

Temporal Bone Fracture

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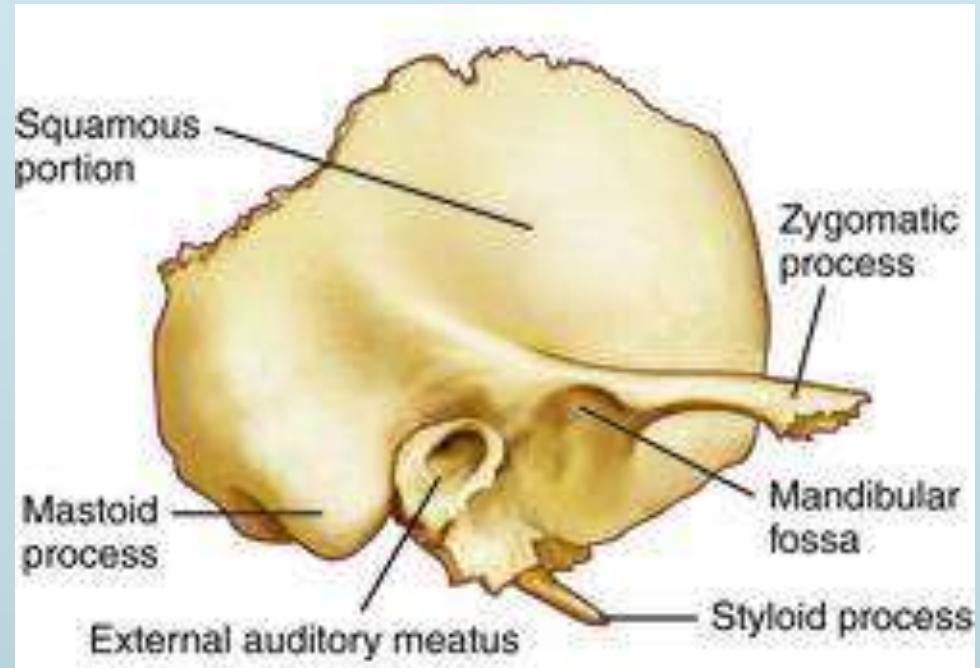
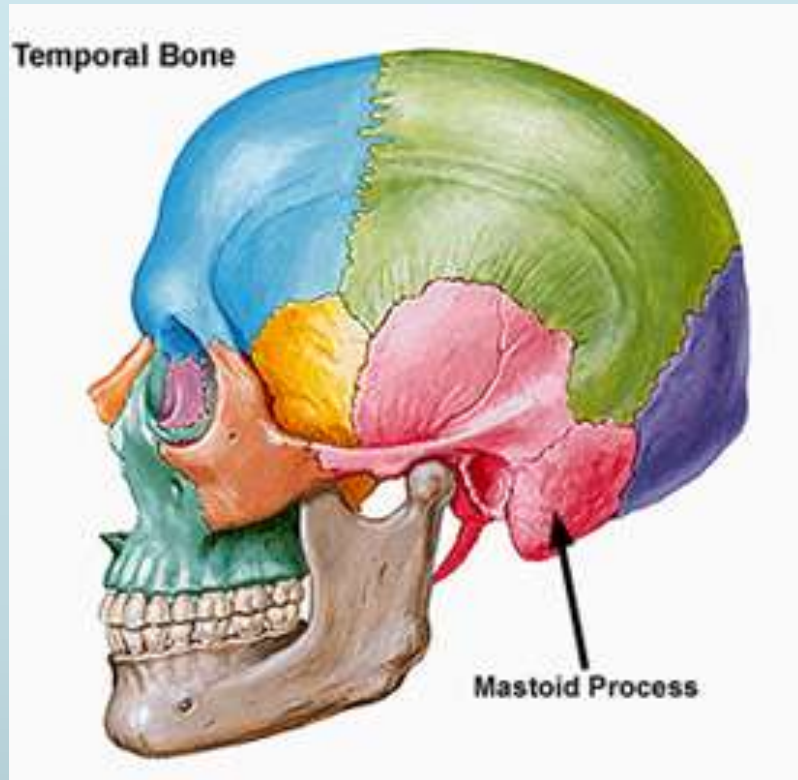
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Temporal bone



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 2-4th 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 Cadaveric study)



