Functional structure of the skull

and

Fractures of the skull

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Functional structure of the skull

According to strain and produced forces on the skull bones we have **thickened** and **thinner parts of the skull.**

- the transmission of masticatory forces, traction of nuchal and cervical muscles …

- fracture predilection

Functional structure of the skull - **Facial buttresses system**

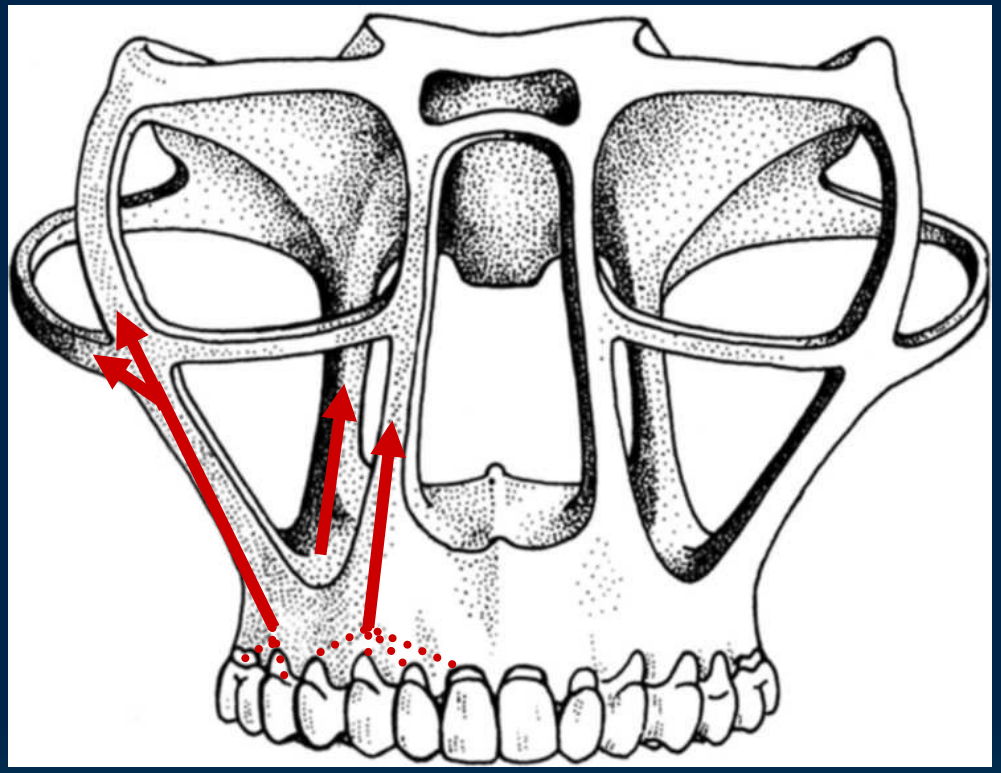
- thin (fragile) segments of bone are encased and supported by more **rigid framework of "buttresses"**

- The midface is anchored to the cranium through this framework

- It is formed by thickened parts of frontal, maxillary, zygomatic and sphenoid bones and their attachments to one another

- The buttress system absorbs and transmits forces applied to the facial skeleton

- Masticatory forces are transmitted to the skull base and skull vault primarily through the vertical buttresses, which are joined and additionally supported by the horizontal buttresses

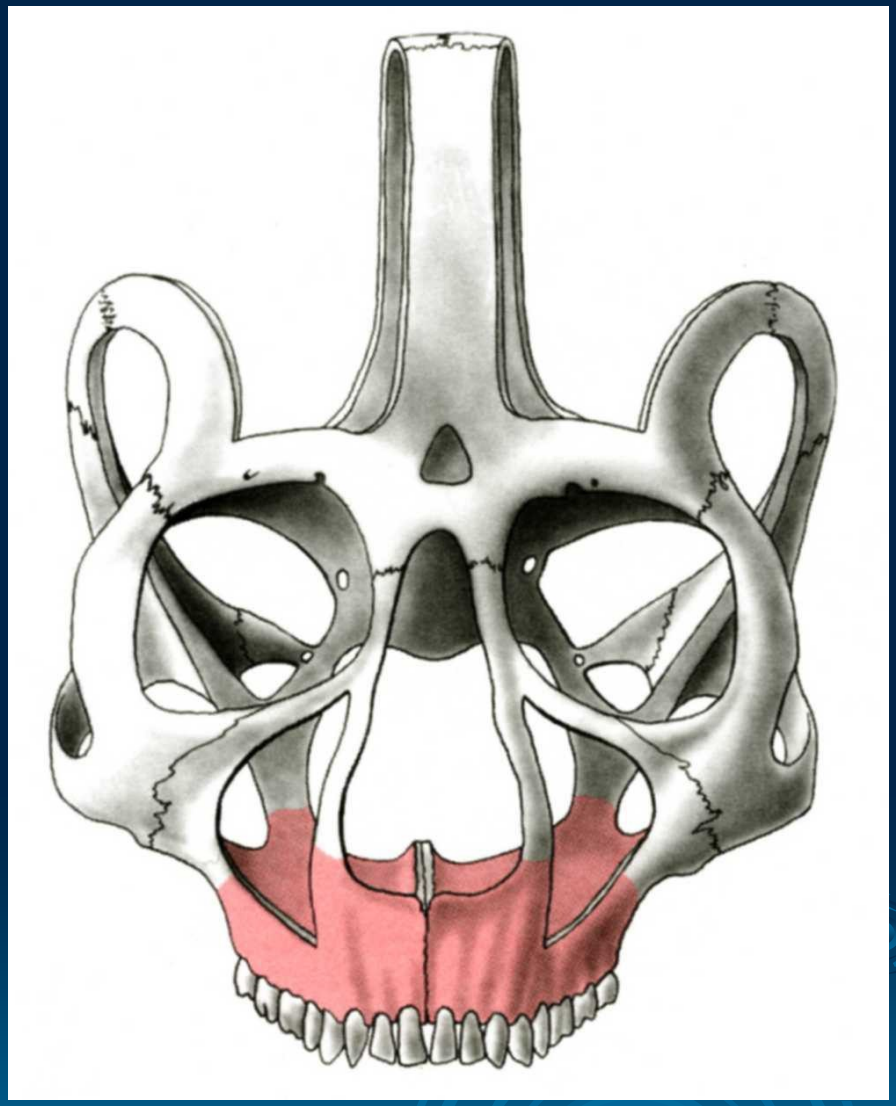


Vertical buttress

- nasomaxillary
- zygomaticomaxillary
- pterygomaxillary

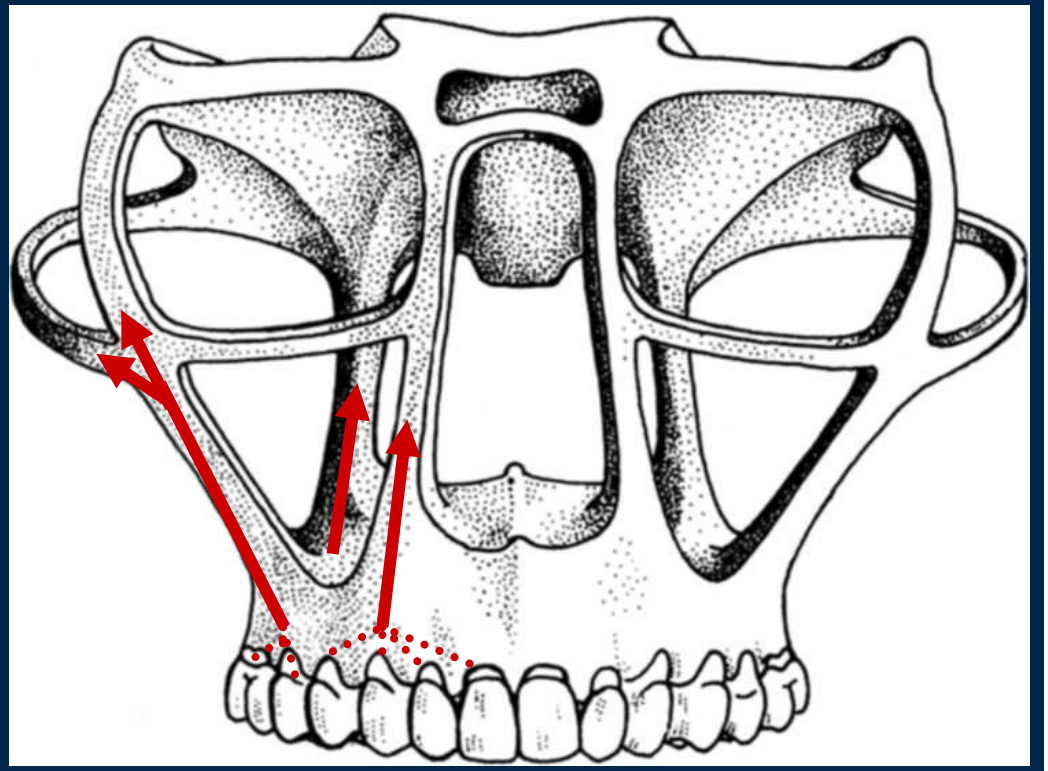
Horizontal buttress

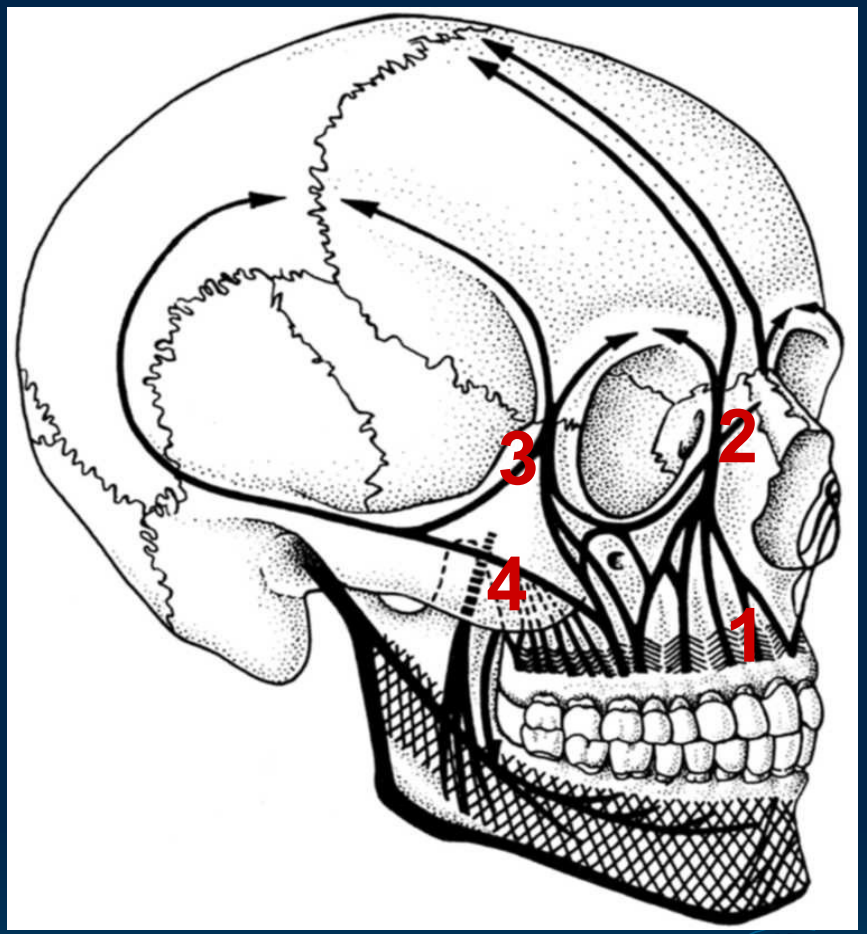
- glabella
- orbital rims
- zygomatic processes
- maxillary palate



