
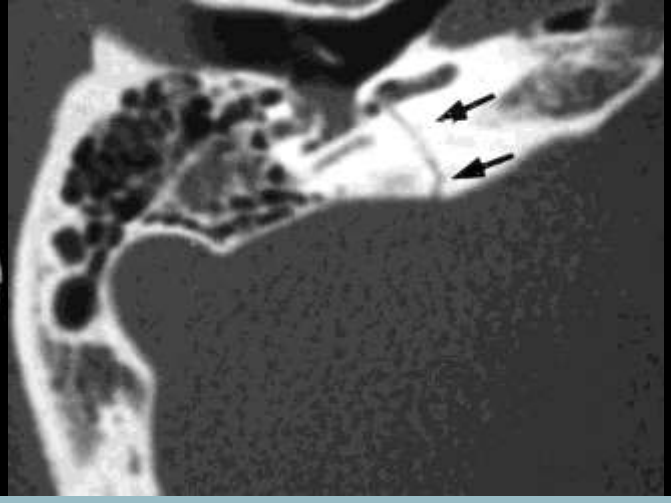
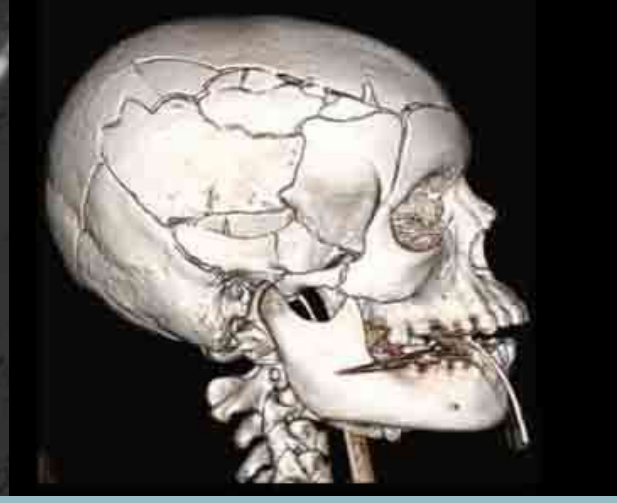

Temporal Bone Fracture

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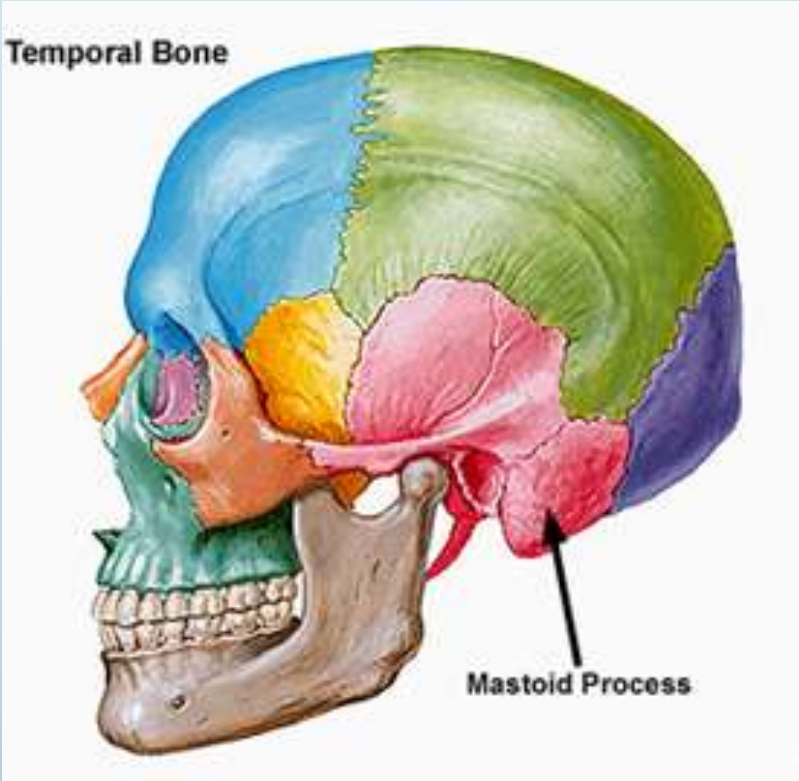
Faculty Advisor: Tomoko Makishima, MD, PhD

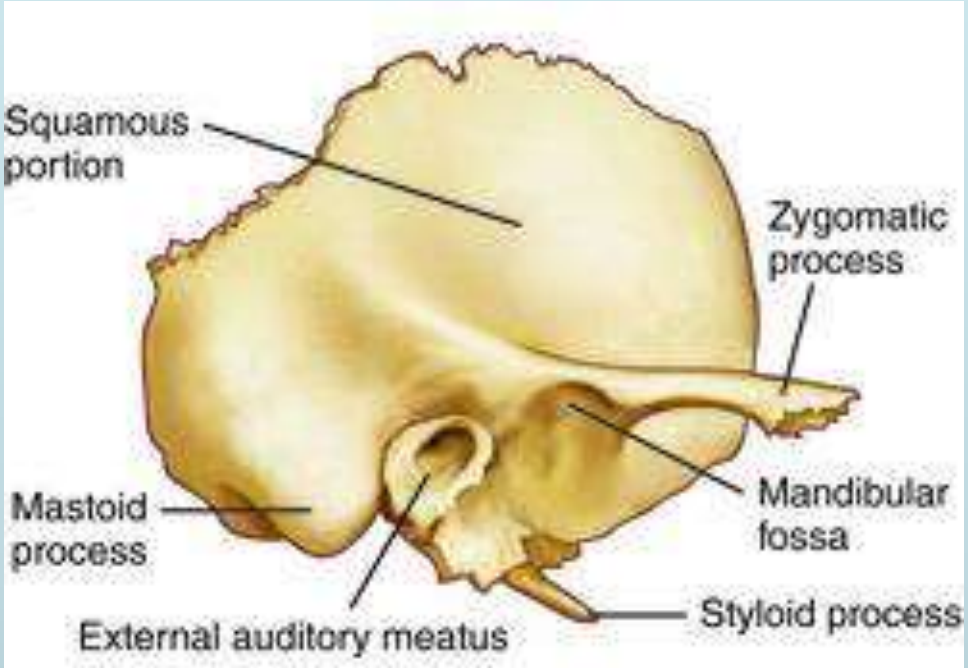
The University of Texas Medical Branch

Department of Otolaryngology

Grand Rounds Presentation, March 31, 2010

Temporal bone





Temporal bone

Virtual temporal bone anatomy

Zirkle M. Laryngoscope. 2007 Feb;117(2):258-63.