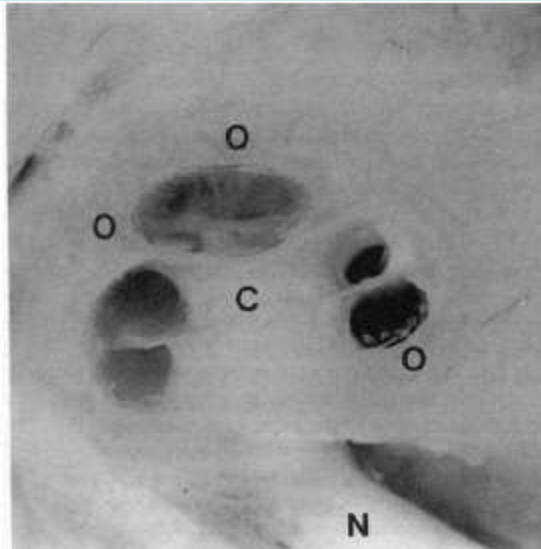
Mechanism



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



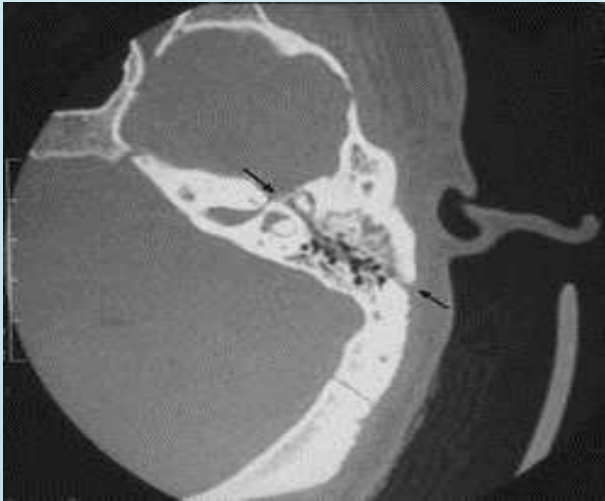
Classification



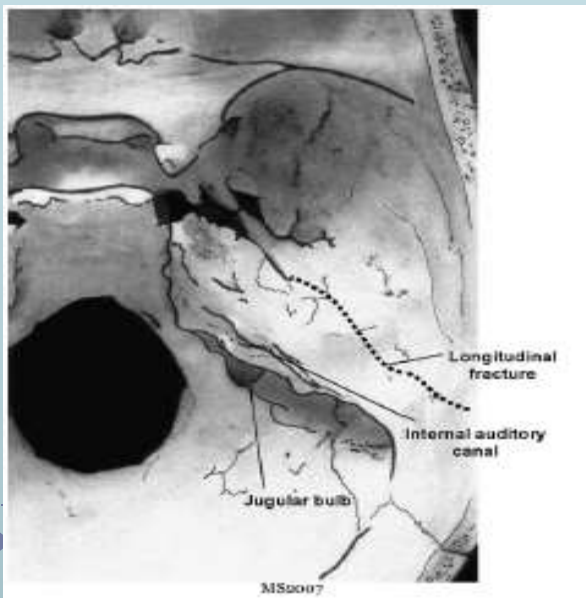
- ▶ **Longitudinal (80%)**
- ▶ **Transverse (10-15%)**
- ▶ **Mixed (60-90%)**
- ▶ **Otic capsule involvement**
 - ▶ **Sparing vs. Disrupting**
 - ▶ **Most predictive of clinical outcome**



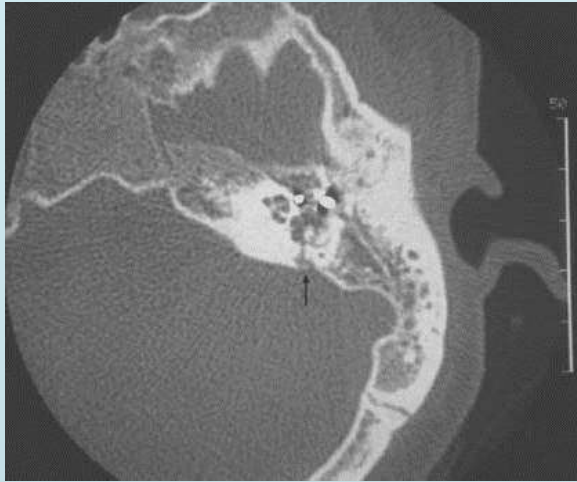
Longitudinal fracture



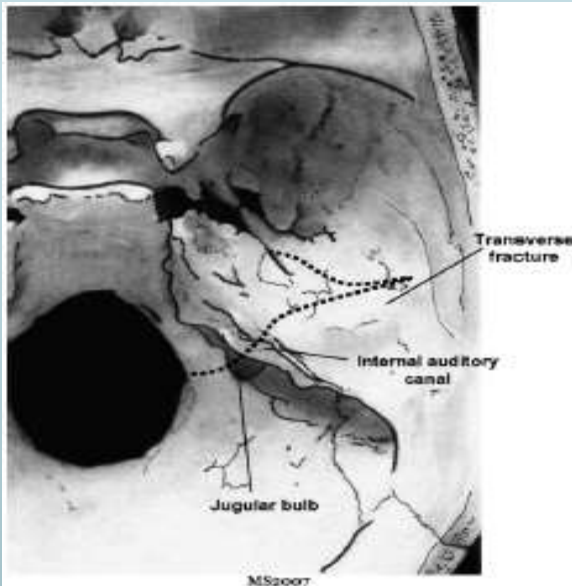
- ▶ Parallels long axis of petrous pyramid
- ▶ 70-90%
- ▶ Temporoparietal impact
- ▶ FN injury in 10-25%



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

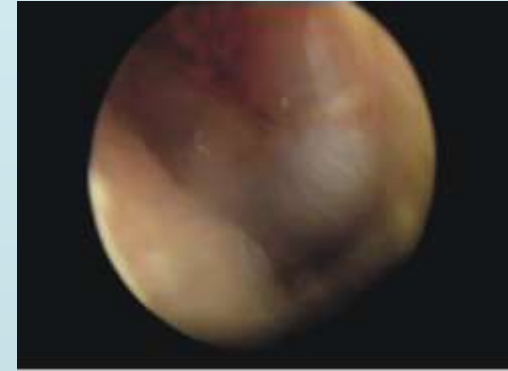


- ▶ **Complete head and neck evaluation**
- ▶ **Trauma workup**
 - ▶ **Cervical spine injury**
- ▶ **HRCT scan temporal bone (cut \leq 1.5 mm)**
- ▶ **Audiogram**
- ▶ **Electrodiagnostic testing (ENoG, EMG)**