„framework“ of the skull

Maxilla

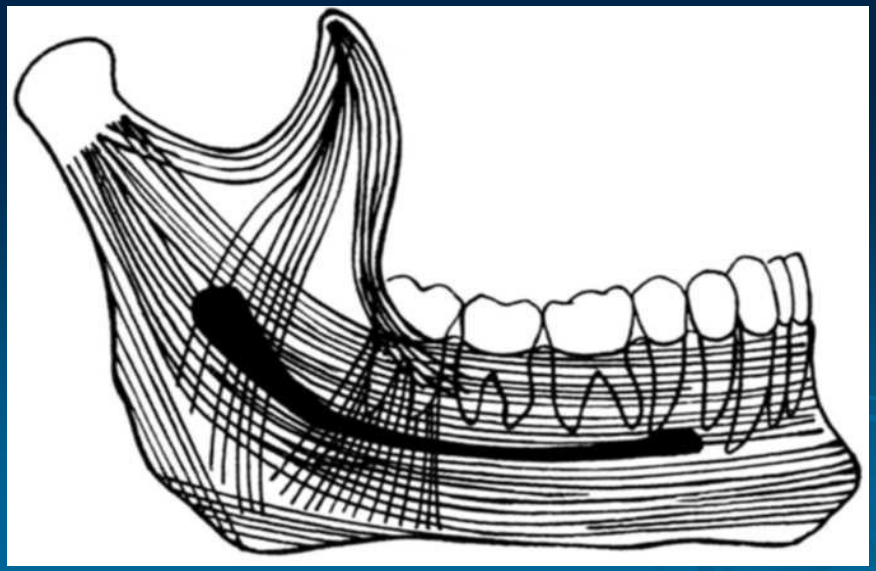




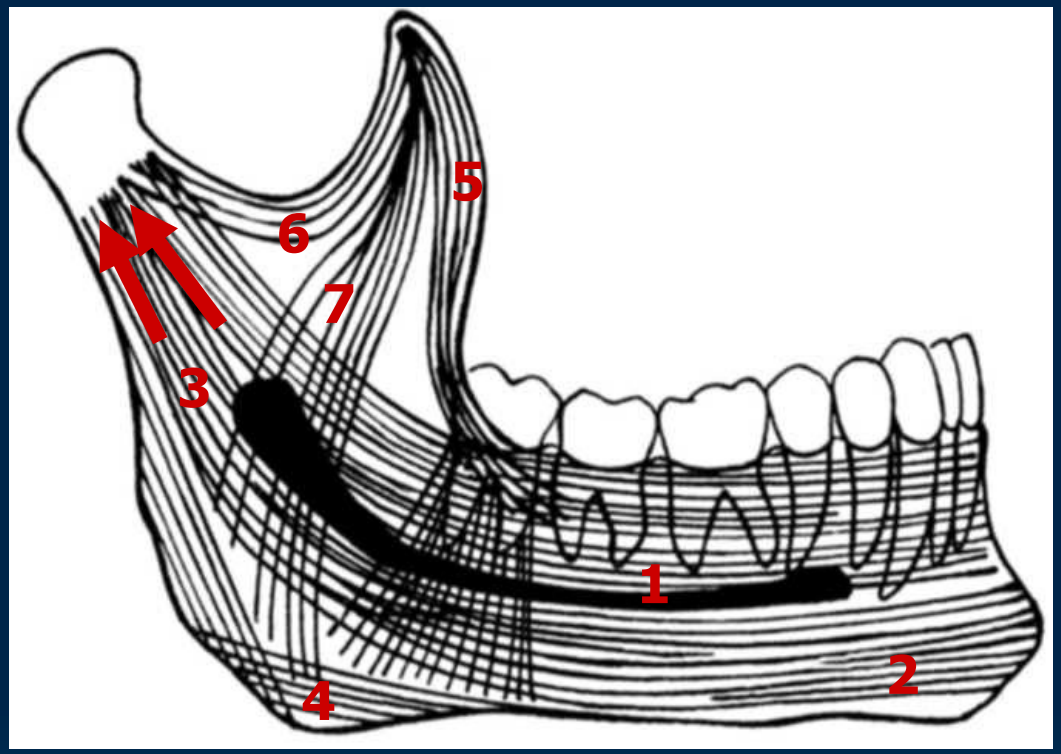
Base of proc. alv. – **upper basal arch (1),** together with the hard palate forms the so-called **palatinal plate**, into which the system of pillars is embedded.

2 nasomaxillary butt. (1-4)
3 zygomaticomaxillary butt. (5-6)
4 pterygomaxillary butt.(7,8)

Strain that occurs from mastication /or trauma/ is transferred from the inferior of the mandible also via various **trajectory lines (thickened patrs)** → to the condyles → articular fossa → temporal bone (small part of masticatory forces)



Mandibula



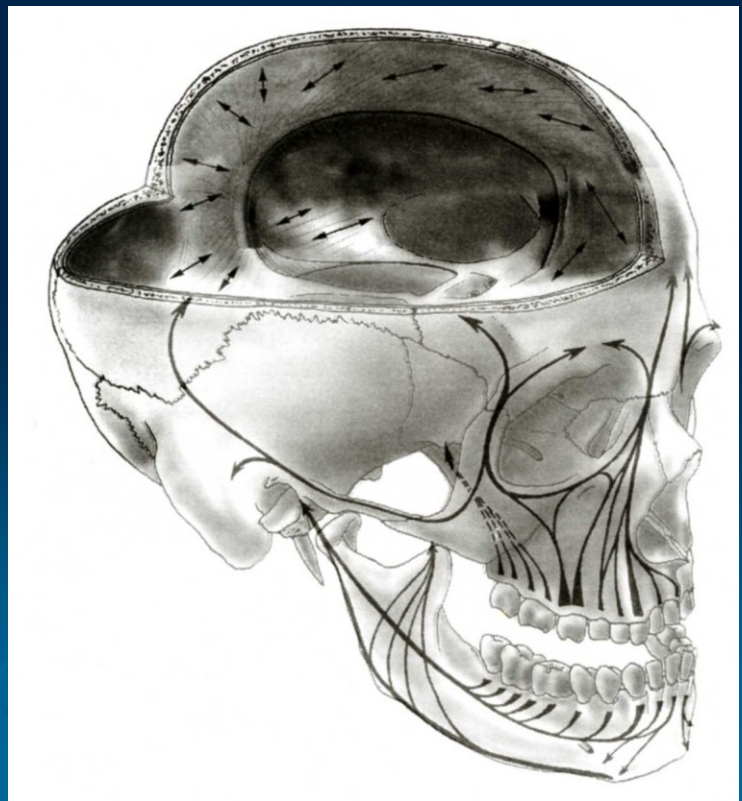
Trajectorium:

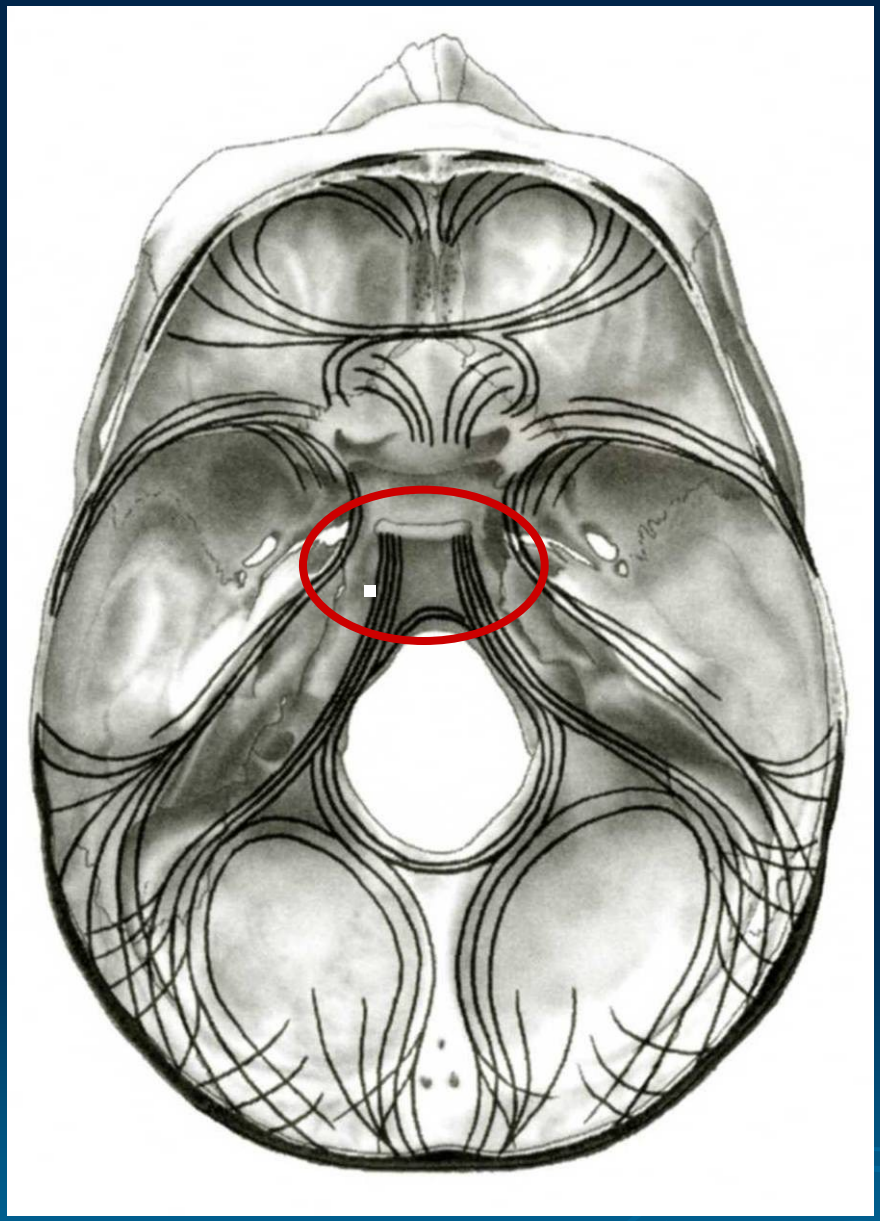
1. **dentale**
2. **basilare**
3. **posticum**
4. **marginale**
5. **praeceps**
6. **copolans**
7. **transversum**

Short columns protrude from the lower teeth to the **lower basal arch** **(tr. basilare)** and through crista colli mandibulae to caput mandibulae.

Vault - thickened parts:

- tubera frontalia
- tubera parietalia
- protuberantia occipitalis ext. et int.
- linea temporalis
- margin of sulcus sinus sagitalis sup. et transversus





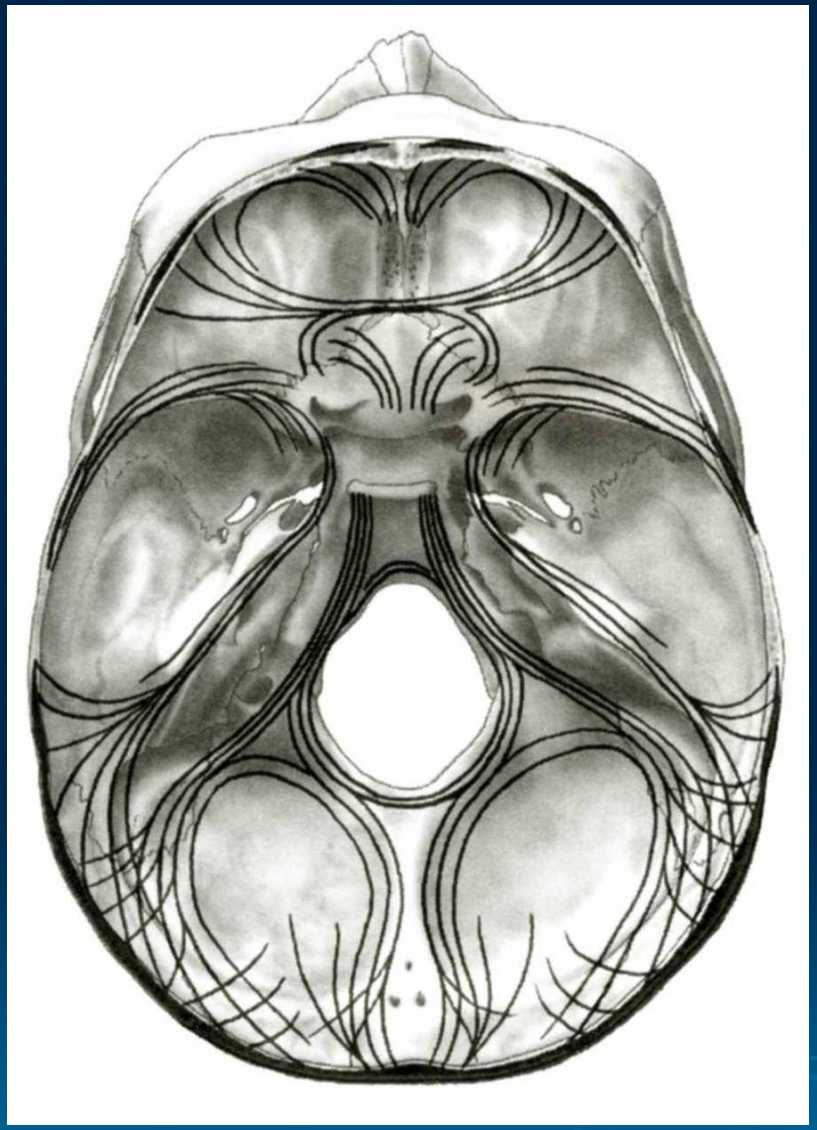
Cranial base - thickened parts:

Base centre and the most solid part - **pars basilaris ossis occipit.**

- sagittal line
- ventral lateral line
- dorsal lateral line

Thinner parts of splanchnocranium

- Sinus maxillae
- Orbita
- Nasal cavity



Thinner parts of skull base

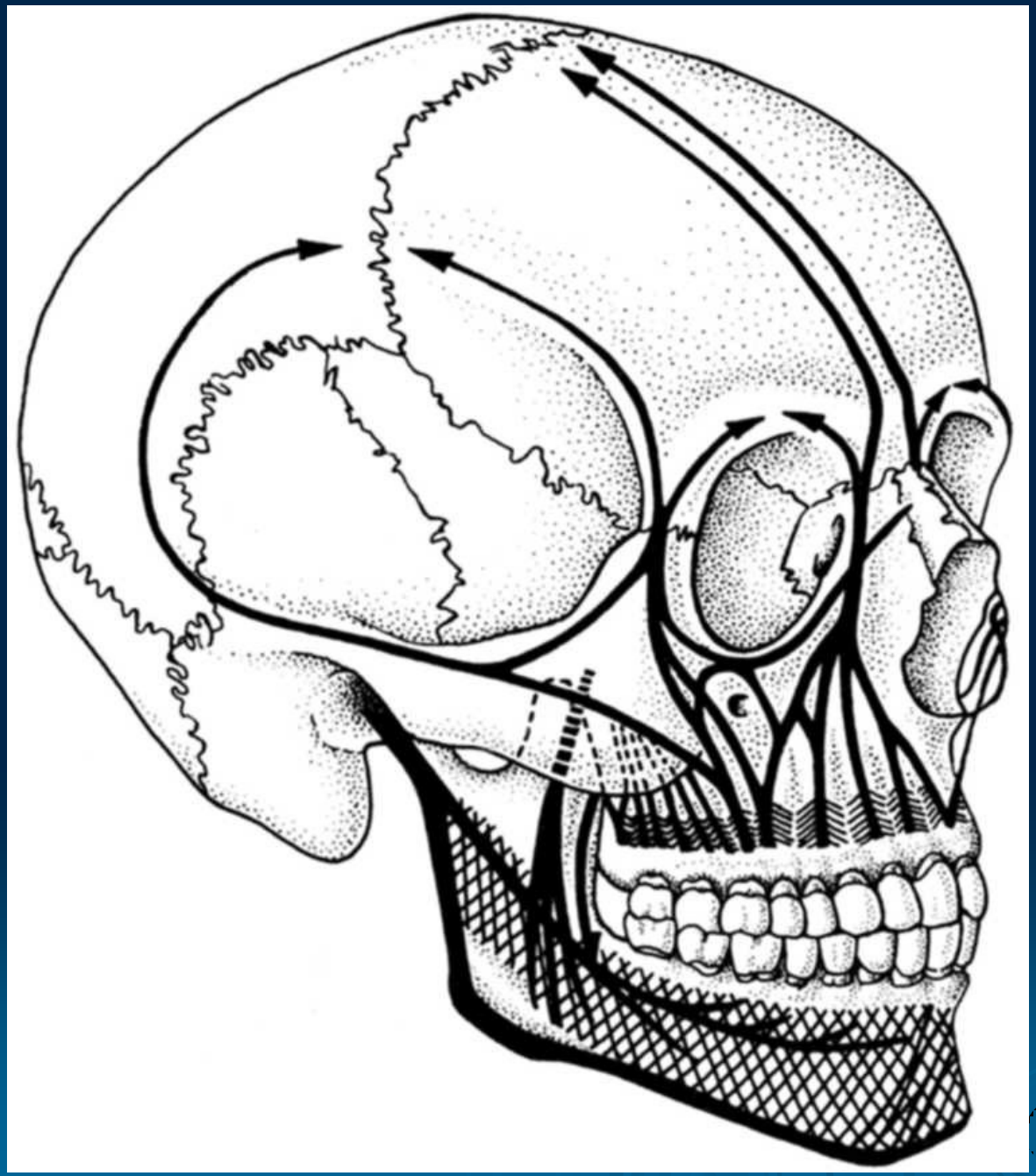
- articular fossa
- cribriform plate
- foramines, canals and fissures
- anterior, medial and posterior cranial fossa

Transmission of chewing pressure

Periodontal ligaments connecting the root of the tooth with the wall of the alveolus by their pull on the adjacent bone cause the formation of bone beams and the formation of so-called trajectories. These trajectories deviate from the tips of the roots in a fan shape, they capture small movements of the teeth in the alveolus during chewing, they act against tensile forces from the periodontium.

Thickened beam - the pillars transmit and neutralize the masticatory pressures from the upper dental arch to the cranial base and vault of the skull, they are anchored in the bone plate (formed by the hard palate and the upper part of the alv.proc. The task is to put resistance to the pressure that the lower jaw exerts on the upper jaw during the bite and to transmit the chewing pressures from the splanchnocr. to neurocr.

The pillars run regardless of the anatomical boundaries of the individual bones. The compact bone and beams of spongiosis are reinforced - arranged in the direction of the load. The maxillary sinus is located in the mechanically empty area of splanchnocr.



- When external forces are applied, these components prevent disruption of the facial skeleton until a critical level is reached and then fractures can occur

Fractures of the skull

We can divide:

- **Infraction / fracture without dislocation / dislocated fracture**
- **Simple** / **multiple** (more fracture lines in one bone) / **comminuted fr.** (more irregular fr.lines)
- **Closed** / **open – compound** (associated with soft tissue injury, where the fractured bone is in direct communication with the outside environment)
- **Primary / secondary**

Etiology of injury

hit hard by a moving object

- the impact of the head on a stationary hard object
- compression effect (between 2 subjects)
- pulse mechanism without direct mechanism of action on the skull (alternation of acceleration and deceleration - traffic accidents)

Alternation of tensile and compressive forces acting on the brain

The type and extent of skull fractures depends on:

- dimensions, weight, shape, consistency and elasticity of the object
- direction, speed and magnitude of the force of the blow
- movement of the head after hit
- place of violence (bone thickness, curvature)
- skull elasticity, age
- fractures due to a patholog. processes

I. Neurocranial fractures

II. Craniofacial fractures

I. Neurocranial fr. of the cranial vault

- A break in the skull bone generally occurs as a result of a **direct impact**

- If the force and deformation is excessive, the skull fractures at or near the site of impact

- Uncomplicated skull fractures themselves rarely produce neurologic deficit, but the **associated intracranial injury may have serious neurologic consequences !**

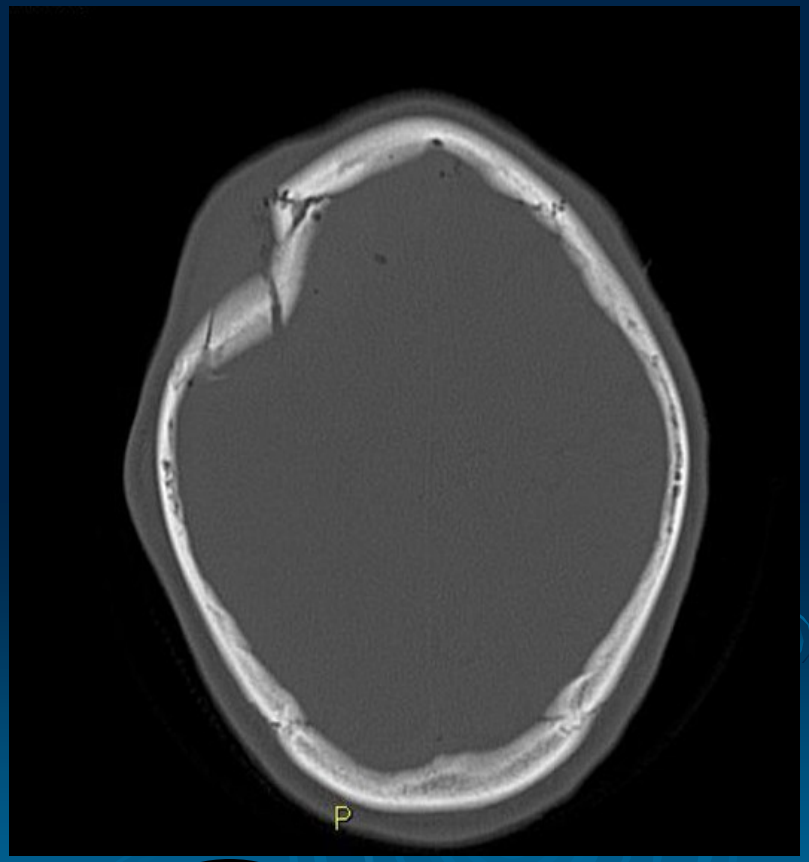
1. Linear skull fracture

- Most common
- Involve a break in the bone but no displacement
- Usually the result of low-energy transfer
- Due to **blunt trauma over a wide surface area** of the skull
- Are usually of little clinical significance

Linear skull fracture

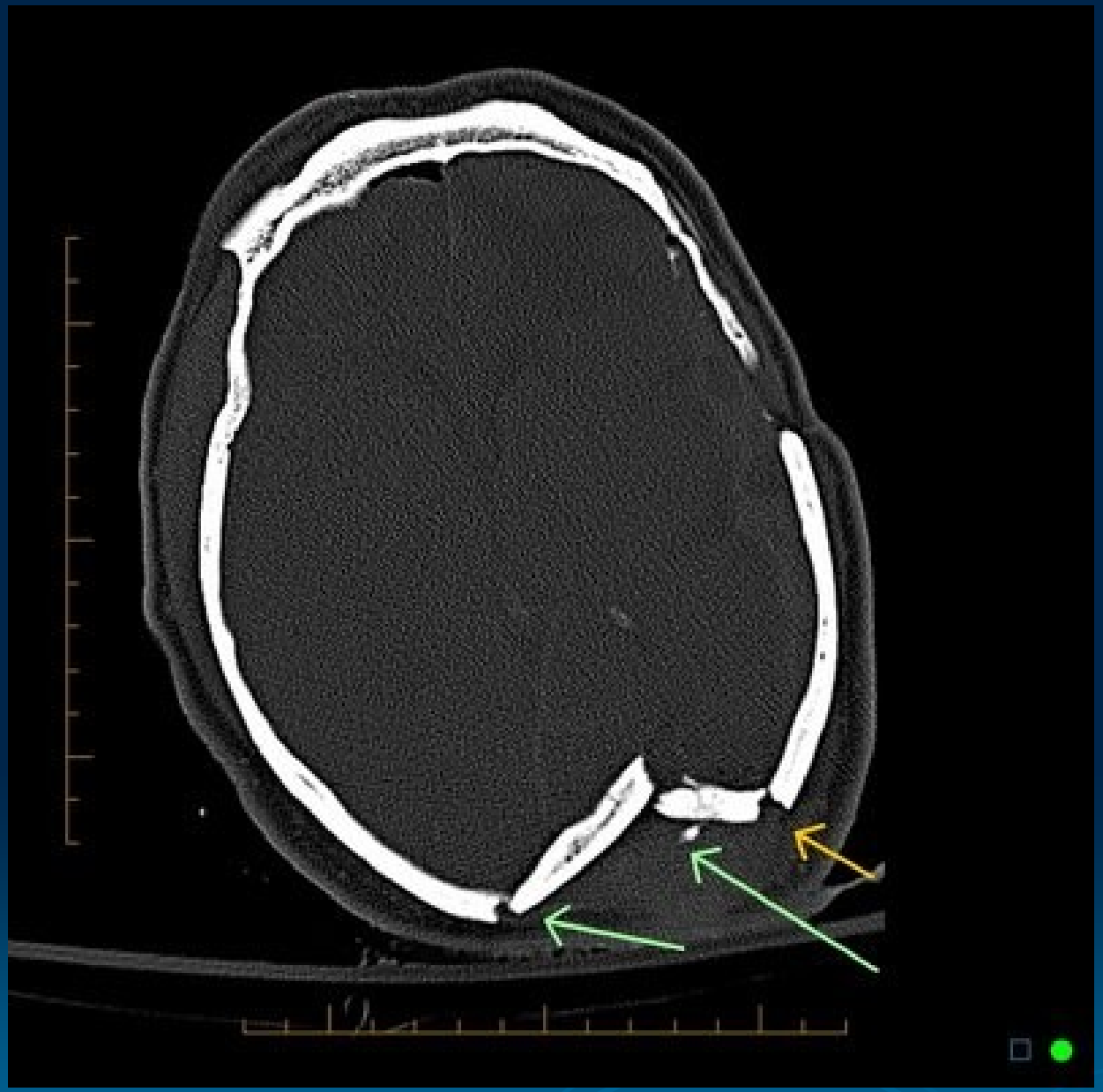
2. Depressed skull fractures

A fracture is clinically significant and sometimes requires surgical elevation of the fragments



Closed or compound (open)

Compound fractures may occur when they are associated with a skin laceration or when the fracture extends into the paranasal sinuses or the middle-ear structures



Depressed fracture

Depressed fractures are usually **comminuted**, with **broken portions of bone displaced inward -** and may require surgical intervention to repair underlying tissue damage

3. Basilar skull fractures

- A basilar skull fracture is a **break of a bone** in the **base of the skull**.

