CT with bone windows – Axial Images
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Magnetic Resonance Imaging (MRI)

- Noninvasive imaging modality which utilizes a high-power magnetic field to produce a diagnostic image
- Images utilized to delineate anatomy and function

MRI – Pros & Cons

- Pros
  - Excellent soft tissue distinction
  - Doesn’t involve ionizing radiation
  - Image slices can be viewed in any orientation (no recons)
  - IV contrast is non-iodine based (less allergy/renal problems)

- Cons
  - Tight scanner
  - Unsafe in those with CI, aneurysm clips?, pacemakers, metal f.b.
  - Acquisition time is long (20-90 min)
  - Must hold still in narrow scanning tube
  - Poor bony definition

MRI - Indications

- Diseases of CNS (Infarcts, Tumors) – CT scan with contrast is contraindicated in hemorrhagic strokes
- Evaluation of IAC – gadolinium contrast enhances tumor visualization
- Evaluation of skull base lesions (soft tissue destruction and neural involvement)
- Malignant otitis externa evaluation
- Diseases of muscles/joints
Noncontrast MRI T1 sequence – Axial Images

Noncontrast MRI T2 sequence – Axial Images
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Neurotologic Pathology

Pathology of the Temporal Bone

- Temporal bone trauma
- Congenital anomalies
- Complications of otitis media
- Osteodystrophy of the temporal bone
Temporal Bone Trauma

- Otic Capsule Disrupting
  - 2.5% of fractures
  - Severe frontal or occipital trauma (deadly force)
  - Otic capsule/IAC damage = SNHL and vertigo
  - Bilateral otic capsule fx can be tx with CI


Temporal Bone Trauma

- Otic Capsule Sparing
  - 97.5% of fractures
  - Trauma to temporo-parietal region
  - Facial nerve paralysis 20%
  - CHL - Perforation of TM, EAC injury, ossicular damage (IS joint most common disruption)


14 yo GSW to right face with right complete SNHL and bullet lodged in mastoid. Facial nerve function was normal. Extensive soft tissue and bony destruction of the EAC and mastoid noted.

A radical mastoidectomy was performed with removal of the bullet fragment
Superior Canal Dehiscence

- SSCD
  - Thinning or absence of bone overlying SSC
  - May be traumatic or gradual resorption
  - Autophony, Dysequilibrium, Tullio’s phenomenon, hyperacusis, Suprathreshold CHL

Congenital Anomalies

- Aural atresia
  - Failure of EAC to canalize
  - Incidence: 1/1000
  - Associated with facial nerve, ossicular, craniofacial anomalies
  - Surgical candidacy based on CT findings (Jahrsdoerfer scale)

Congenital Anomalies

- Cochlear malformations
  - Mondini deformity (incomplete partition)
  - SNHL
  - 1.5 turns
  - Higher risk of CSF leak
  - Schiebe’s dysplasia: membranous dysplasia (bone is normal)
**Congenital Anomalies**

- Cochlear malformations
  - Michel’s aplasia
  - SNHL
  - <1% of anomalies
  - Completely atretic cochlea
  - May see small cystic area of otic capsule
  - Contraindication of CI

**Complications of Otitis media**

- Cholesteatoma
  - Epithelial lined pocket of squamous debris that slowly erodes bone
  - CT scans used frequently to evaluate atypical symptoms (vertigo) or preoperative planning
  - Erosion of HSCC

- Mastoiditis
  - Fluid accumulation in mastoid normal w/ AOM
  - Osteitis can occur (coalescent)
  - Abscess formation (intracranial, neck)
### Tumors of the CPA

<table>
<thead>
<tr>
<th>Schwannoma</th>
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<td>- Most common IAC lesion</td>
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<td>- CN 8 most common</td>
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<td>- Asymmetric SNHL, tinnitus, vertigo</td>
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<tr>
<td>- MRI is key</td>
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<tr>
<td>- Isointense T1, T2</td>
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<td>- Bright on T1 w/ contrast</td>
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### Glomus Tumors

