Middle and Inner Ear Trauma

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Anatomy

Right tympanic membrane (eardrum) viewed through speculum

- Long crus of incus
- Posterior malleal fold
- Pars flaccida
- Anterior malleal fold
- Lateral process of malleus
- Pars tensa
- Manubrium of malleus
- Umbo
- Cone of light
Anatomy

Medial wall of tympanic cavity: lateral view

- Prominence of lateral semicircular canal
- Prominence of facial canal
- Geniculum of facial nerve
- Greater petrosal nerve
- Tensor tympani muscle (tendon cut)
- Auditory (Eustachian) tube
- Levator veli palatini muscle
- Promontory with tympanic nerve (of Jacobson) and plexus under mucosa
- Internal carotid artery
- Tympanic cells
- Facial nerve (VII) in stylomastoid foramen
- Jugular fossa
- Fossa of round (cochlear) window
- Tendon of stapedius muscle
- Pyramidal eminence
- Chorda tympani nerve (cut)
- Mastoid cells
- Crura of stapes
- Footplate of stapes in fossa of oval (vestibular) window
- Tympanic (mastoid) antrum

Diagram labels correspond to anatomical structures in the tympanic cavity and surrounding regions, including nerves, muscles, and vascular structures.
Superior projection of right osseous labyrinth on floor of skull

- Cochlea
- Cochlear nerve
- Facial nerve (VII)
- Opening of internal acoustic meatus
- Vestibulocochlear nerve (VIII)
- Vestibular nerve
- Petrous part of temporal bone
- External opening of vestibular aqueduct for endolymphatic duct
- Groove of greater petrosal nerve
- Geniculum of facial nerve
- Plane of anterior (superior) semicircular canal
- Lateral (horizontal) semicircular canal
- Plane of posterior semicircular canal
Etiology

- TM is much more traumatized than the Inner Ear
- 1.4-8.6 per 100,000
  - Men > Women
  - Children are curious
Classification of TM Perforations

- Quadrant
- Size
  - % vs. mm
- Marginal vs. Central
Traumatic TM Perforations

- Compression Injuries
  - Barotrauma
- Penetrating Injuries
- Thermal Injuries
- Lightning/Electrical Injuries
Middle Ear Trauma

Is usually associated with TM or inner ear trauma unless Iatrogenic

- Ossicular discontinuity
- Facial Nerve Injury
- Chorda tympani Nerve Injury
- Barotrauma to Stapes footplate
Inner Ear Trauma

- Blunt Trauma
- Penetrating Trauma
- Barotrauma
Blunt Trauma

- Temporal Bone Fractures
  - Longitudinal vs. Transverse
  - Oblique
Longitudinal fractures

- 80% of Temporal Bone Fractures
- Lateral Forces along the petrosquamous suture line
- 15-20% Facial Nerve involvement
- EAC laceration
Transverse fractures

- 20% of Temporal Bone Fractures
- Forces in the Antero-Posterior direction
- 50% Facial Nerve Involvement
- EAC intact
Penetrating Trauma

- Increase in violence and firearms
- Associated with more dismal outcome
  - More likely to involve intracranial lesions
Barotrauma

- Rapid pressure fluctuations with the inner ear
- Air travel or SCUBA diving
  - “the bends”
Evaluation and Management

- ATLS
- H & P
  - Thorough head & neck examination
Physical Examination

- Basilar Skull Fractures
  - Periorbital Ecchymosis (Raccoon’s Eyes)
  - Mastoid Ecchymosis (Battle’s Sign)
  - Hemotympanum
Physical Examination

- Tuning Fork exam
- Pneumatic Otoscopy
Imaging

- HRCT
- MRI
- Angiography/ MRA
Symptoms

- Hearing Loss
- Dizziness
- CSF Otorrhea and Rhinorrhea
- Facial Nerve Injuries
Hearing Loss

- Formal Audiometry vs. Tuning Fork
- 71% of patients with Temporal Bone Trauma have hearing loss
- TM Perforations
  - CHL > 40db suspicious for ossicular discontinuity
Hearing Loss

Longitudinal Fractures
- Conductive or mixed hearing loss
- 80% of CHL resolve spontaneously

Transverse Fractures
- Sensorineural hearing loss
- Less likely to improve
Dizziness

- Otic capsule fracture, labyrinthine concussion, Perilymphatic Fistula
Dizziness