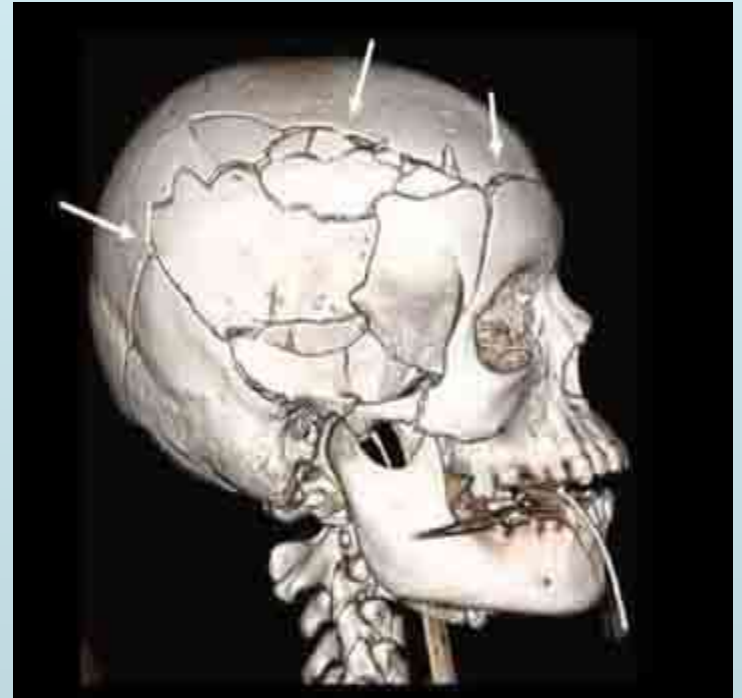
Physical exam findings

- ▶ Otorrhea
- ▶ Hemotympanum
- ▶ TM perforation
- ▶ Facial palsy
- ▶ “Raccoon” sign for ant skull base fracture
 - ▶ Periorbital ecchymosis
- ▶ Battle’s Sign
 - ▶ Postauricular ecchymosis



Associated injuries

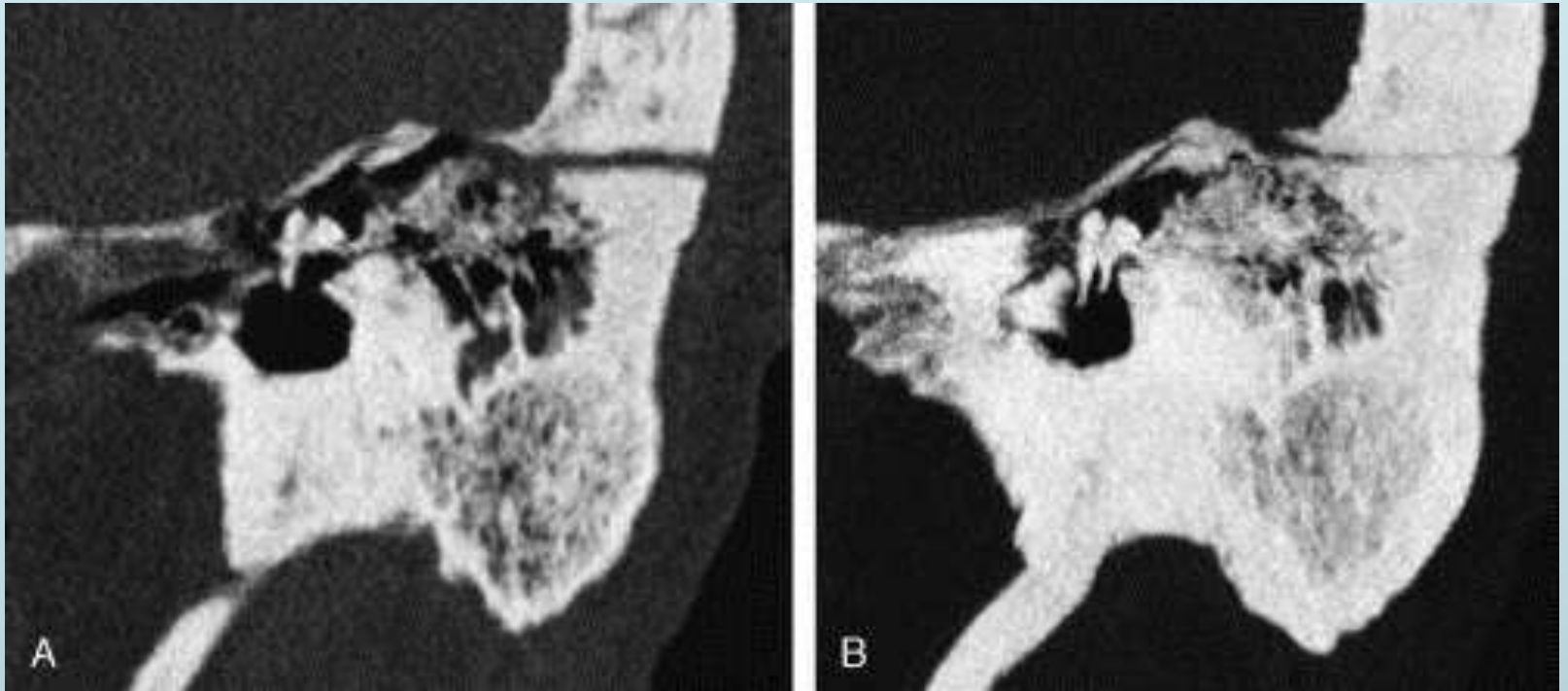
- ▶ Other skull fractures
- ▶ Maxillofacial fractures
- ▶ CN VI, IX and XI injury
- ▶ Intracranial injuries
 - ▶ Subdural hemorrhage
 - ▶ Subarachnoid hemorrhage
 - ▶ Tension pneumocephalus
 - ▶ Brain contusion
 - ▶ Cerebral edema