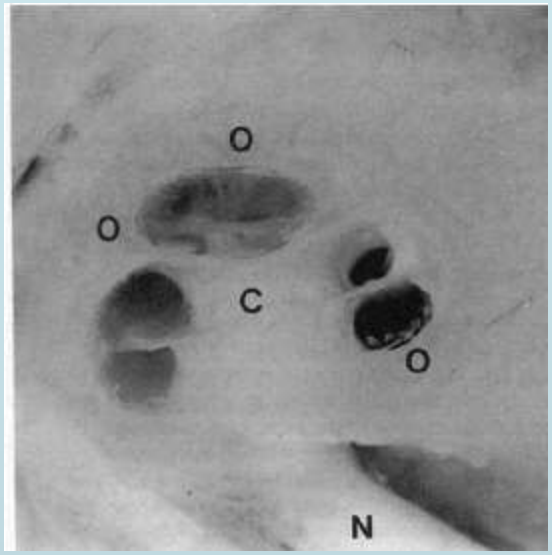
Epidemiology - Temporal bone fracture

- Occur in 14-22% of all skull injuries
- 3:1 male to female ratio
- 70% occur during 2-4th 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

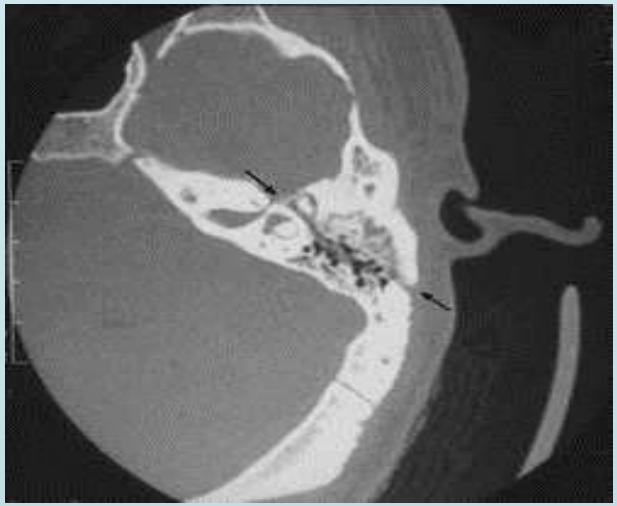
- MVA (12-47%)
- Fall (10-37%)
- Assault (16-40%)
- Gunshot (3-33%)

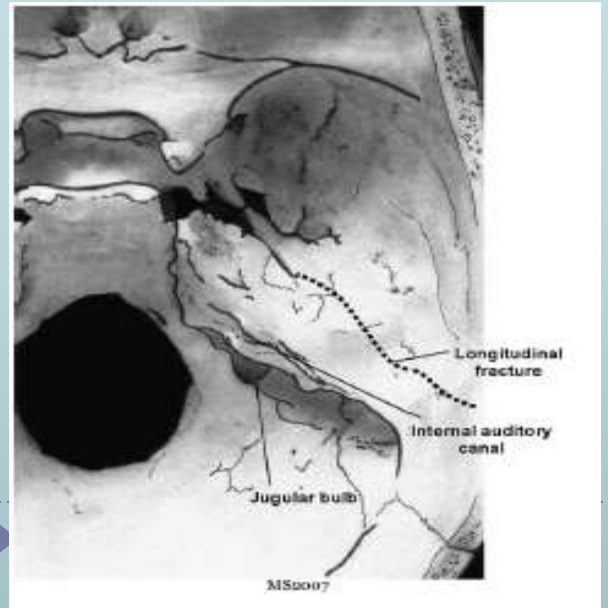
Classification



- **Longitudinal (80%)**
- **Transverse (10-15%)**
- **Mixed (60-90%)**
- **Otic capsule involvement**
  - Sparing vs. Disrupting
  - Most predictive of clinical outcome

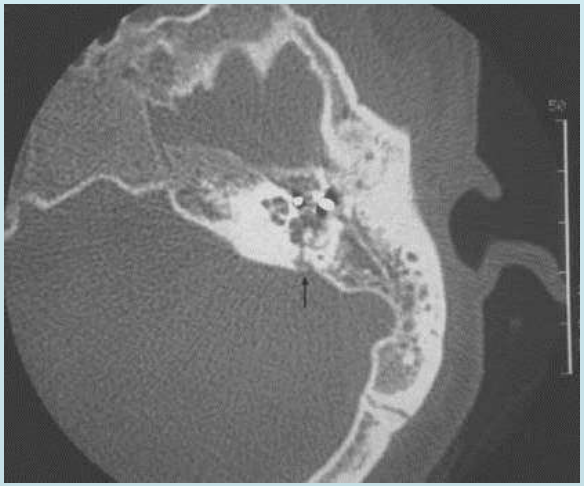
Longitudinal fracture



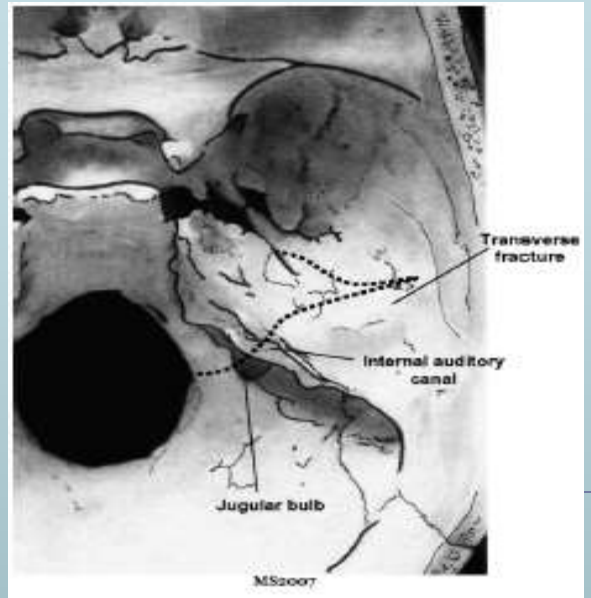


- Parallels long axis of petrous pyramid
- 70-90%
- Temporoparietal impact
- FN injury in 10-25%