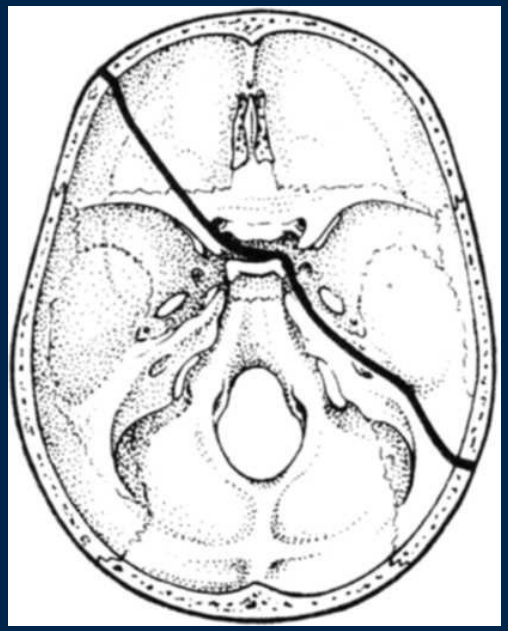
- Usually **indirect** force

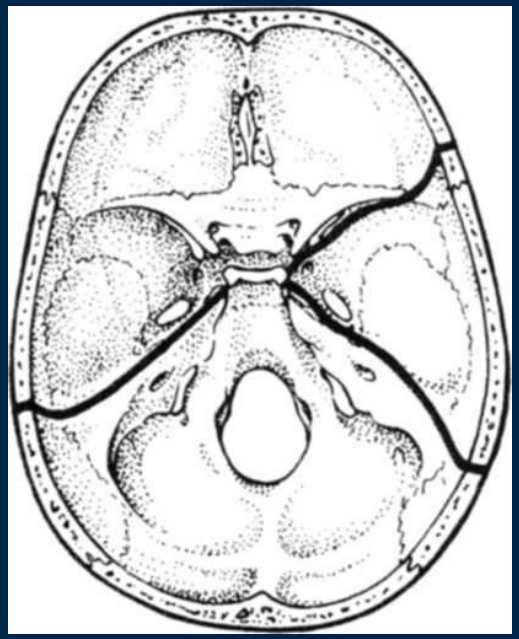
- Basilar fractures are the **most serious!**

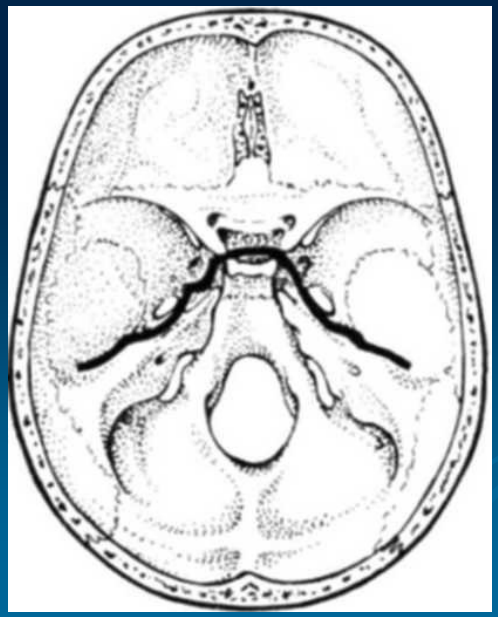
- Can be isolated or together with fractures of cranilal vault / calvaria

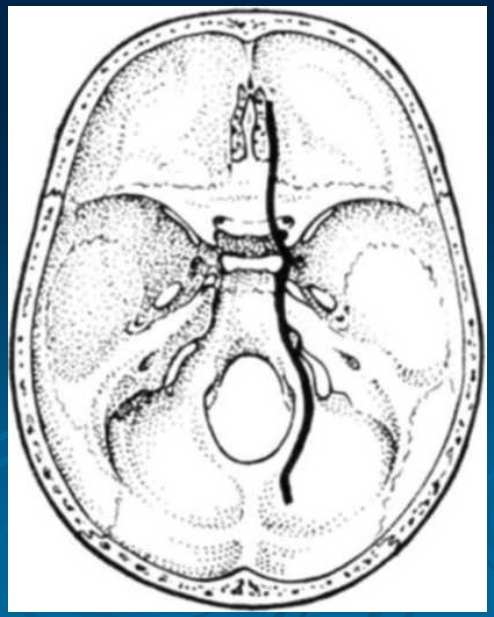
- Fracture lines often occur at predilection sites

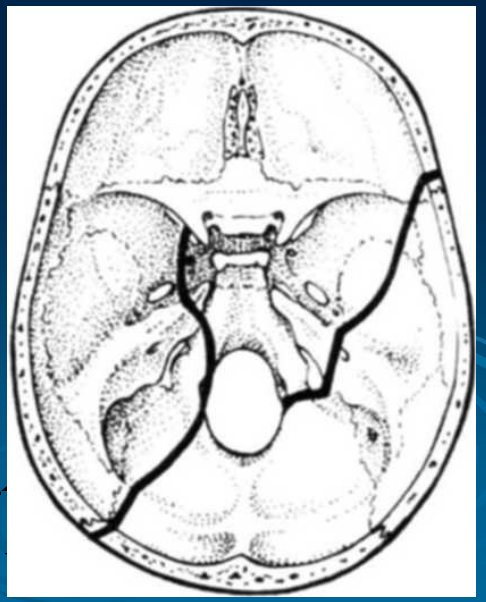
Spreading of the fracture lines











Basilar fractures

characteristic signs:

- blood in the sinuses
- a clear fluid - cerebrospinal fluid (CSF) leaking from the nose (rhinorrhea) or ears (otorrhea)
- periorbital ecchymosis often called 'raccoon eyes
- retroauricular ecchymosis known as "Battle's sign„
- pneumocephalus

Symptoms and complications of skull fracture

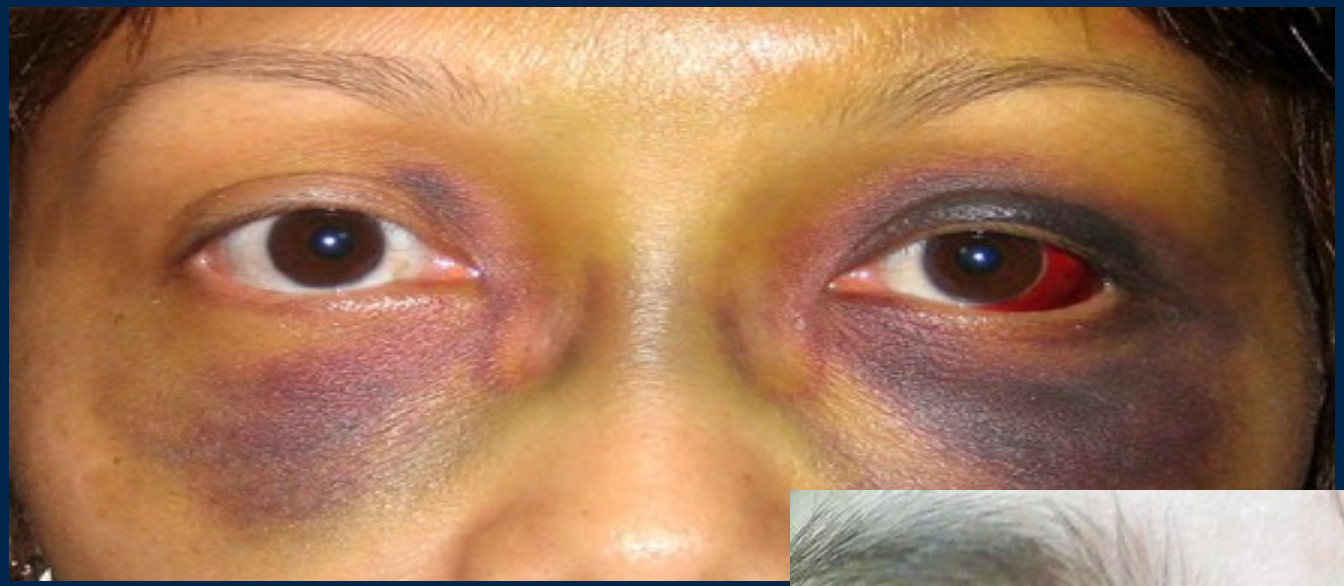
- Otorrhea, rhinorrhea, epistaxis, bleeding
- Battle s sign, Raccoon eyes
- Cranial nerve lesion …
- Pneumocephalus
- Intracranial hemorrhage: extradural / epidural
  subdural
  subarachnoideal
  intracerebral
- Damage of the brain, brain oedema, hypoxy, posttraumatic epilepsy, meningitis …

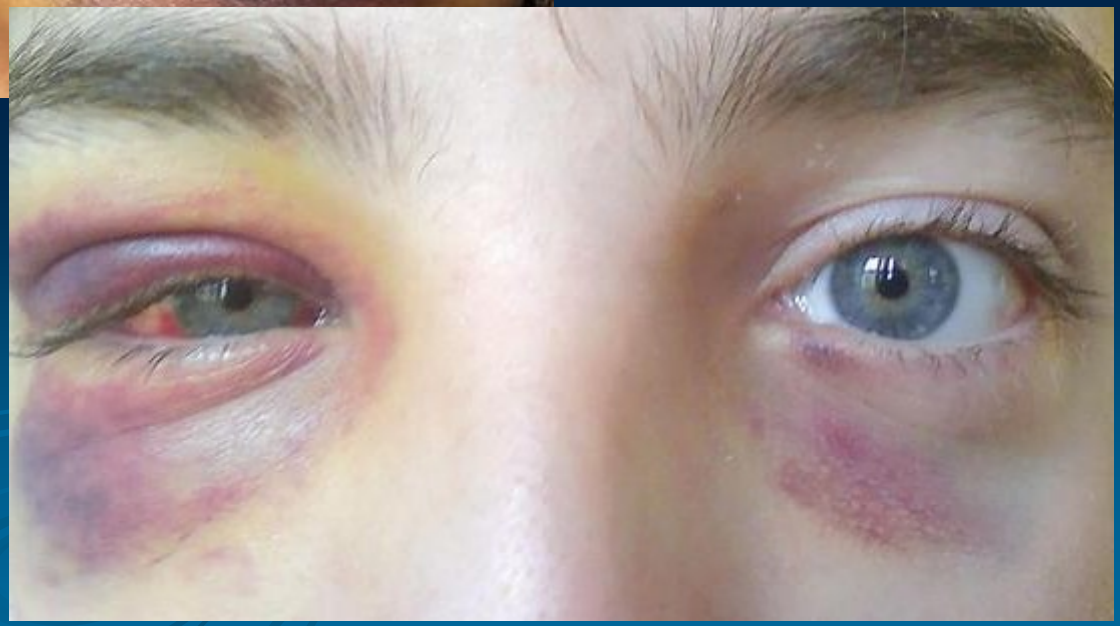
A cerebrospinal fluid (CSF) leak occurs in about 20% of cases of a **basilar skull fracture** and can result in fluid leaking from the nose or ear
High risk of infection!

Battle's sign, also known as **mastoid ecchymosis**, is an indication of fracture of middle cranial fossa of the skull. These fractures may be associated with underlying brain trauma.
Battle's sign consists of bruising over the mastoid process as a result of extravasation of blood along the path of the posterior auricular artery

Raccoon eyes – periorbital ecchymosis

Raccoon eyes (also known in the United Kingdom and Ireland as **panda eyes**) or **periorbital ecchymosis** is a sign of basal skull fracture

