Temporal Bone Fracture

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Temporal bone

- Mastoid Process
- Squamous portion
- Zygomatic process
- Mastoid process
- Mandibular fossa
- External auditory meatus
- Styloid process
Temporal bone
Virtual temporal bone anatomy

Epidemiology - Temporal bone fracture

- Occur in 14-22% of all skull injuries
- 3:1 male to female ratio
- 70% occur during 2-4\textsuperscript{th} decades of life
- Bilateral in 9-20%
- Children account for 8-22% patients with temporal bone fracture
- Average force required to produce temporal bone fracture = 1875 lb with speed of 25 mph (Travis et al. 1977 Cadeveric study)
Mechanism

- MVA (12-47%)
- Fall (10-37%)
- Assault (16-40%)
- Gunshot (3-33%)
Classification

- Longitudinal (80%)
- Transverse (10-15%)
- Mixed (60-90%)

Otic capsule involvement
- Sparing vs. Disrupting
- Most predictive of clinical outcome
Longitudinal fracture

- Parallels long axis of petrous pyramid
- 70-90%
- Temporoparietal impact
- FN injury in 10-25%
Transverse fracture

- Perpendicular to long axis of petrous pyramid
- 10-30%
- Fronto-occipital impact
- FN injury in 30-50%
# Otic capsule involvement

<table>
<thead>
<tr>
<th>Otic Capsule Sparing</th>
<th>Otic Capsule Disrupting</th>
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<tbody>
<tr>
<td>94.2 - 97.5%</td>
<td>2.5 - 5.8%</td>
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<tr>
<td>Blow to temporoparietal region</td>
<td>Blow to occipital region</td>
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<tr>
<td>FN paralysis 6-13%</td>
<td>FN paralysis 30-50%</td>
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<tr>
<td>Conductive or Mixed HL</td>
<td>SNHL</td>
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<tr>
<td>CSF leak less likely</td>
<td>CSF leak 2-4 x more likely</td>
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Diagnostic workup

- Complete head and neck evaluation
- Trauma workup
  - Cervical spine injury
- HRCT scan temporal bone (cut \( \leq 1.5 \text{ mm} \))
- Audiogram
- Electrodiagnostic testing (ENoG, EMG)
Physical exam findings

- Otorrhea
- Hemotympanum
- TM perforation
- Facial palsy
- "Raccoon" sign for ant skull base fracture
  - Periorbital ecchymosis
- Battle’s Sign
  - Postauricular ecchymosis
Associated injuries

- Other skull fractures
- Maxillofacial fractures
- CN VI, IX and XI injury
- Intracranial injuries
  - Subdural hemorrhage
  - Subarachnoid hemorrhage
  - Tension pneumocephalus
  - Brain contusion
  - Cerebral edema
Audiogram
CT Temporal bone

Complications

- Hearing loss
- Facial nerve injury
- CSF leak
- Meningitis
- Meningocele/encephalocele
- Vascular injury
Hearing loss

- Otic capsule sparing fractures - CHL
  - Hemotympanum
  - 20% disrupts ossicular chain
    - Incudostapedial joint separation
    - Incudomalleolar joint separation
    - Incus fracture
    - Malleoincudal complex dislocation
    - Stapediovestibular dislocation
Types of ossicular chain injury

- Incudostapedial joint separation
- Incudomalleolar joint separation
- Incus fracture
- Malleoincudal complex dislocation
- Stapediovestibular dislocation
Incus dislocation

Hearing loss

- Otic capsule disrupting fractures – SNHL
- Causes
  - Disruption of the membranous labyrinth
  - Avulsion or trauma to the cochlear nerve
  - Interruption of the cochlear blood supply
  - Hemorrhage into the cochlea
  - Perilymphatic fistulas
  - Obstruction of the endolympathic duct by the temporal bone fracture
Transverse fracture through vestibule

Management of Hearing loss

- Repeat audiogram in about 1 month to allow hemotympanum to resolve
- Conservative management in the first 3 months
- Exploratory tympanotomy if CHL persists > 3 months
- IS joint dislocation most common finding
- Unilateral profound SNHL: BAHA
- Bilateral profound SNHL: Cochlear implant
Hearing improvement after cochlear implantation

Facial nerve injury

- Facial paralysis in 7% of temporal bone fractures (Brodie et al. 1997)
  - ¼ being complete paralysis
- Site of injury in perigeniculate region in 80-93%
- Contusion in 86% cases, transection in 14% (Darrouzet et al. 2001)
- Immediate paralysis likely due to transection
- Delayed paralysis may be due to neural compression from increasing edema/ hematoma
Sunderland Classification of Facial nerve injury