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<th>Vascular tumors of neural crest cell origin occurring around jugular bulb (jugulare) or middle ear ( tympanicum)</th>
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<td>- Pulsatile tinnitus, HL</td>
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<tr>
<td>- MRI with contrast and CT</td>
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<td>- Angiography used to embolize lesion</td>
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### Tumors of the CPA

<table>
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<th>Meningioma</th>
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<td>- Most common benign intracranial lesion</td>
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<td>- Develop from arachnoid granulation</td>
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<tr>
<td>- Isointense on T1, T2</td>
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<tr>
<td>- Dural tail</td>
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Tumors of the CPA

- Metastatic Lesions
  - May be intra-axial or dural based
  - Bright w/ contrast
  - Rapid HL
  - Peritumoral edema

Neurotologic Case Studies

Case #1

- 50 yo female with 6 month hx of gradual left-sided hearing loss and tinnitus
  - No vertigo
  - No hx of otologic sx, drugs, infxn, or trauma
  - No family hx of hearing loss
  - Otherwise healthy and takes no meds
  - Exam normal, Weber to R, Rinne + AU
  - Audio shows asymmetric mild to moderate left sloping HFSNHL, SRS 100% AD and 86% AS
### Case #1

- Which study next?
  - What sequence will be helpful?
  - Where do we need to rule out disease?

### T1 w/ contrast

![Image of T1 w/ contrast MRI](image)

### Case #2

- 2 year old with speech delay
  - History of a failed newborn screen and failed follow-up ABR
  - Normal external ear
  - Normal tympanometry and middle ear exam
  - No family hx of ear disease
Case #3

- 16 yo male involved in altercation and was struck in the back of the head. +LOC.
  Experienced R sudden HL, vertigo
  - No hx of otologic sx, drugs, or infxn
  - No family hx of hearing loss
  - Otherwise healthy and takes no meds
  - Exam normal, Weber to L, Rinne + AS, NR AD
  - Audio shows profound R SNHL, L normal, SRS 100% AS and 0% AD

Case #3

- Which study next?
- Contrast or not?
- What is in the DDx?
  - Labyrinthine concussion (no fracture)
  - PLF
  - Temporal bone fracture
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CT without contrast

Case #3

- Treatment and Suggestions
  - Protect the left ear
  - Cros or BAHA
  - Say less, listen more

Case #4

- 17 yo male with long history of chronic ear disease with multiple previous mastoidectomies on the left ear.
  - Developed profound hearing loss and complete facial paralysis 1 year ago
  - No family hx of hearing loss
  - Otherwise healthy and takes no meds
  - Dry and clean left mastoid cavity, Weber right, Grade 6 HB facial nerve function
Case #5

- 72 yo male with a hx of right sudden HL, tinnitus, vertigo, right facial weakness, and ataxia
  - ENG showed no caloric response on right
  - Audio revealed R profound SNHL, L normal
  - Left beating nystagmus

- Which CN/CNS tracts are involved?
  - CN 7, 8
  - Cerebellum

- Which vessel is involved?
  - AICA

- Name of the syndrome?
  - Lateral Pontine syndrome
Bilateral Sudden Deafness as a Prodrome of Anterior Inferior Cerebellar Artery Infarction

Hyung Lee, MD; Gregory T. Whitman, MD; Jung Geung Lim, MD; Sang Doe Lee, MD; Young Chun Park, MD


Case #6

- 40 yo female with hx of chronic ear disease with cholesteatoma. Multiple surgical mastoidectomies and ossiculoplasties for recurrent cholesteatoma and persistent CHL. Drop in right CHL over the past 6 months
  - Normal tympanic membrane
  - Moderately severe right CHL with 100% WRS

CT 3D Reconstruction
To ask a question, please type your question into the chat box in the lower left corner of the screen and click on the “Send” button located right below the box.

Thank you!

Questions?
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