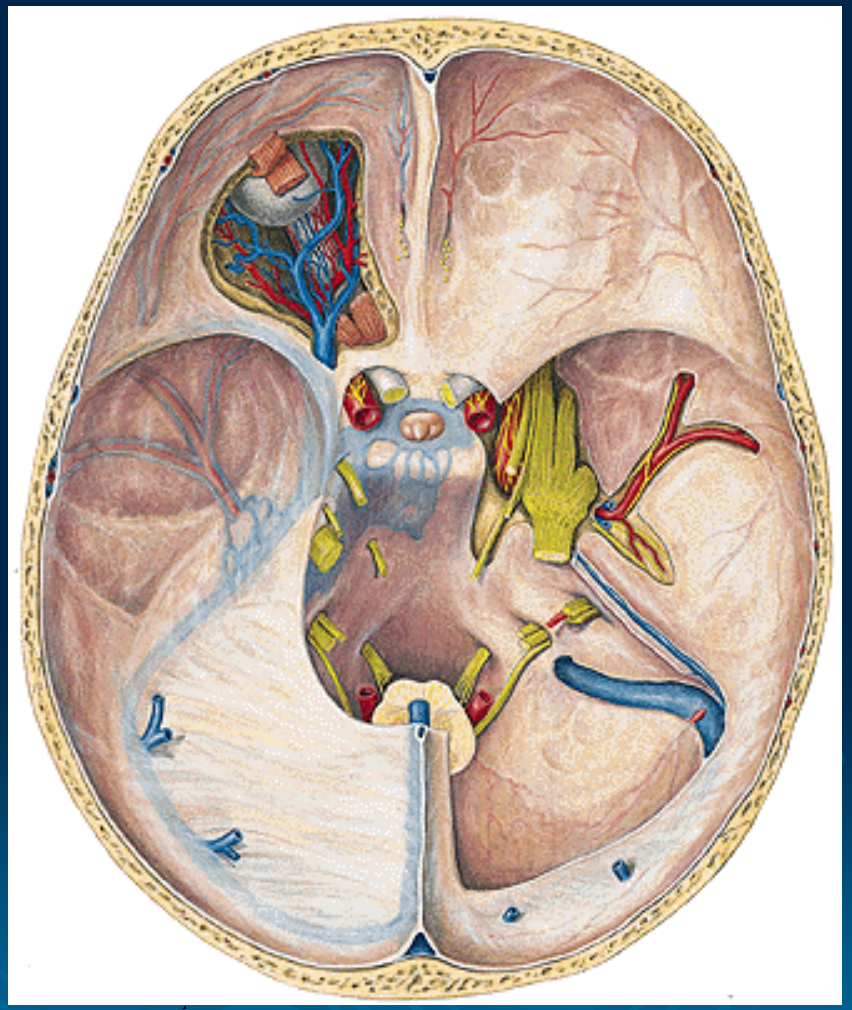




They are most often associated with fractures of the anterior cranial fossa

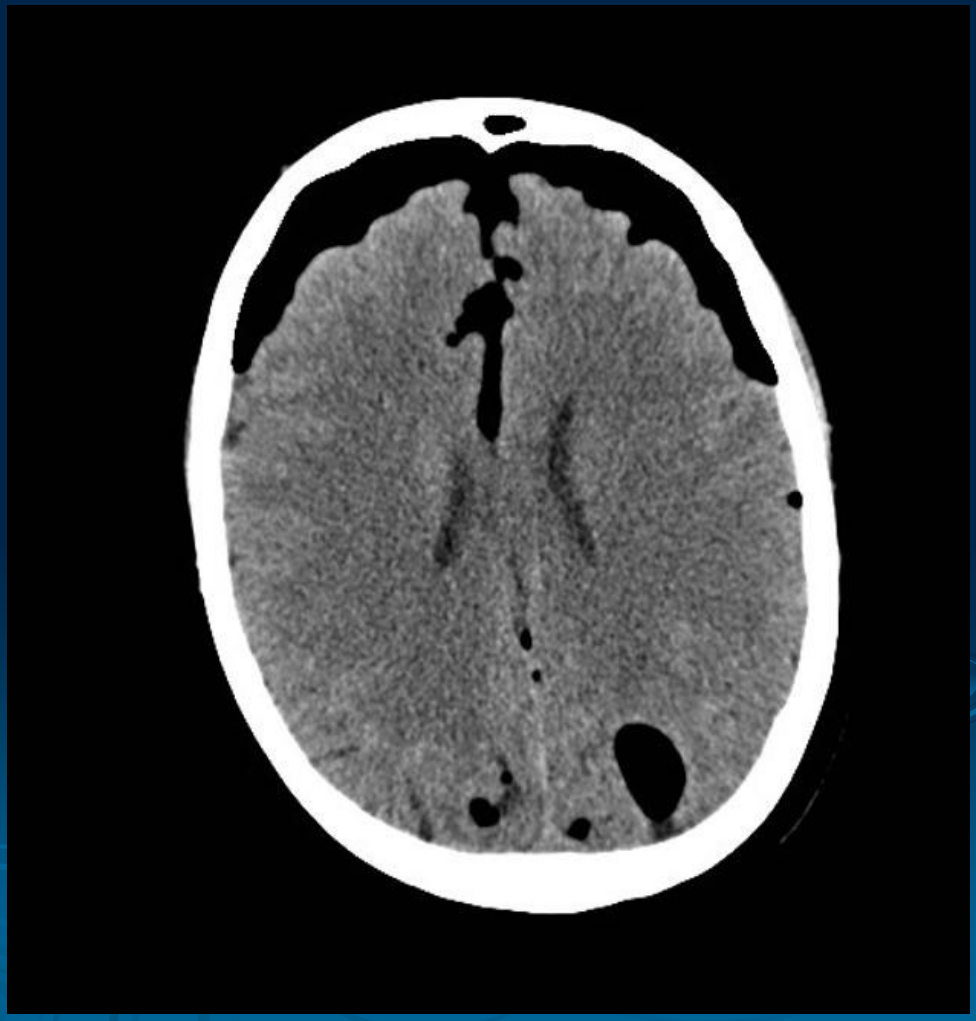
Cranial nerve lesion

I. (Olfactory n.) - loss of smell (anosomia)
II. (Optic n.) - loss of vision, abnormal pupillary reflex
III. (Oculomotor n.) - loss of accommodation, lateral strabism
VI. (Abducens n.) - medial strabism
VII. (Facial n.) - paralysis
VIII. (Auditory n.) - hearing loss



Pneumocephalus

- presence of intracranial gas / air
- is most commonly encountered following trauma or surgery

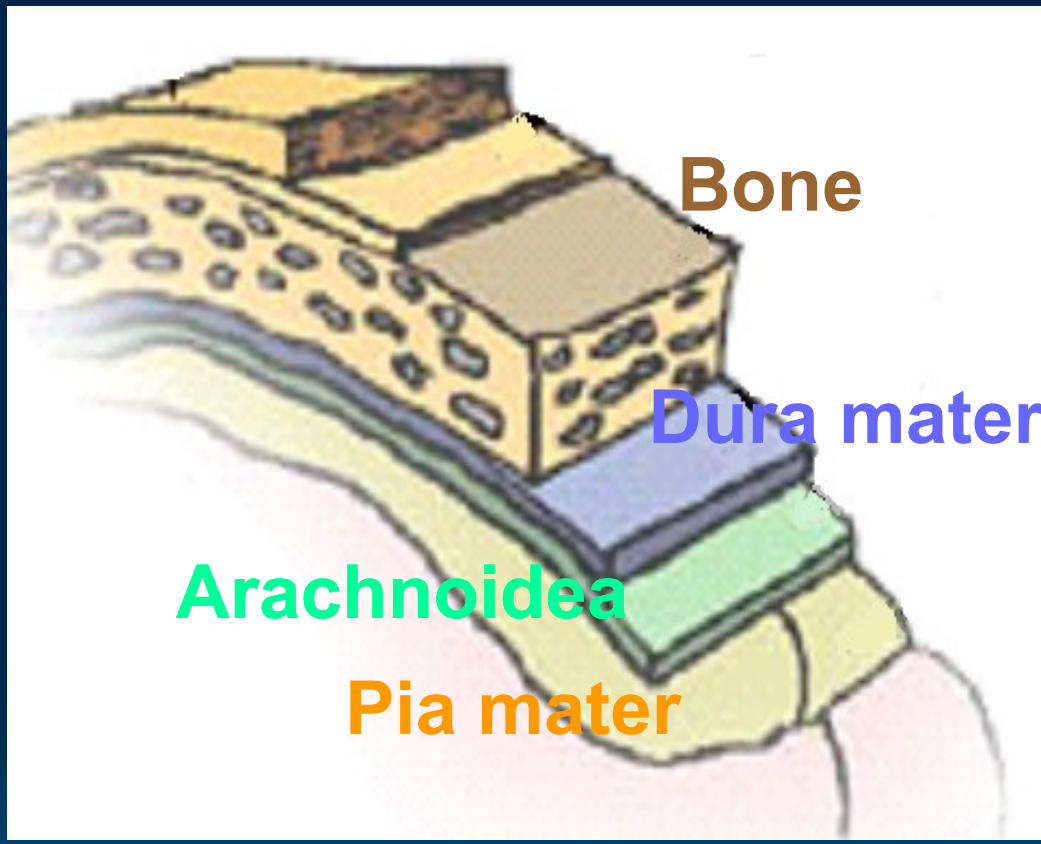


Epidural hemorrhage

- An arterial bleeding from a **middle meningeal artery** accumulates and forms a hematoma

- Between the inner skull table and dura matter

- The temporal bone is usually the thinnest part of the skull



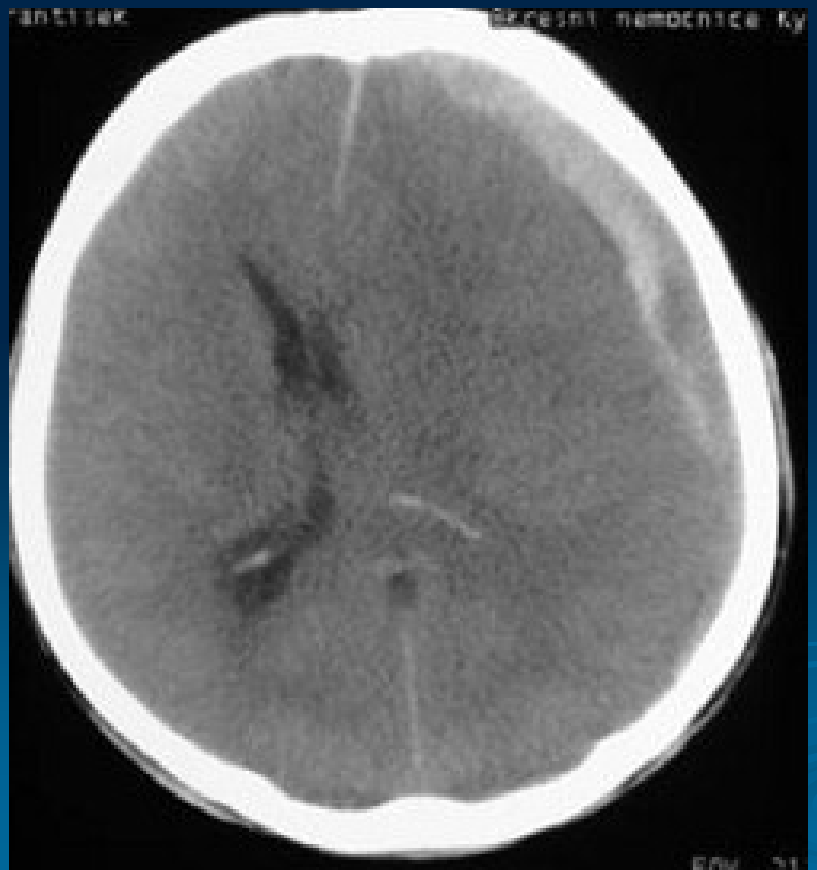
NOTE! „Extradural“ = **epidural**

Epidural hemorrhage

Subdural hemorrhage

- tears of the **small veins** that bridge the gap between the dura and the cortical surface of the brain