Audiogram



CT Temporal bone



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

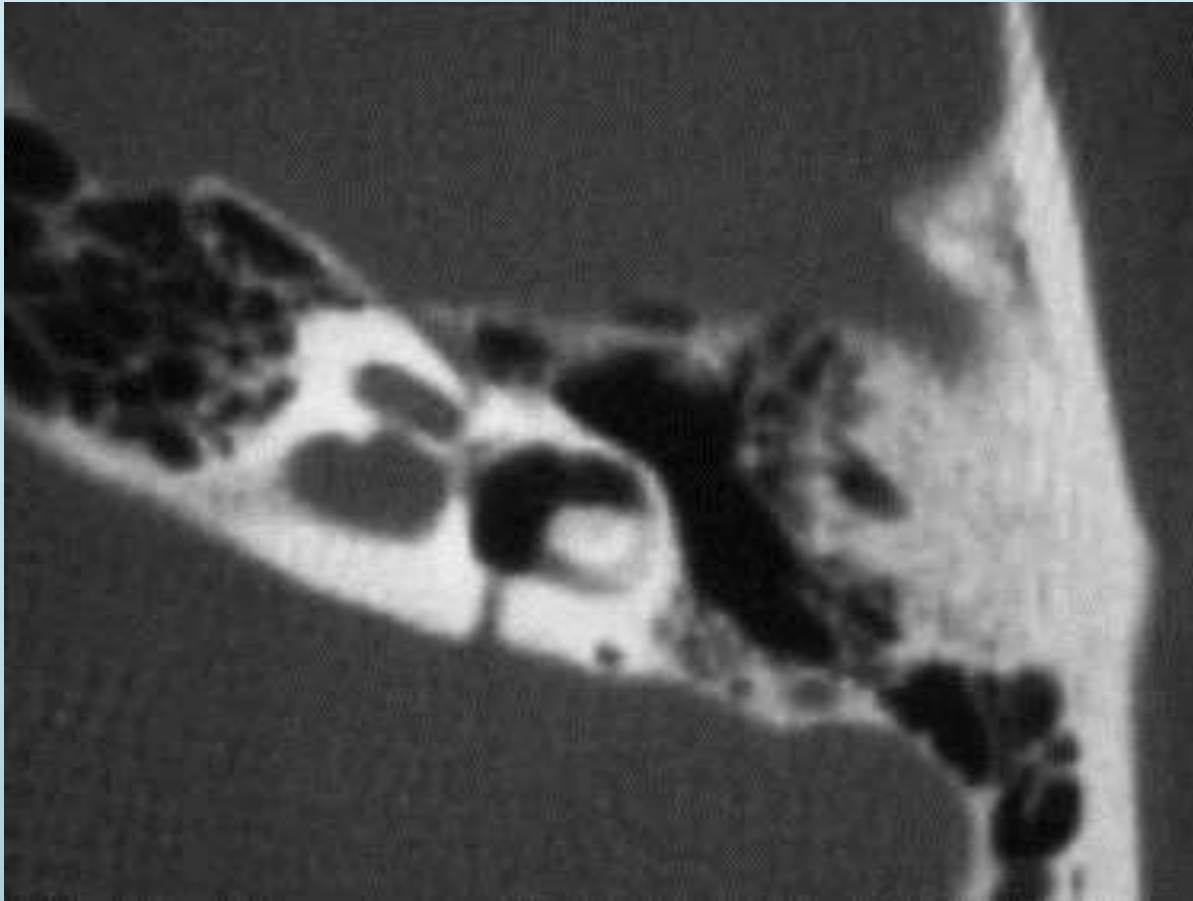


Hearing loss

- ▶ 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 endolymphatic duct by the temporal bone fracture