Transverse fracture



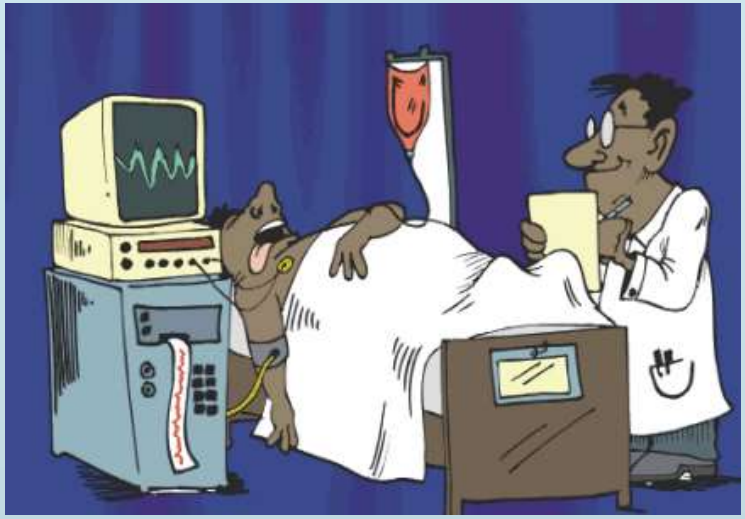
- Perpendicular to long axis of petrous pyramid
- 10-30%
- Fronto-occipital impact
- FN injury in 30-50%



Otic capsule involvement

Otic Capsule Sparing	Otic Capsule Disrupting
94.2 - 97.5%	2.5 - 5.8%
Blow to temporoparietal region	Blow to occipital region
FN paralysis 6-13%	FN paralysis 30-50%
Conductive or Mixed HL	SNHL
CSF leak less likely	CSF leak 2-4 x more likely

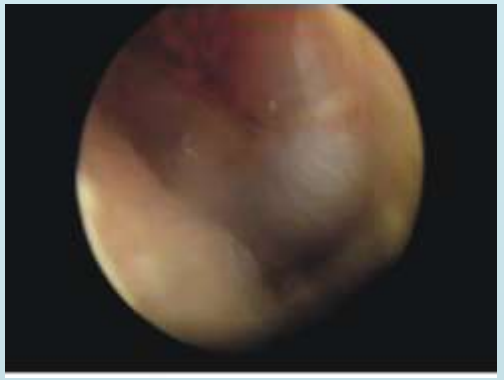
Diagnostic workup



- Complete head and neck evaluation
- Trauma workup
  - Cervical spine injury
- HRCT scan temporal bone (cut ≤ 1.5 mm)
- Audiogram
- Electrodiagnostic testing (ENoG, EMG)