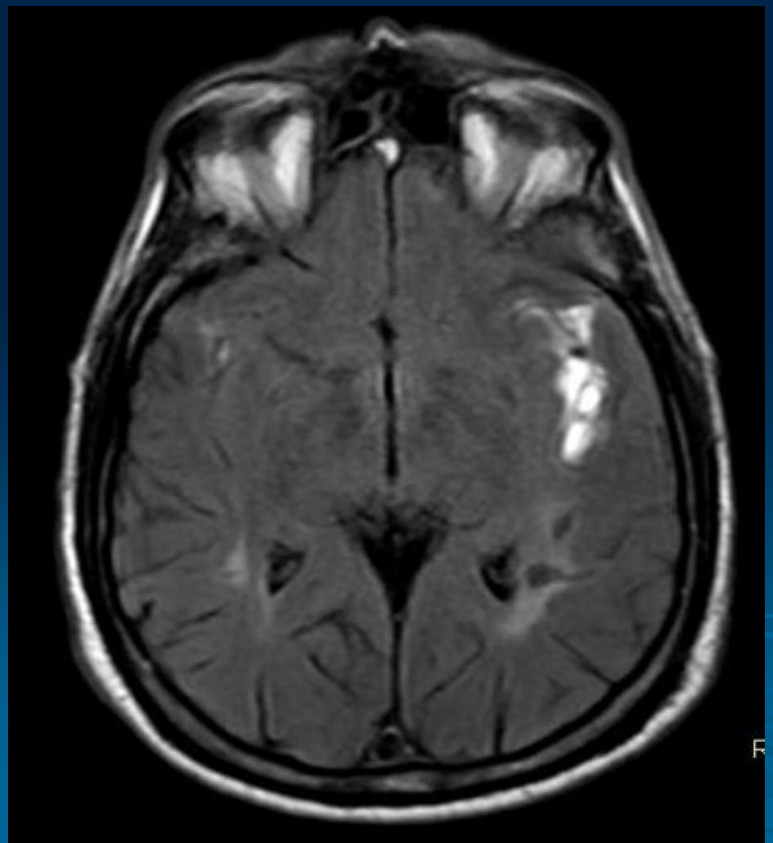
- Between the dura matter and arachnoid

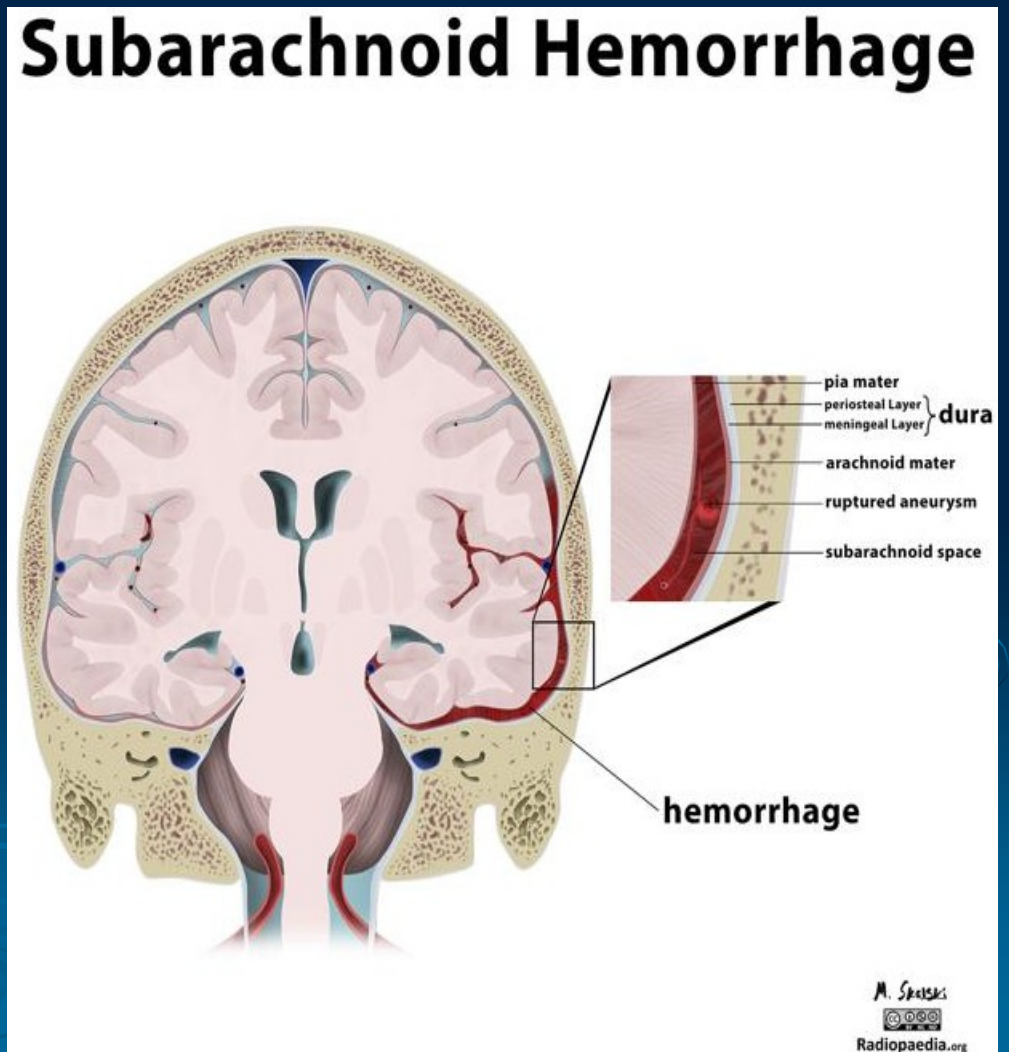


Subarachnoid hemorrhage

- A result of a ruptured of **intracranial arterial aneurysm** or **trauma**

Beneath arachnoid



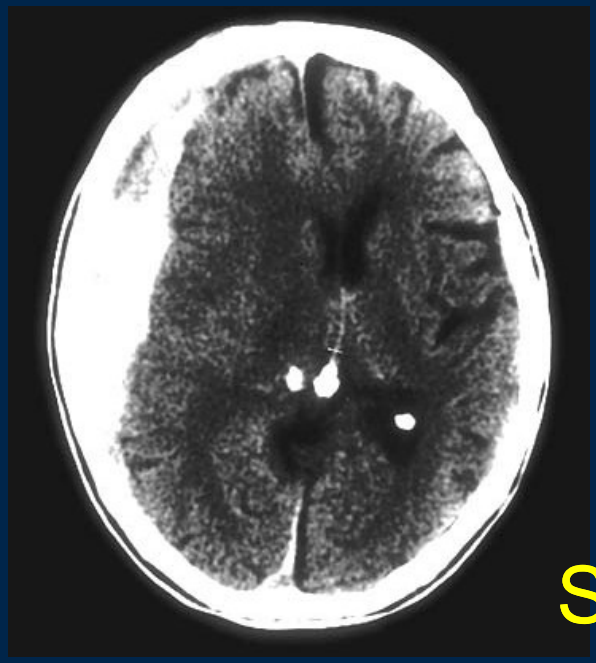


Intracerebral hemorrhage

- A result of a ruptured atheromatous **intracerebral arteriole**, vasculitis, ruptured intracranial arterial aneurysm, or trauma

- Traumatic intracerebral hemorrhage is usually due to extension of hemorrhage from surface contusions deep into the substance of the brain