Neurapraxia

Axonotmesis

Neurotmesis
ENoG

- Performed 3 days – 3 weeks
- Perform EMG if ENoG shows absent responses, since degeneration and regeneration can cause phase cancellation
EMG Interpretation

- **Active voluntary motor units (MU)**
  - Intact motor axon

- **Myogenic fibrillation potentiation & Absent voluntary MU**
  - Complete nerve degeneration

- **Fibrillation + MU**
  - Partial degeneration

- **Polyphasic MU**
  - Regenerating nerve
Management of facial nerve injury

- Onset of paralysis
  - Immediate onset paralysis:
    - Surgical decompression or repair if ENoG > 90% degeneration
  - Delayed onset or incomplete paralysis:
    - Conservative management: eg. Steroid
    - ENoG
    - Prognosis is excellent

- Timing indeterminant: treated as immediate
- Late decompression as late as 3 months can be beneficial
  - 7 of 9 patients recover to HB I or II (Quaranta A 2001)
- Eye protection, gold weight implant
- Dynamic vs. static reanimation
Algorithm for facial nerve trauma

Facial nerve injury

Acute onset

Complete paralysis at presentation

Complete paralysis at presentation

Progression

Incomplete paralysis at presentation

Serial ENoG

>95% degeneration within 14 days

Surgery
Facial nerve exploration

<95% degeneration

<95% degeneration

>14 days elapsed

>14 days elapsed

Complete

Incomplete

Observe
Surgical approaches for facial decompression

- Medial to the Geniculate Ganglion
  - No useful hearing
    - Translabyrinthine
  - Intact hearing
    - Transmastoid/ supralabyrinthine
    - Middle Cranial Fossa for better exposure

- Lateral to Geniculate Ganglion
  - Transmastoid
Outcome of facial nerve injury

- The longer duration of nerve interruption, the worse the outcome after repair
- Average recovery of facial function after repair: 7 months
- Overall, at 2 years f/u (Darrouzet 2001)
  - > 94 % recover to HB grade III
  - 45 % with Grade I
  - None worse than Grade IV
- Nerve suturing:
  - 78% recover to at least HB grade III
CSF Leak

- Occur in 11-20% of temporal bone fractures
- Most present as CSF otorrhea
- 2-4 fold increase in otic capsule violating cases
- Flow increased with exertion or leaning forward
- Usually close spontaneously with conservative management within one week
- Increase risk of meningitis if leak lasts > 7 days
CSF leak

- **Diagnosis:**
  - Halo sign
  - Beta-2 transferrin
  - HRCT
  - CT cisternography (intrathecal contrast in active leak)
  - MRI (when defect > 2 cm)
  - Intrathecal fluorescein
Management of CSF leak

- **Conservative Treatment:**
  - Elevation of the head
  - bed rest
  - stool softeners
  - cessation of sneezing, straining, and nose blowing
  - intermittent lumbar punctures or indwelling lumbar drains if the leak persists

- Spontaneous resolution in 95-100%
- Closure within 7 days in ~ 80%
- Antibiotics use is controversial
- Meningitis risk higher for risk > 7 days or concurrent infection
- Surgery indicated if leak persists 7-10 days
Vascular injury

- 44 of 127 (35%) temporal bone fracture patients had carotid canal fractures (Dempewolf et al. 2009)
- 5 of 127 (4%) had carotid artery injury
  - Only 2 patients had significant PE findings (epistaxis, focal neuro deficit)
- CT maxillofacial / CT temporal bone
  - Negative predictive value > 95 %
- CT angiography, MRA, or angiography
- Neuro interventional radiologist consultation
Vertigo

- Either concussion (OC sparing) or disruption
- Usually self-limiting, resolving in 6-12 months from central adaptation
- BPPV
  - Traumatic displacement of otoconia to posterior SSC
- Endolymphatic hydrops (rare)
  - Fluctuating HL, tinnitus, aural fullness
- Perilymph fistula
  - Severe profound SNHL
  - Exploratory tympanotomy
Late complications

- Meningocele/ Encephalocele
- Cholesteatoma
- Late CSF leak
- Late meningitis
Pediatric population

- Bimodal distribution: 3 years and 12 years
- Increased incidence due to falls in younger children
- Biking accidents and blow to the head in older children
- Higher incidence of intracranial complications (58%)
- Lower incidence of facial paralysis (3%)
  - May be related to flexibility of pediatric skull
- Prophylactic antibiotics did not influence development of meningitis
Conclusions

- Temporal bone fracture is a common injury among patients with skull fractures
- Early management focuses on stabilization of the patient by working closely with trauma surgeons
- Early conservative management is recommended for hearing loss, CSF leak, and facial paresis
- Long-term follow up is necessary to address hearing loss and monitor for intratemporal and intracranial complications.
Thank you