Transverse fracture through vestibule

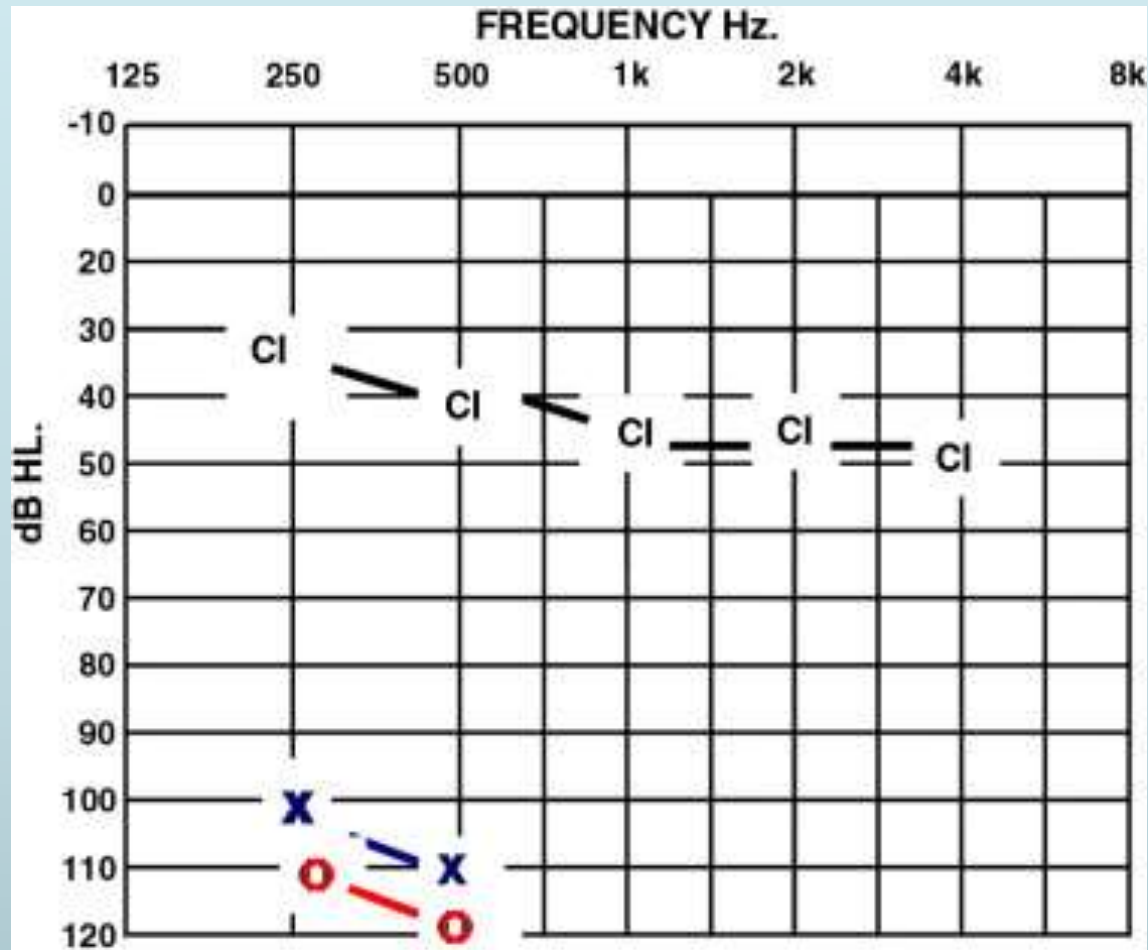


Management of Hearing loss

- ▶ 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



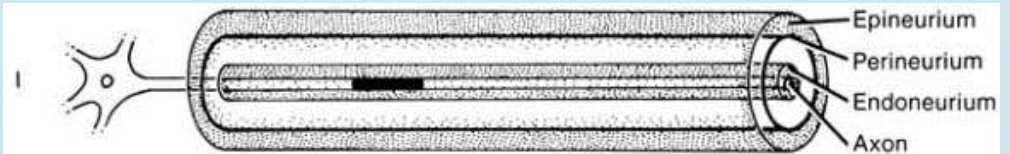
Facial nerve injury

- ▶ Facial paralysis in 7% of temporal bone fractures (Brodie et al. 1997)
 - ▶ 1/4 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

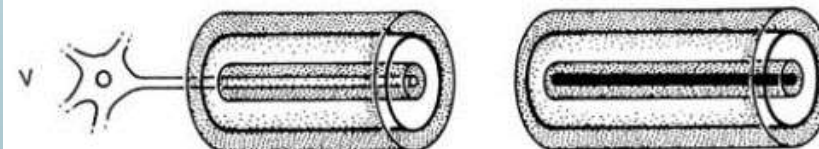
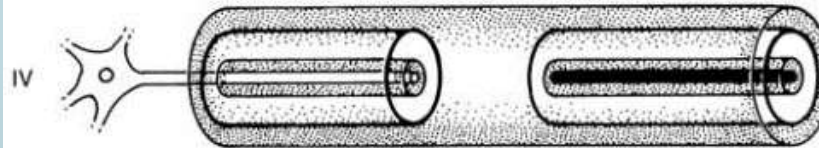
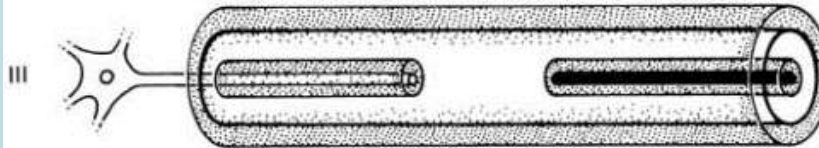
Neurapraxia