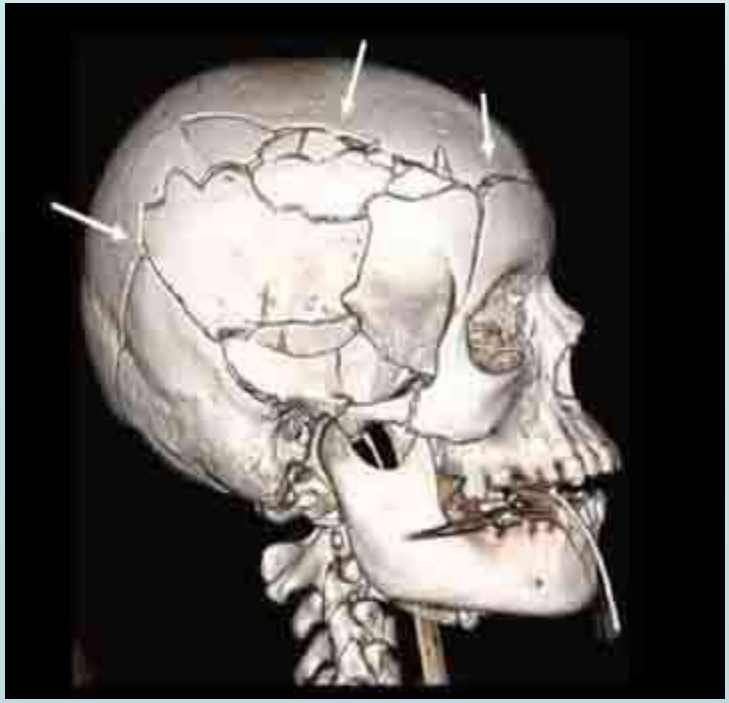
Physical exam findings

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

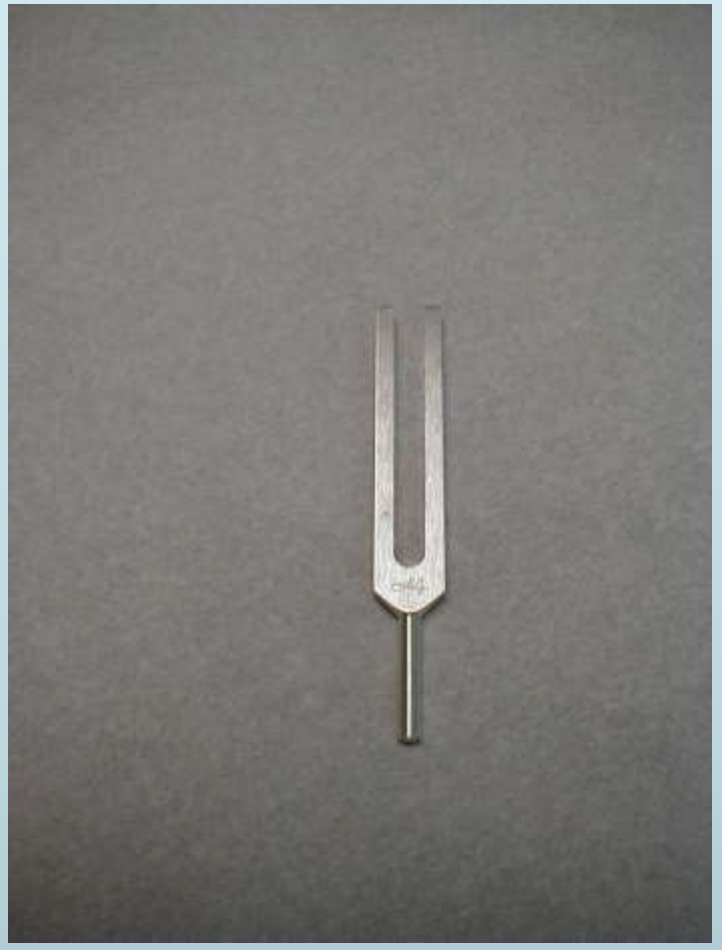


Associated injuries

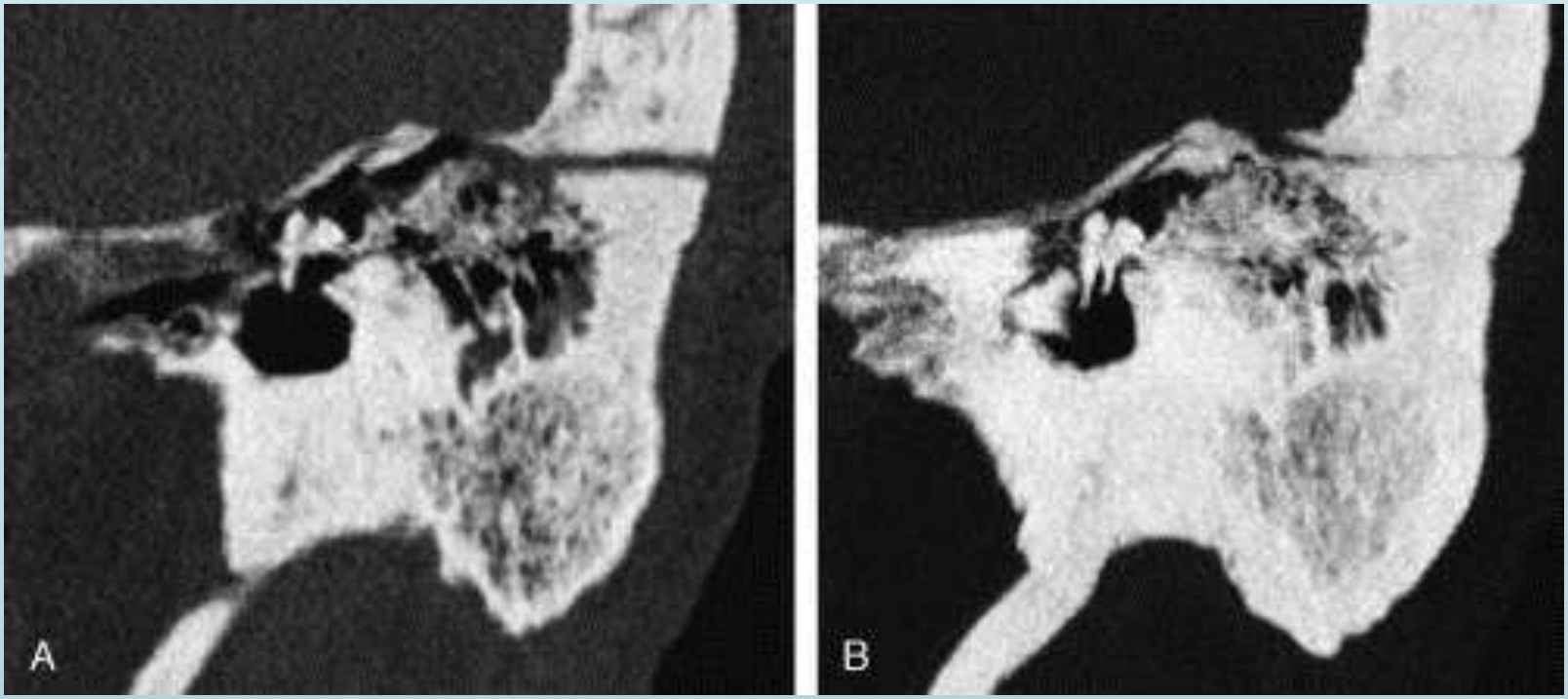
- Other skull fractures
- Maxillofacial fractures
- CN VI, IX and XI injury
- Intracranial injuries
  - Subdural hemorrhage
  - Subarachnoid hemorrhage
  - Tension pneumocephalus
  - Brain contusion
  - Cerebral edema



Audiogram



CT Temporal bone



Bin Z et al. J Comput Assist Tomogr. 2008 Nov-Dec;32(6):951-4.