- Perilymphatic Fistulas
  - Fluctuating dizziness and/or hearing loss
  - Tulio’s Phenomenon
- Management
  - 40% spontaneously close
  - Surgical management
Dizziness

- BPPV
  - Acute, latent, and fatigable vertigo
  - Can occur any time following injury
  - Dix Hallpike
  - Epley Maneuver
CSF Otorrhea and Rhinorrhea

- Temporal bone Fractures are the most common cause of CSF Otorrhea
- Beta-2-transferrin
- HRCT
CSF Otorrhea and Rhinorrhea

- Management
  - Conservative therapy
  - Antibiotics
  - Surgery
CSF Otorrhea and Rhinorrhea Surgical Management

- Surgical approach
  - Status of hearing
  - Meningocele/encephalocele
  - Fistula location
- Transmastoid
- Middle Cranial Fossa
Facial Nerve Anatomy
Facial Nerve Injuries

- Evaluation
  - Previous status
  - Time
  - Onset and progression
  - Complete vs. Incomplete
## House Brackman grading system

<table>
<thead>
<tr>
<th>Grade</th>
<th>Severity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Normal</td>
<td>Normal facial function</td>
</tr>
<tr>
<td>II</td>
<td>Mild</td>
<td>Slight synkinesis/weakness</td>
</tr>
<tr>
<td>III</td>
<td>Moderate</td>
<td>Complete eye closure, noticeable synkinesis, slight forehead movement</td>
</tr>
<tr>
<td>IV</td>
<td>Moderately Severe</td>
<td>Incomplete eye closure, symmetry at rest, no forehead movement</td>
</tr>
<tr>
<td>V</td>
<td>Severe</td>
<td>Assymetry at rest, barely noticeable motion</td>
</tr>
<tr>
<td>VI</td>
<td>Total</td>
<td>No movement</td>
</tr>
</tbody>
</table>
Electrophysiologic Testing

- NET
- MST
- ENoG
Nerve Excitability Test
Maximal Stimulation Test

- >3.5mA difference suggests a poor prognosis for return of facial function.
Electroneuronography

- Most accurate, qualitative measurement
- Reduction of >90% amplitude correlates with a poor prognosis for spontaneous recovery
Electromyography

- Limited use until 10-14 days
- Polyphasic potentials = Good
Facial Nerve Injuries

- Decision to treat is primarily based on whether there is complete vs. incomplete paralysis
Treatment

- Conservative treatment candidates
- Surgical candidates
Conservative Treatment Candidates

- Chang and Cass
  - Normal Facial Function regardless of progression
  - Incomplete paralysis and no progression to complete paralysis
  - Less than 95% degeneration by ENoG
Surgical Candidates

- Critical Prognostic factors
  - Immediate vs. Delayed
  - Complete vs. Incomplete paralysis
  - ENoG criteria
Algorithm for Facial Nerve Injury

Facial nerve injury

Acute onset

- Complete paralysis at presentation
- Incomplete paralysis at presentation

Progression

Serial ENoG

- Complete
- Incomplete

>95% degeneration within 14 days

<95% degeneration

>14 days elapsed

Surgery

Facial nerve exploration

Observe
Surgical Approach

- Suspect location of neural injury
- Presence or absence of hearing
Surgical Approach

- Lateral to the geniculate ganglion
  - transmastoid
Surgical Approach

- Medial to the Geniculate Ganglion
  - No useful hearing
    - Transmastoid-translabyrinthine
  - Intact hearing
    - Transmastoid-trans-epitympanic
    - Middle Cranial Fossa
Surgical findings

- Nerve repair
  - Direct anastomosis
  - Nerve graft
- Decompression
Iatrogenic Facial Nerve Injuries

- Mastoidectomy (55%)
- Tympanoplasty (14%)
- Bony Exostoses (14%)
- 79% were not identified at the time of surgery
Management of Iatrogenic Facial Nerve Injuries

- <50% decompression
  - 75% had HB of 3 or better!
- >50% nerve repair
  - No patients had better than a HB 3
Case Report

- 32 yr old fisherman was wading
  - Minding his own business
- Hit in head by a flying fish
- Immediate profound vertigo, hearing loss
- CT scan revealed longitudinal Temp bone fracture
Flying fish (*Cheilopogon heterurus*) usually attains a length of between 23–48 cm and are able to leap from the water and glide as far as 183 m attaining a speed of up to 70 km/h. (Computer produced image)