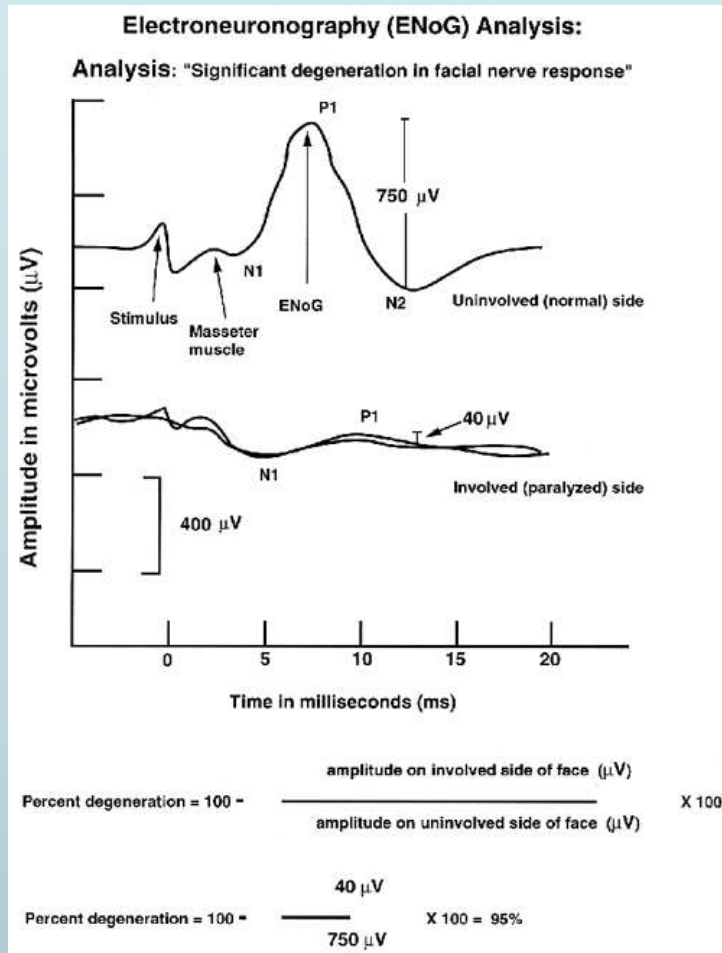
Axonotmesis



Neurotmesis

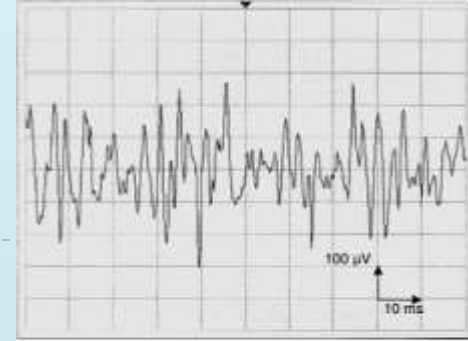


ENoG



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

EMG Interpretation



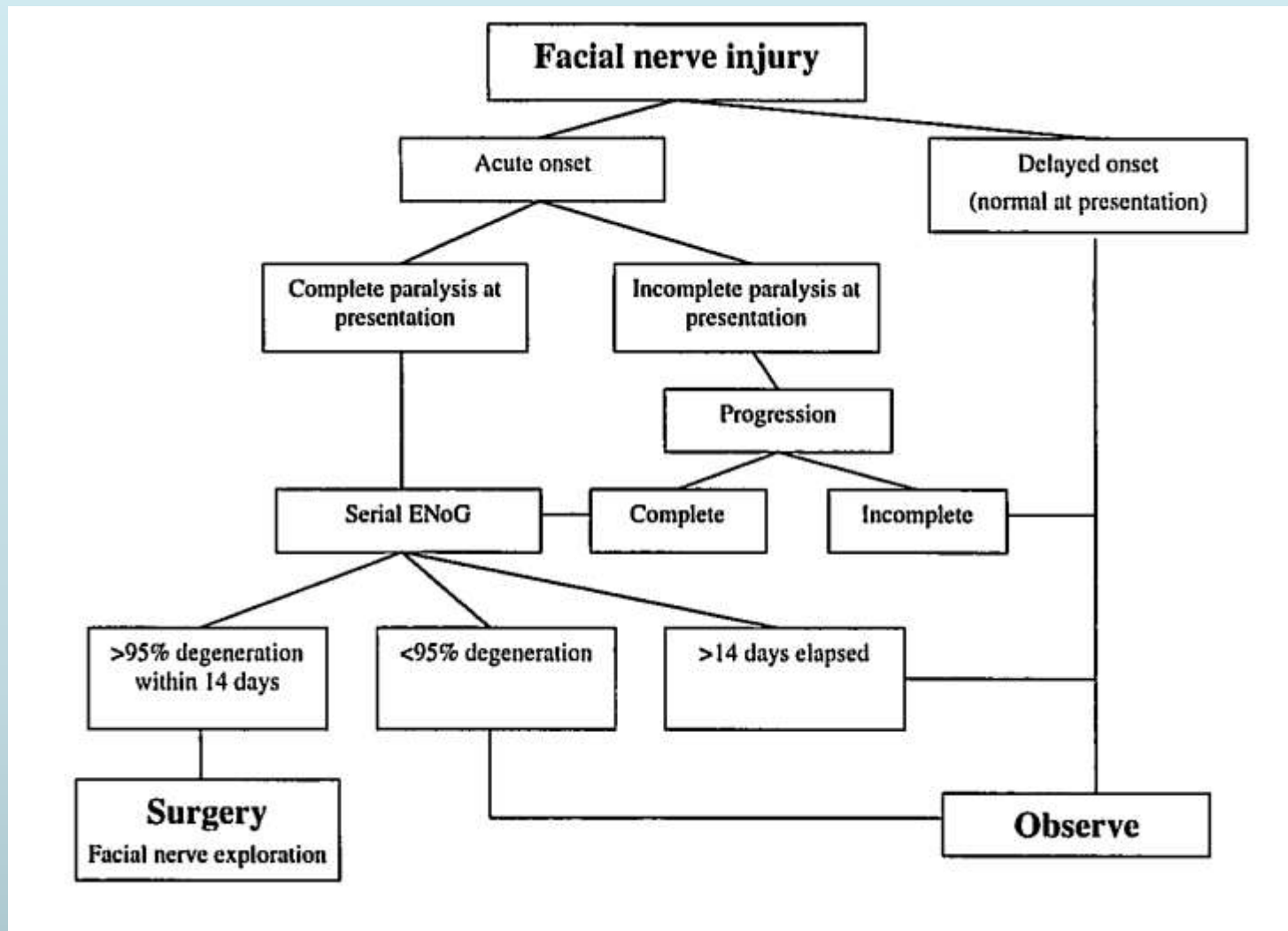
- **Active voluntary motor units (MU)**
 - Intact motor axon
- **Myogenic fibrillation potentiation & Absent voluntary MU**
 - Complete nerve degeneration
- **Fibrillation + MU**
 - Partial degeneration
- **Polyphasic MU**
 - Regenerating nerve