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

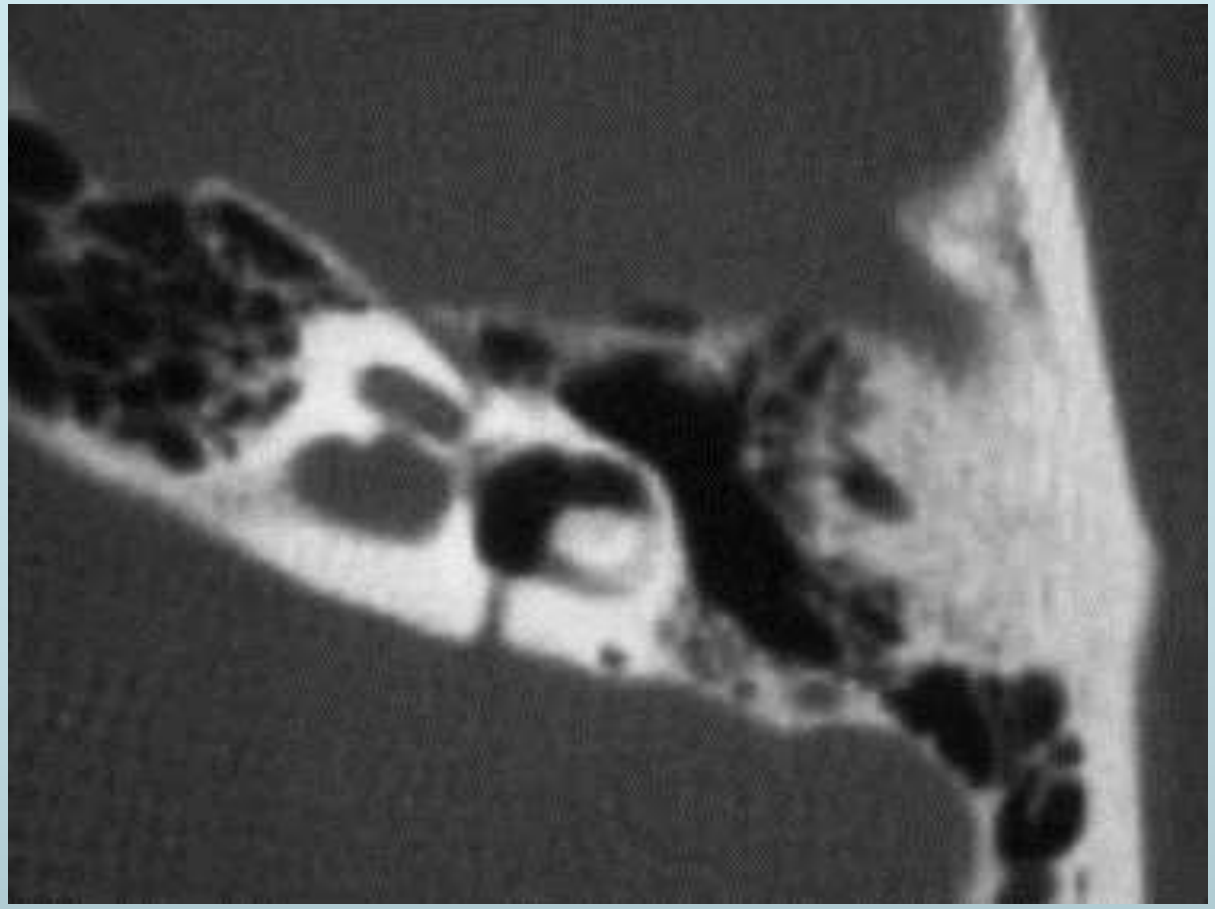
Incus dislocation

Tsai YT. Otolaryngol Head Neck Surg. 2009 Dec;141(6):786-7.

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 endolymphatic duct by the temporal bone fracture