Management of facial nerve injury

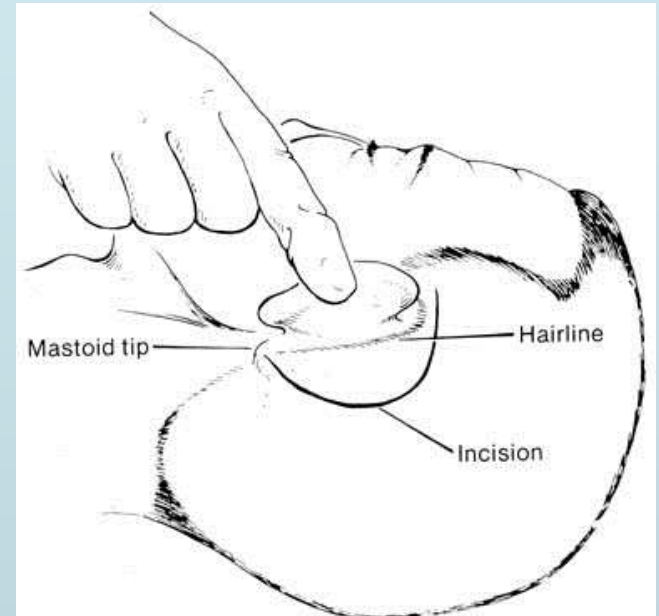
- ▶ Onset of paralysis
- ▶ Immediate onset paralysis:
 - ▶ Surgical decompression or repair if ENoG > 90% degeneration
- ▶ Delayed onset or incomplete paralysis:
 - ▶ Conservative management: eg. Steroid
 - ▶ ENoG
 - ▶ Prognosis is excellent
- ▶ Timing indeterminant: treated as immediate
- ▶ Late decompression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