Transverse fracture through vestibule

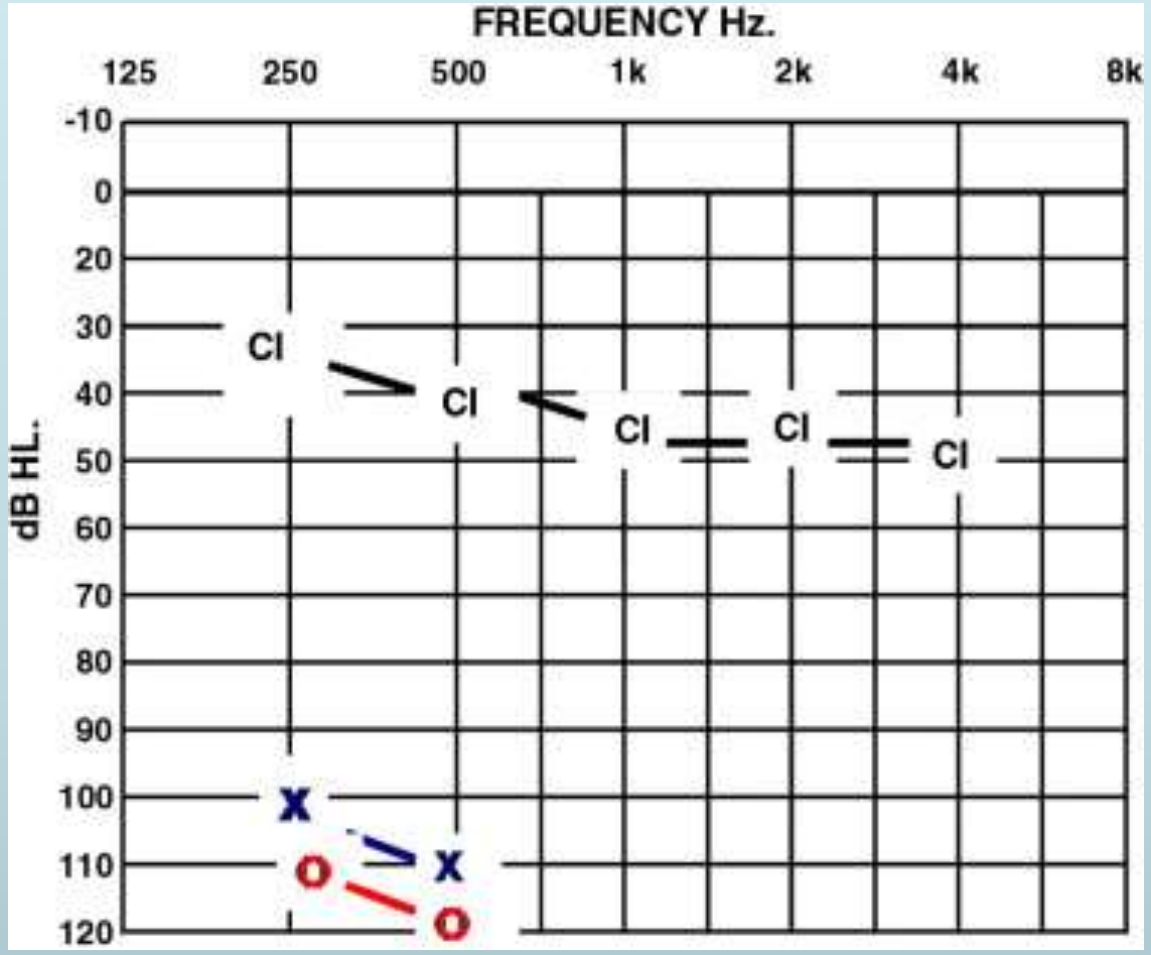


Serin GM et al. Am J Otolaryngol. 2009 Jun 23

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



Serin GM et al. Am J Otolaryngol. 2009 Jun 23

Facial nerve injury

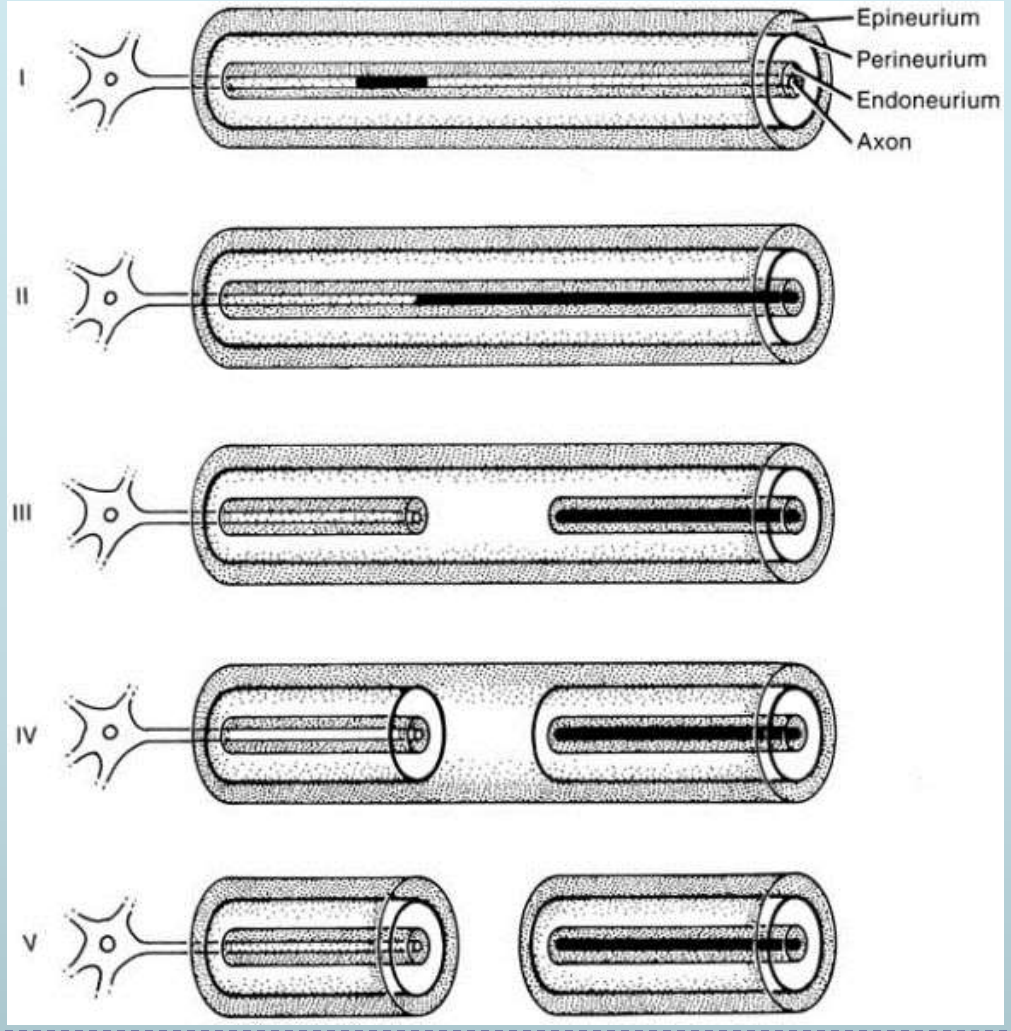
- Facial paralysis in 7% of temporal bone fractures (Brodie et al. 1997)
  - ¼ being complete paralysis
- Site of injury in perigeniculate region in 80-93%
- Contusion in 86% cases, transection in 14 % (Darrouzet et al. 2001)
- Immediate paralysis likely due to transection
- Delayed paralysis may be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

Sunderland Classification of Facial nerve injury

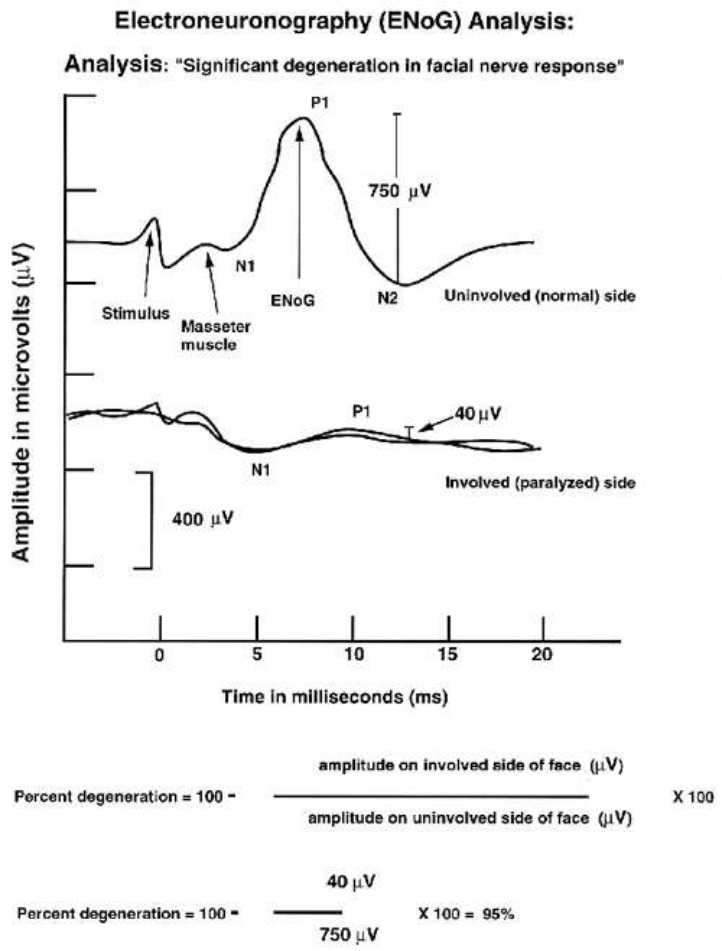
Neurapraxia

Axonotmesis

Neurotmesis

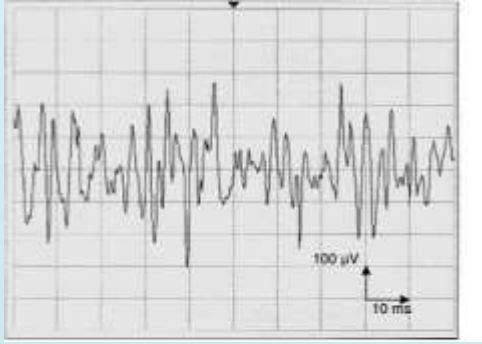


ENoG



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

EMG Interpretation

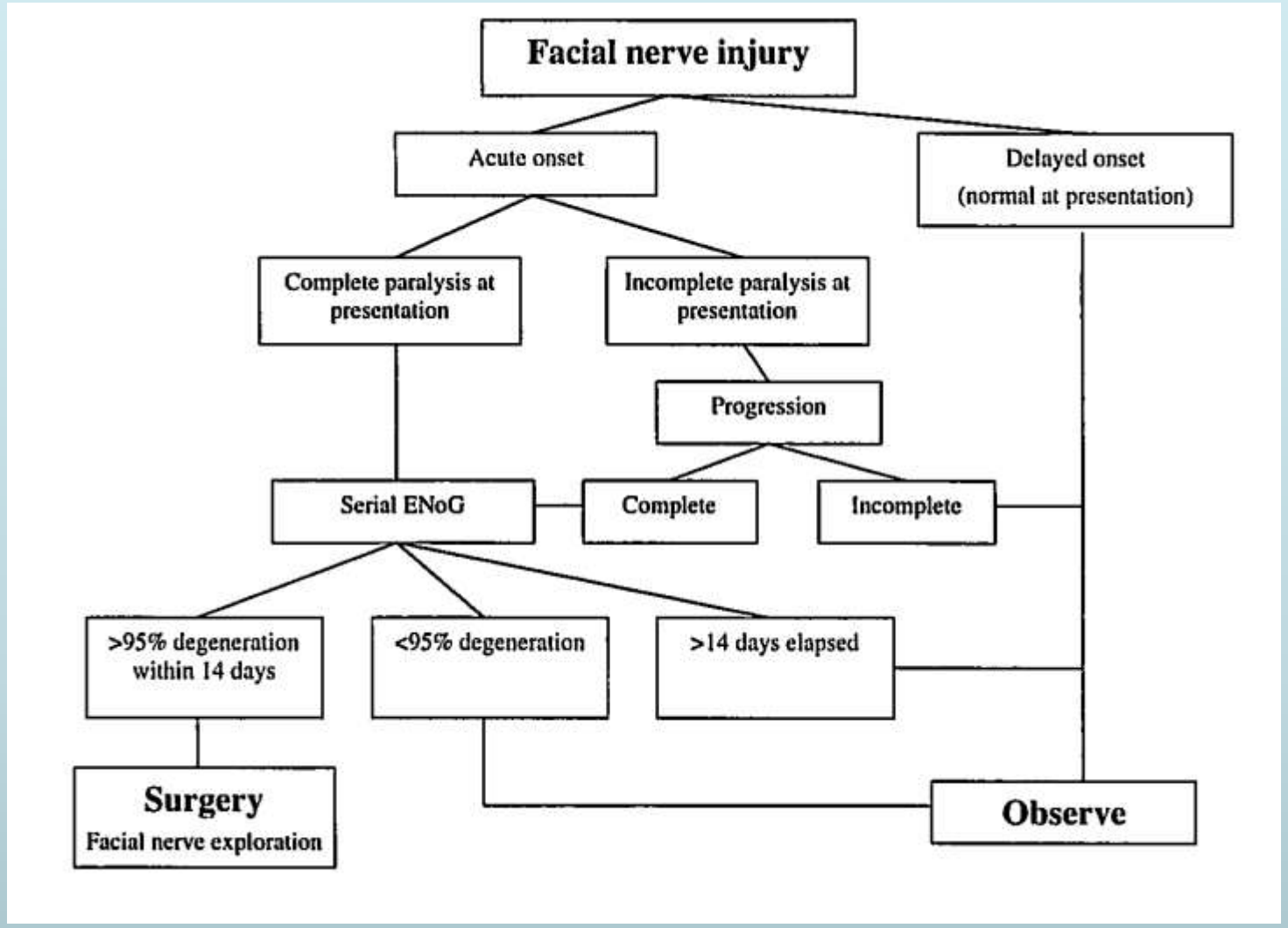


- **Active voluntary motor units (MU)**
  - Intact motor axon
- **Myogenic fibrillation potention & Absent voluntary MU**
  - Complete nerve degeneration
- **Fibrillation + MU**
  - Partial degeneration
- **Polyphasic MU**
  - Regenerating nerve

Management of facial nerve injury

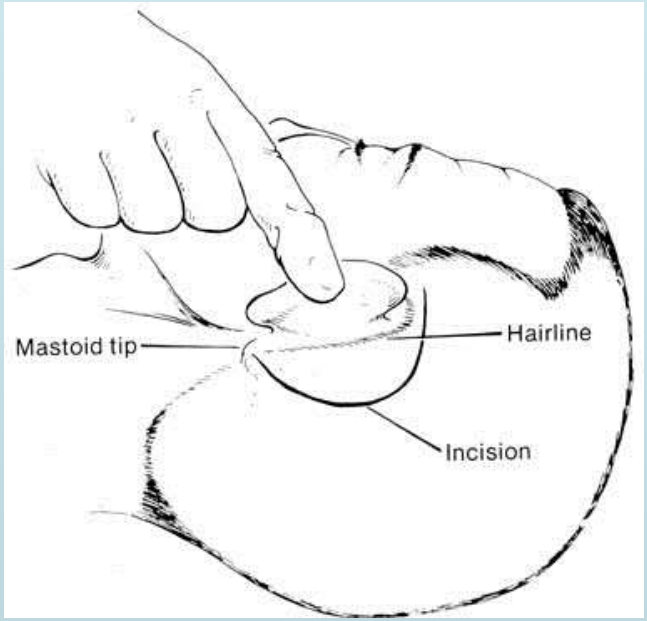
- Onset of paralysis
- Immediate onset paralysis:
  - Surgical decompression or repair if ENoG > 90% degeneration
- Delayed onset or incomplete paralysis:
  - Conservative management: eg. Steroid
  - ENoG
  - Prognosis is excellent
- Timing indeterminant: treated as immediate
- Late decompression as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



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

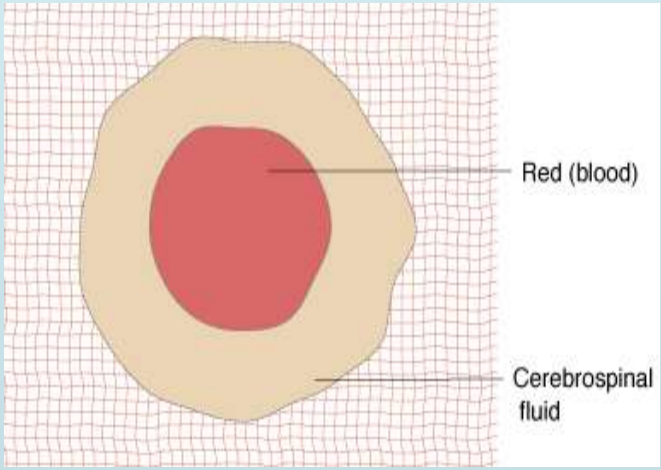
- The longer duration of nerve interruption, the worse the outcome after repair
- Average recovery of facial function after repair: 7 months
- Overall, at 2 years f/u (Darrouzet 2001)
  - > 94 % recover to HB grade III
  - 45 % with Grade I
  - None worse than Grade IV
- Nerve suturing:
  - 78% recover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