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



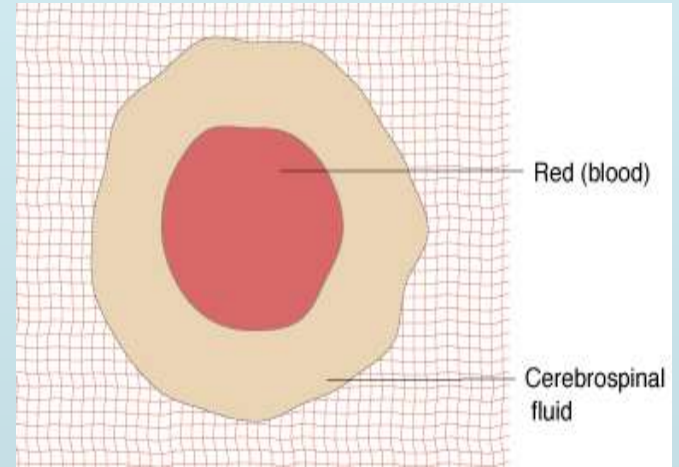
CSF Leak

- ▶ 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

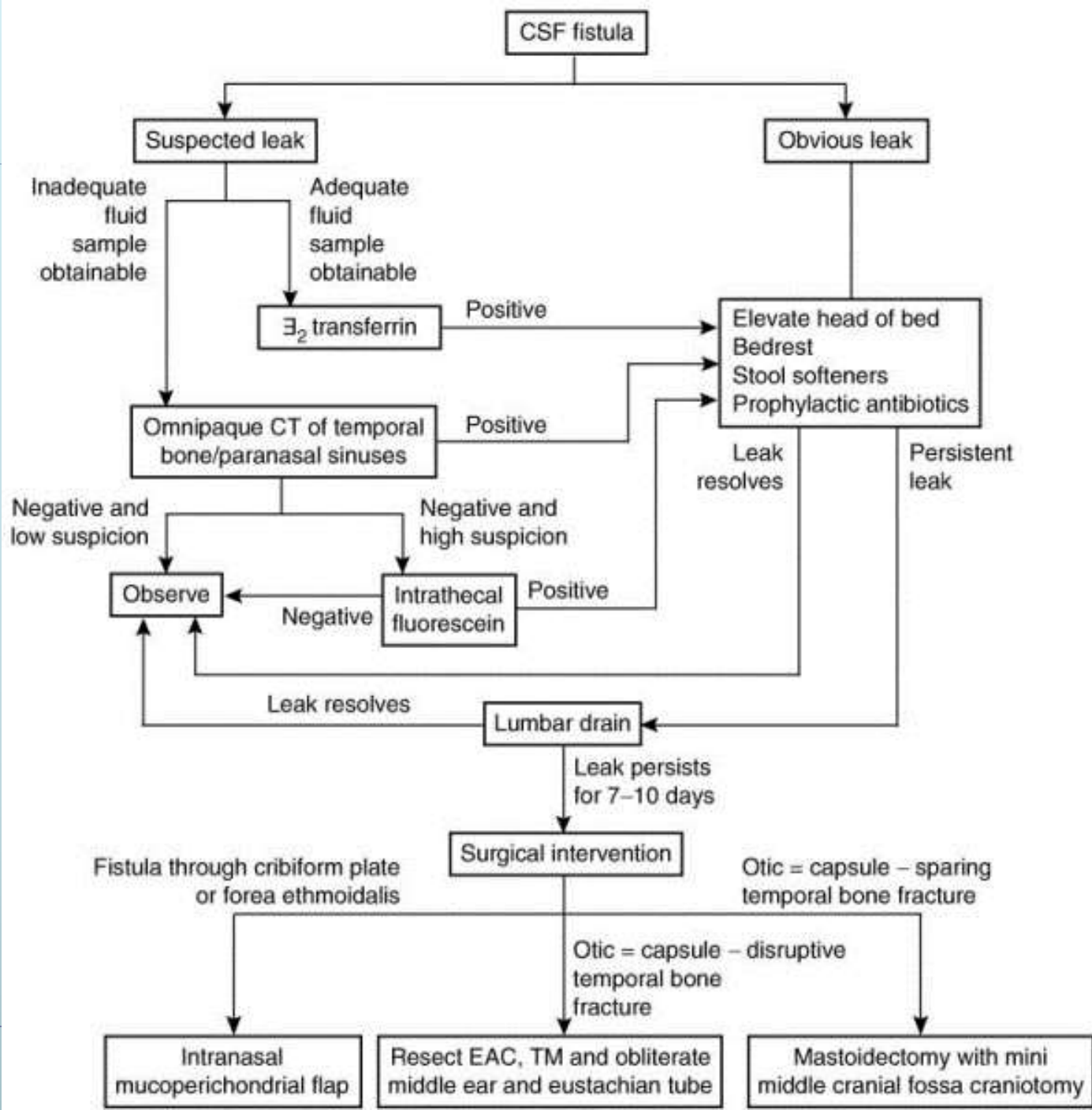
- ▶ **Diagnosis:**
 - ▶ Halo sign
 - ▶ Beta-2 transferrin
 - ▶ HRCT
 - ▶ CT cisternography (intrathecal contrast in active leak)
 - ▶ MRI (when defect > 2 cm)
 - ▶ Intrathecal fluorescein



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



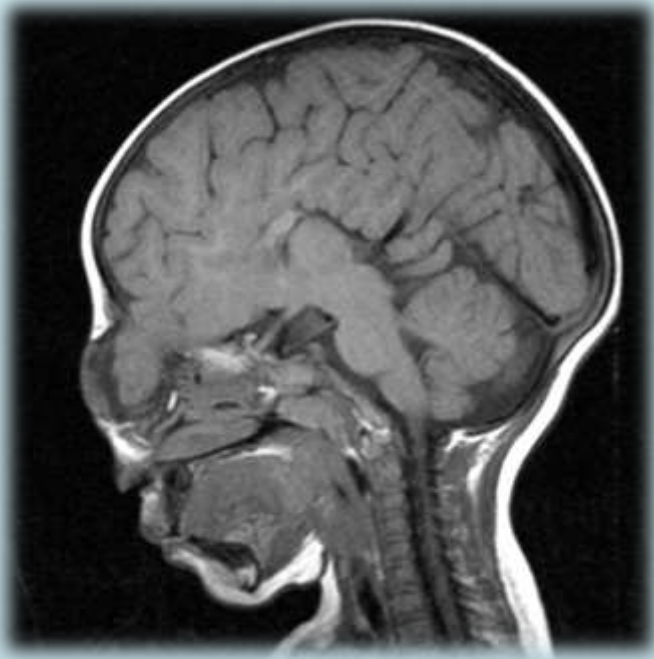
Vertigo



- ▶ 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