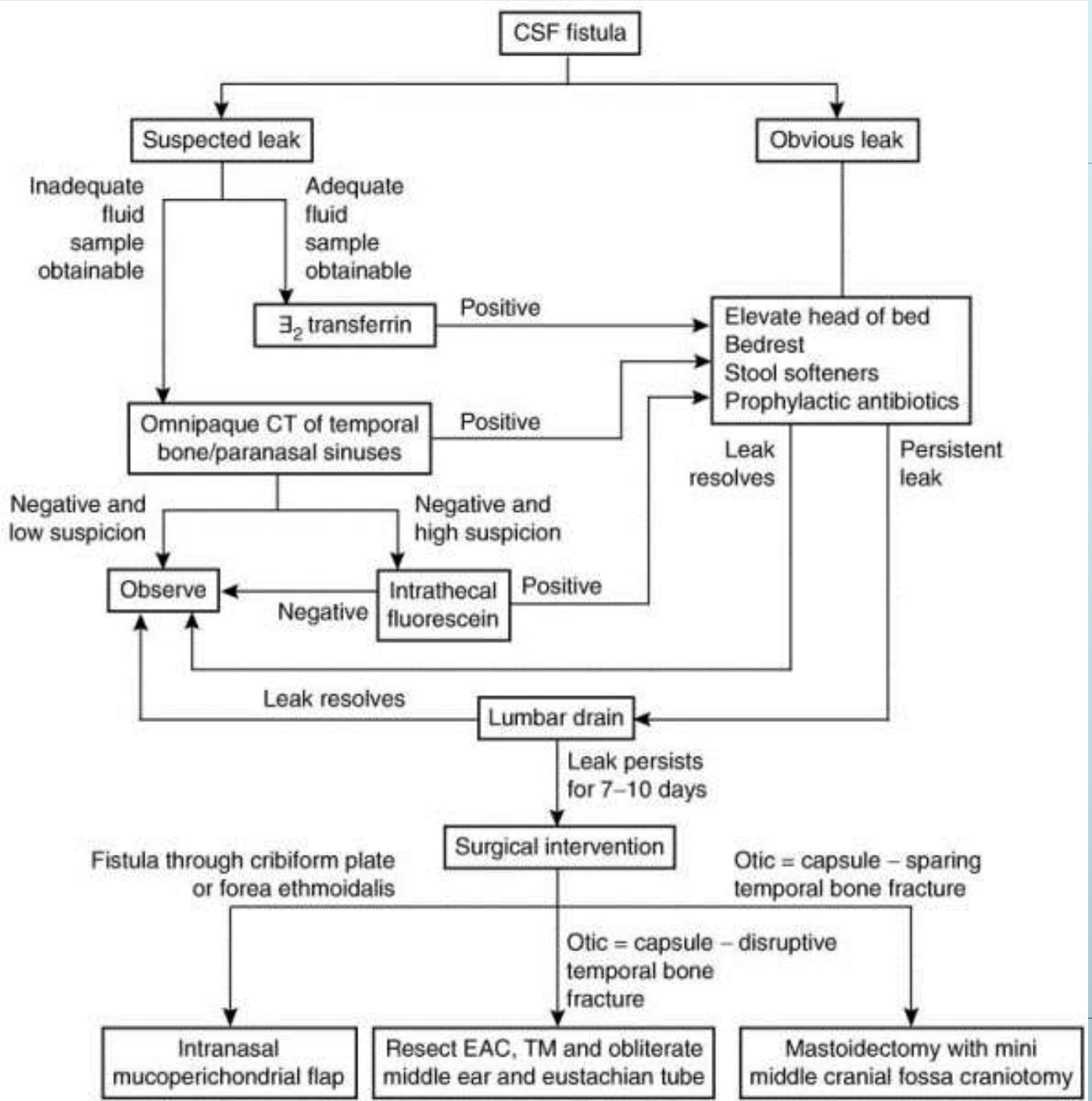
CSF leak

- 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


CSF fistula
Suspected leak
Obvious leak
Inadequate fluid sample obtainable
Adequate fluid sample obtainable
$\exists_2$ transferrin
Positive
Elevate head of bed
Bedrest
Stool softeners
Prophylactic antibiotics
Omnipaque CT of temporal bone/paranasal sinuses
Positive
Leak resolves
Persistent leak
Negative and low suspicion
Negative and high suspicion
Observe
Intrathecal fluorescein
Negative
Positive
Leak resolves
Lumbar drain
Leak persists for 7–10 days
Surgical intervention
Fistula through cribiform plate or forea ethmoidalis
Otic = capsule – sparing temporal bone fracture
Otic = capsule – disruptive temporal bone fracture
Intranasal mucoperichondrial flap
Resect EAC, TM and obliterate middle ear and eustachian tube
Mastoidectomy with mini middle cranial fossa craniotomy

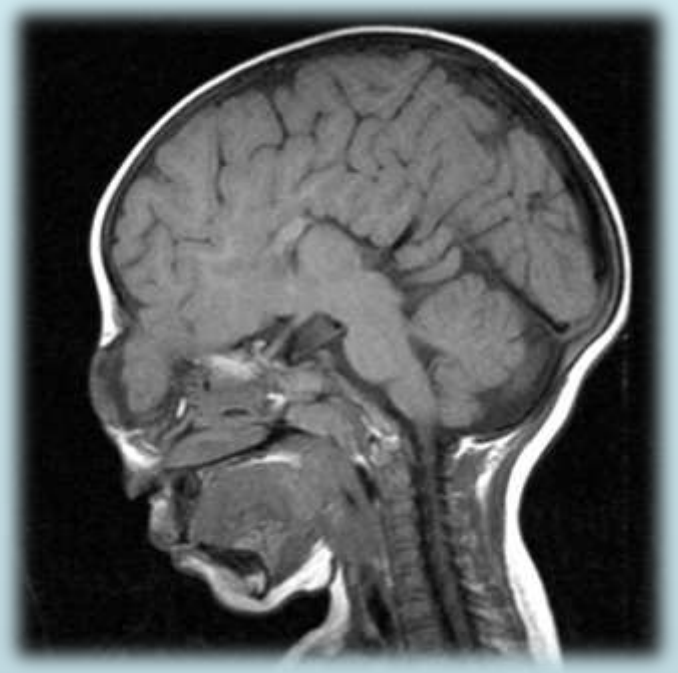
Vascular injury

- 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 meningitits

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