Epidural



Subdural

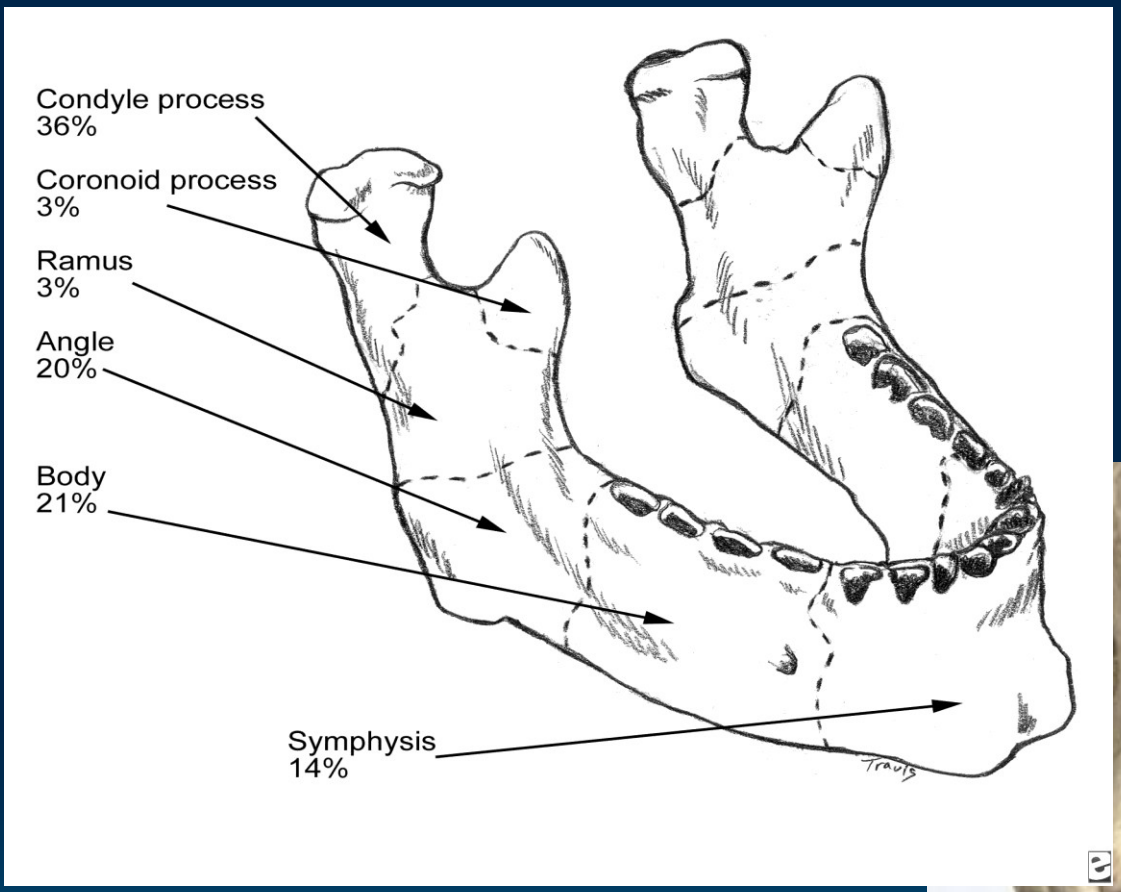
Subarachnoid

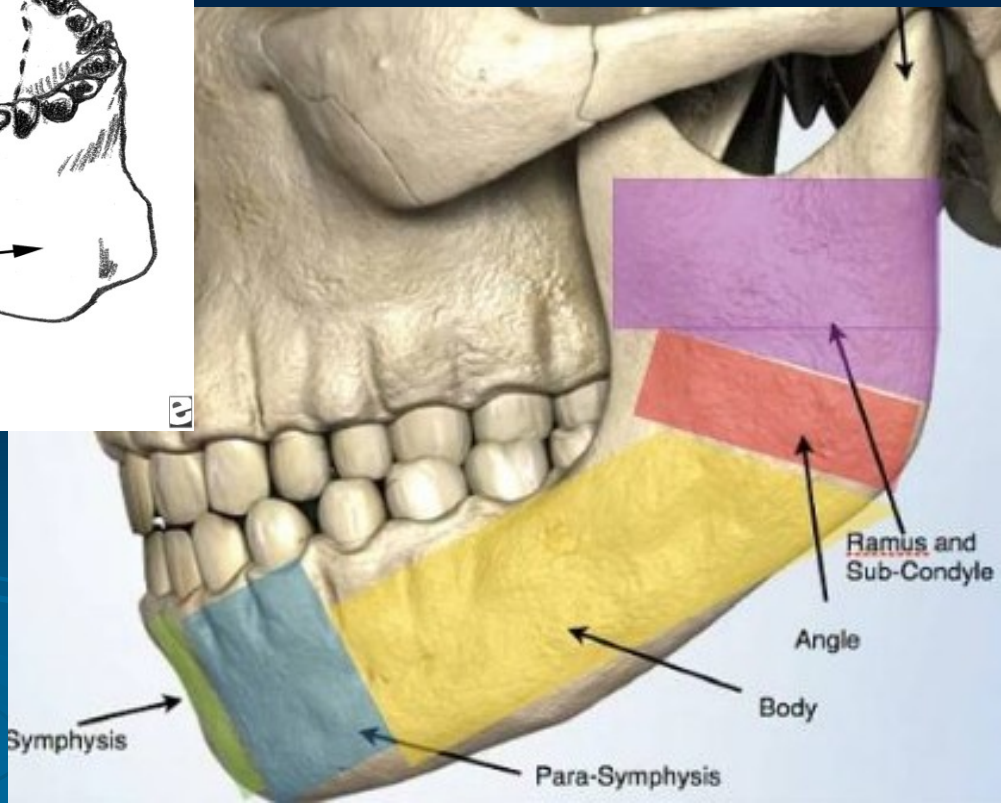
Intracerebral

II. Craniofacial Fractures

1. Mandible
2. Lower mid-face
3. Upper mid-face

1. Fracture of the mandible



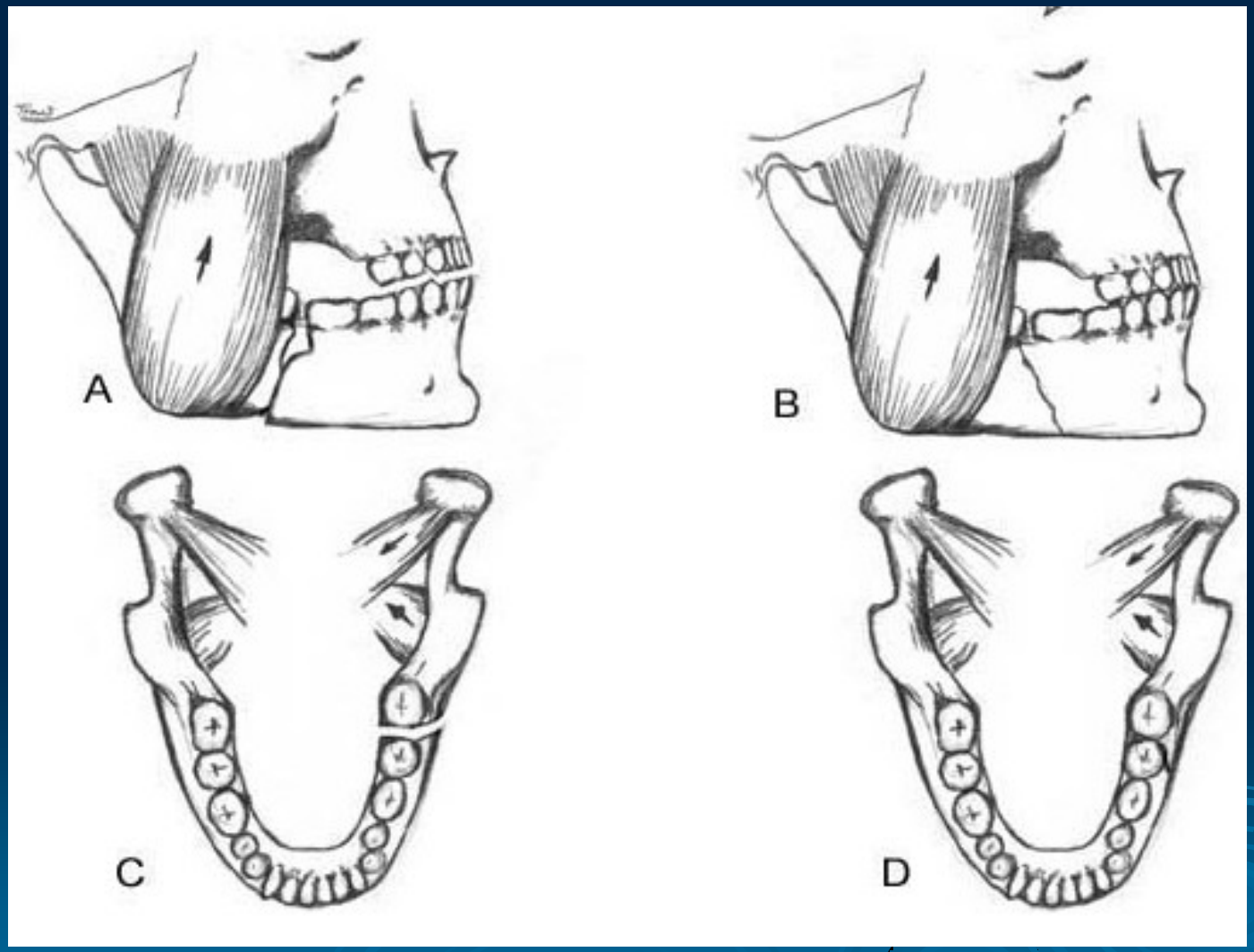


Body fractures

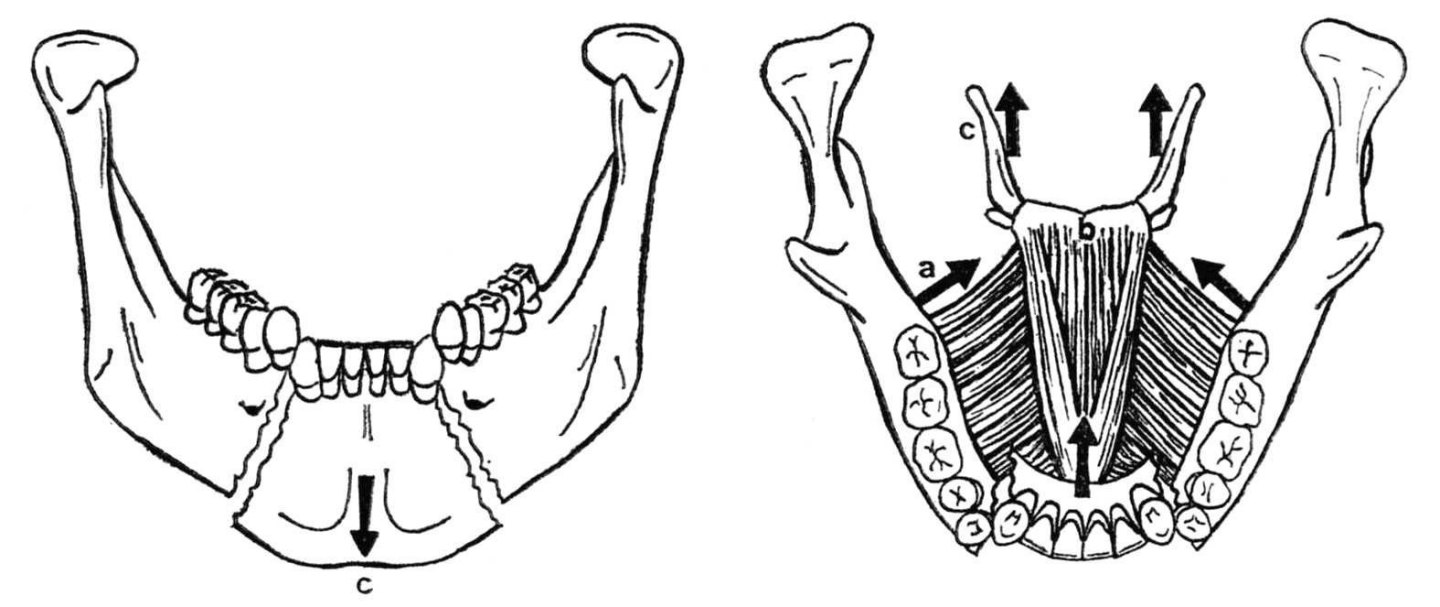
- Between the distal aspect of the canines and a hypothetical line corresponding to the anterior attachment of the masseter, proximal to the third molar

- The actions of the masseter, temporalis, and medial pterygoid muscles distract the proximal segment superomedially

- The mylohyoid muscle and anterior belly of the digastric muscle may contribute to the displacing the fractured segment posteriorly and inferiorly


A
B
C
D

Bilateral fracture in the canine location



Dislocation of the chin part dorsocaudally by the pull of depressors -> **the root of the tongue sinks back to the oropharynx**

Symphyseal and parasymph. fractures

- In the midline of the mandible are classified as symphyseal

- When teeth are present, the fracture line passes between the mandibular central incisors

- fr. not in the midline, are classified as parasymphyseal

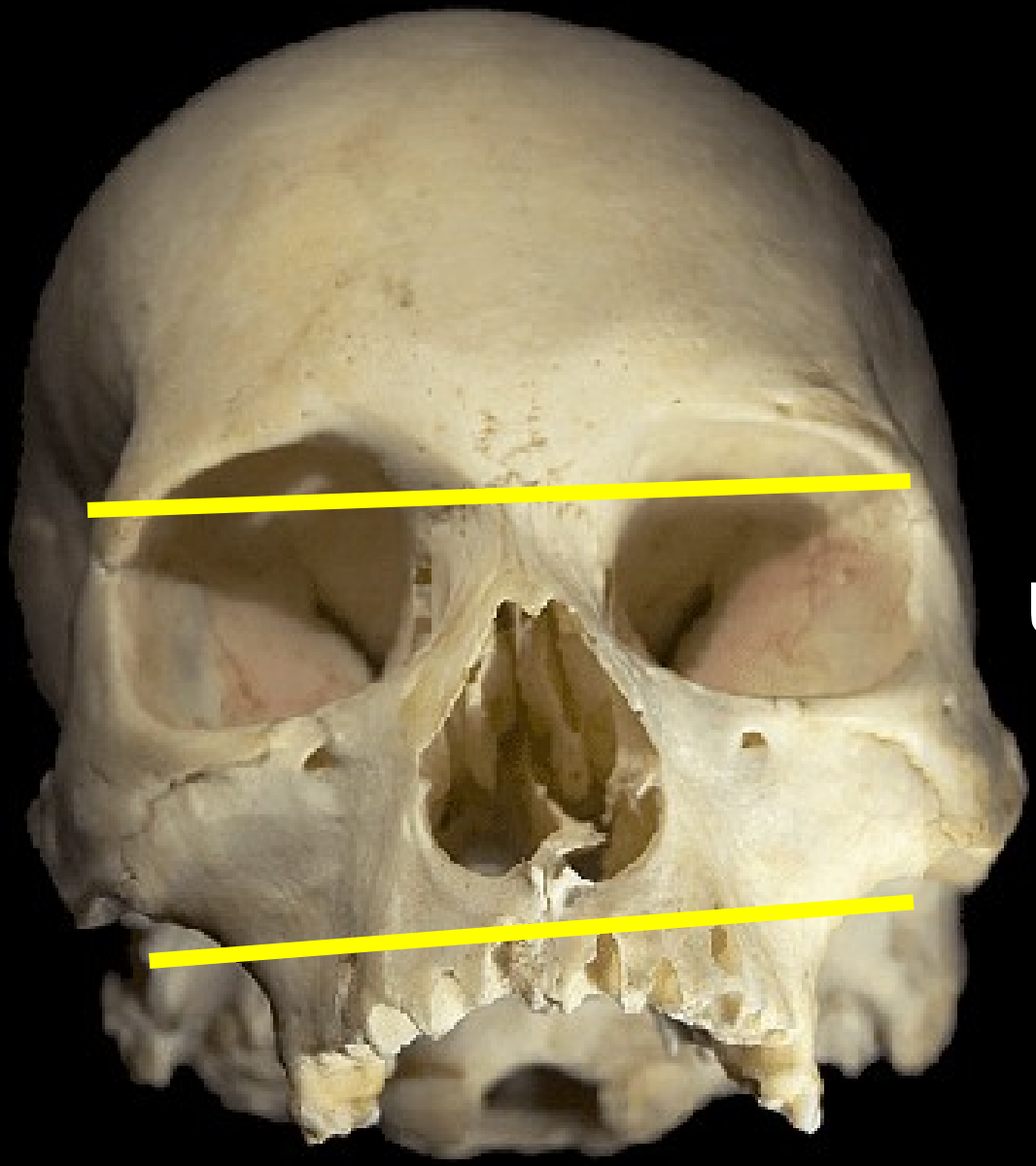
Angle fractures

- Occur in a triangular region between the anterior border of the masseter and the posterosuperior insertion of the masseter, distal to the third molar

- The actions of the masseter, temporalis, and medial pterygoid muscles distract the proximal segment superomedially

Condylar process fractures

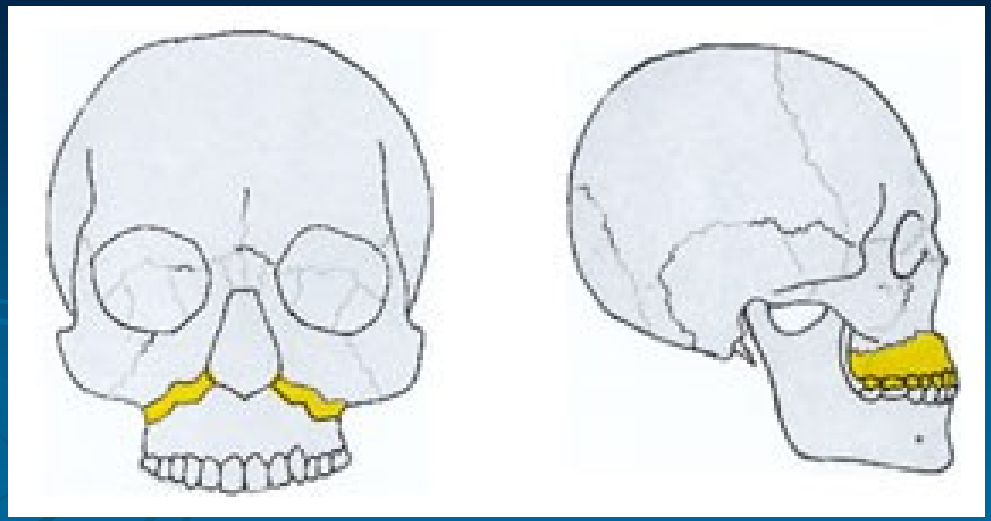
- Classified as extracapsular, intracapsular and subcondylar
- The lateral pterygoid muscle tends to cause anterior and medial displacement of the condylar head

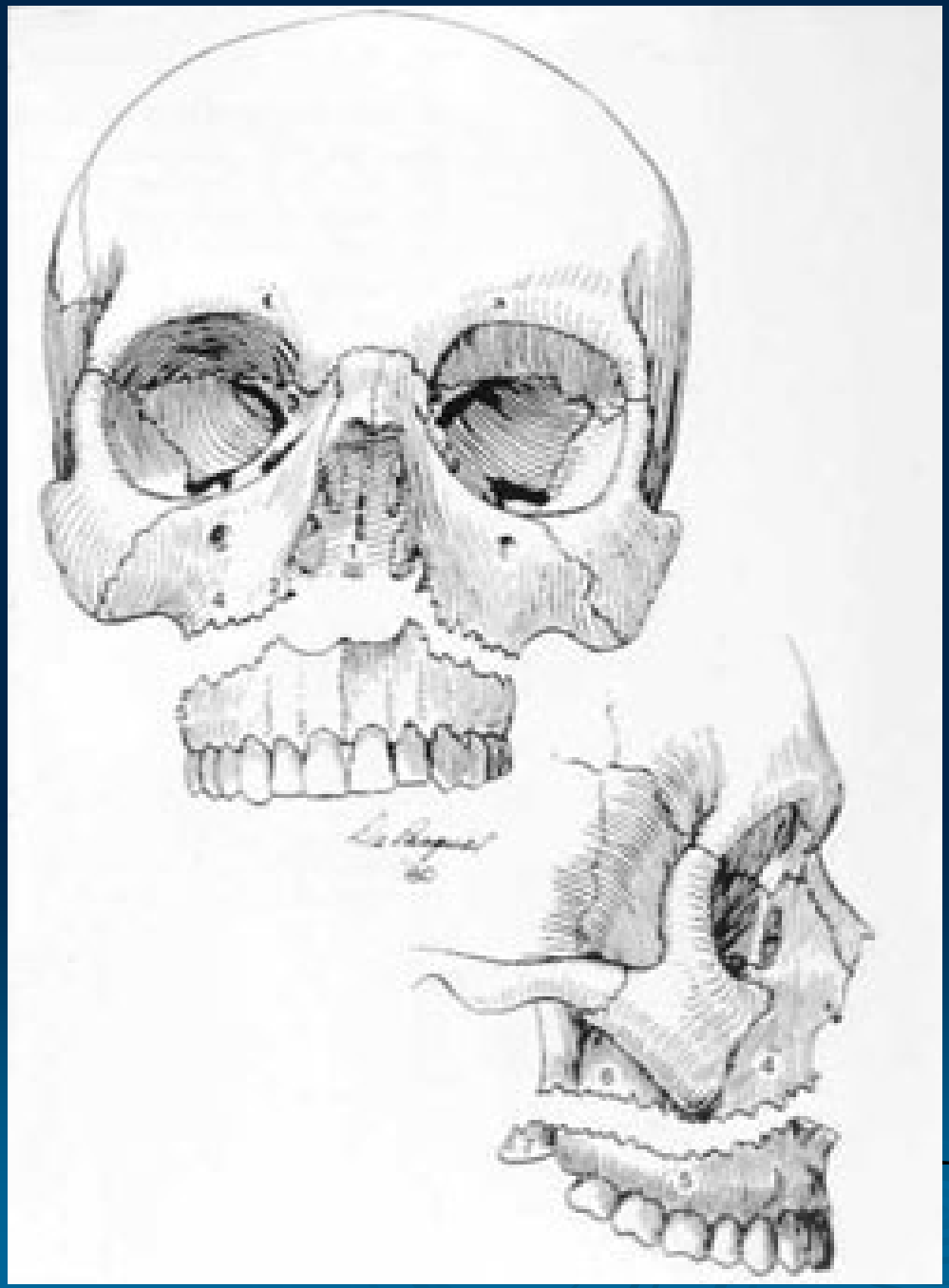

Upper mid-face
Lower mid-face

2. Lower midfacial fracture

Le Fort I or **low horizontal fractures**:

From nasal septum to the lateral pyriform rims -
horizontally above the teeth apices
→ below the zygomaticomaxillary junction,
and traverses the pterygomaxillary junction
to interrupt the pterygoid plates





3. Upper midfacial fracture

a) Naso-orbitoethmoid Fractures

b) Zygomaticomaxillary Complex

c) Orbital fractures

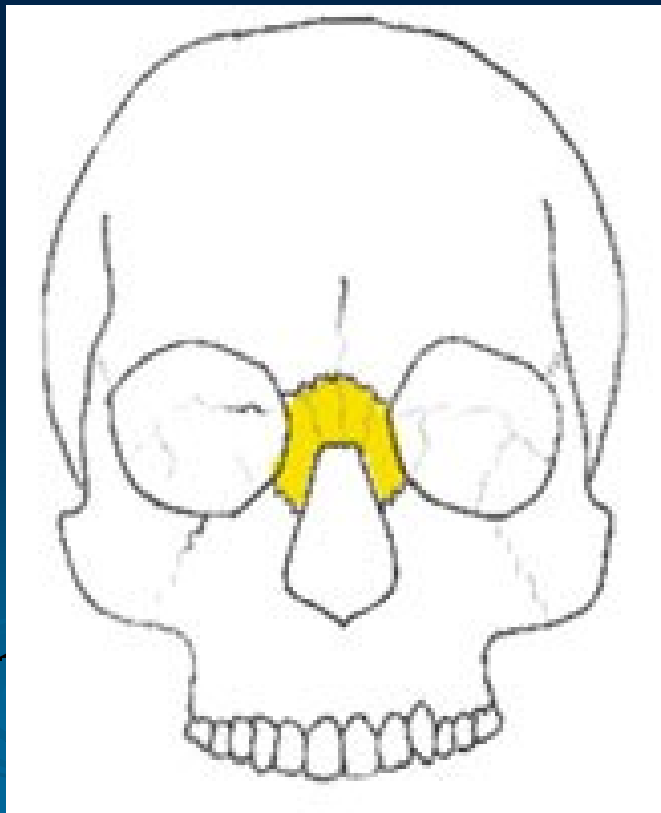
d) Le Fort II

e) Le Fort III

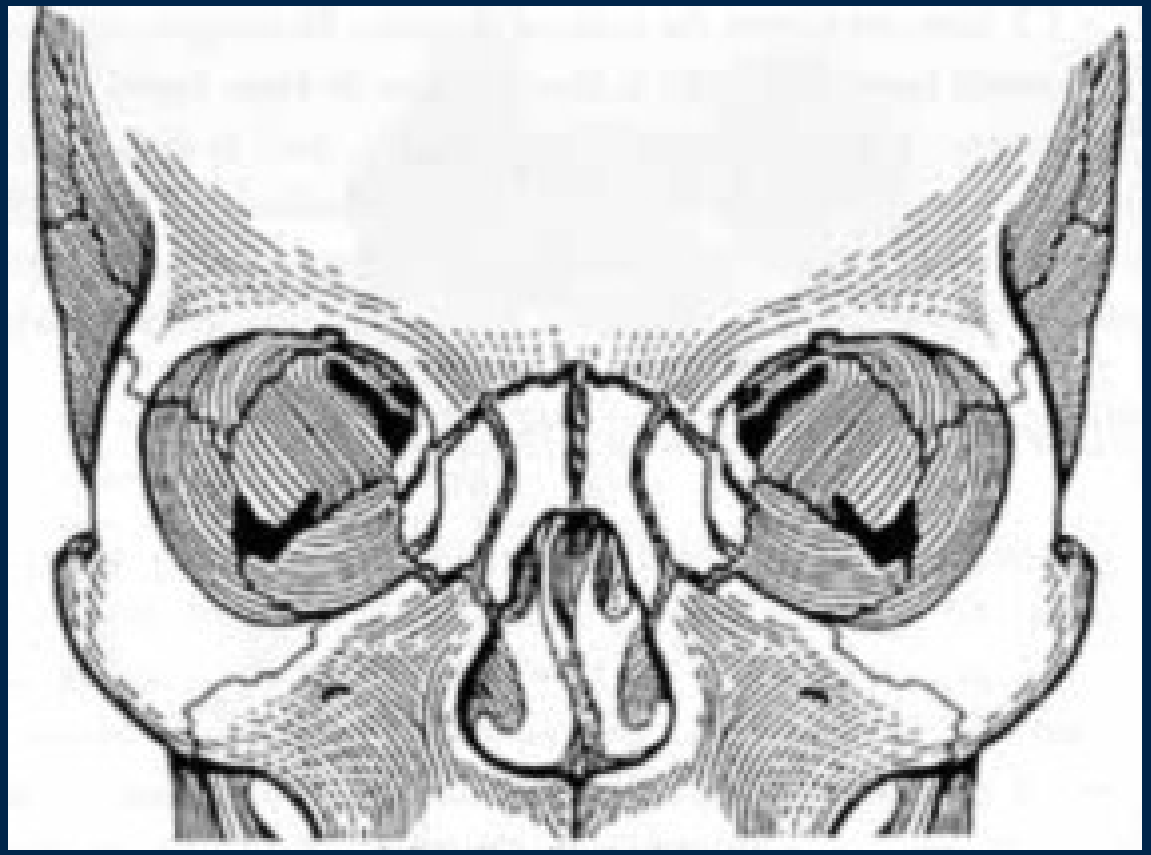
a) Naso-orbitoethmoid Fractures

- The NOE complex represents a bony fractures that separate the nasal, orbital, and cranial cavities (the nasal, frontal, maxillary, ethmoid, lacrimal, and sphenoid bones)

- If there is bilateral comminution and displacement, the nasofrontal ducts are disrupted - predisposes the patient to future mucocele formation



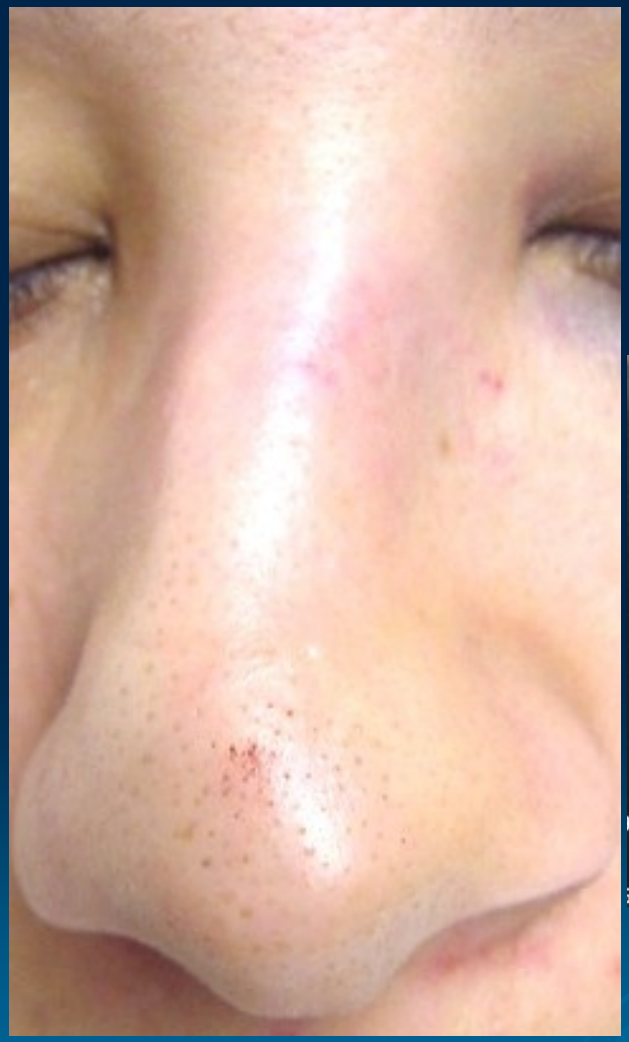
- If the fracture segments are displaced, nasal bones and frontal process of the maxilla may be telescoped posteriorly beneath the frontal bone

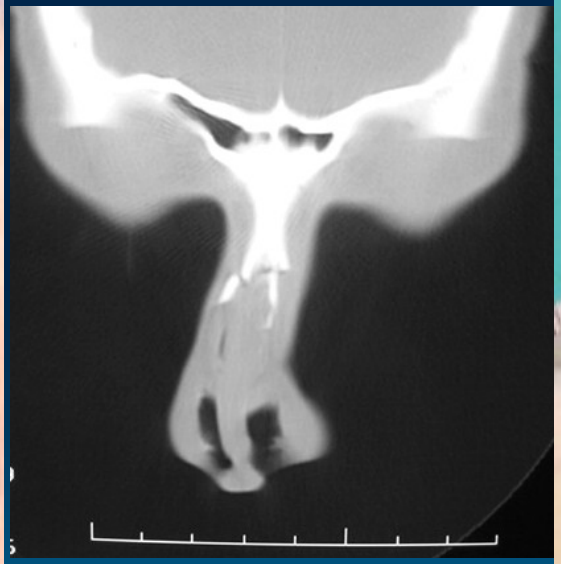


- In patients with comminution, the bony segments may spread medially into the nasal cavity, superiorly to the anterior cranial fossa, and laterally into the orbit

Damage of the angulus med. dx.
-> enlargement of the interorbital distance
= telecanthus

Isolated fractures of nasal bones



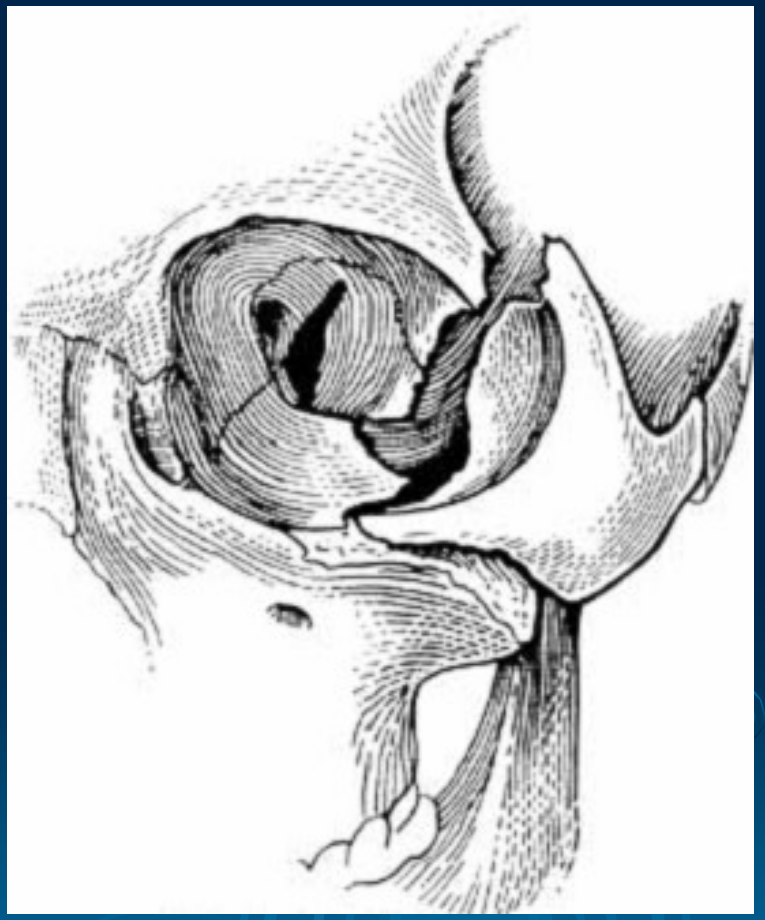


b) Zygomaticomaxillary Complex

- Fracture lines usually run through the infraorbital rim, involve the posterolateral orbit, and extend to the inferior orbital fissure

- The fracture line then continues to the zygomatic sphenoid suture area and on to the frontozygomatic suture line

- All zygomatic complex fractures involve the orbit, making visual complications a frequent occurrence



c) Orbital Fractures

The fractures of orbital skeleton include blow-out (hydraulic) fr.

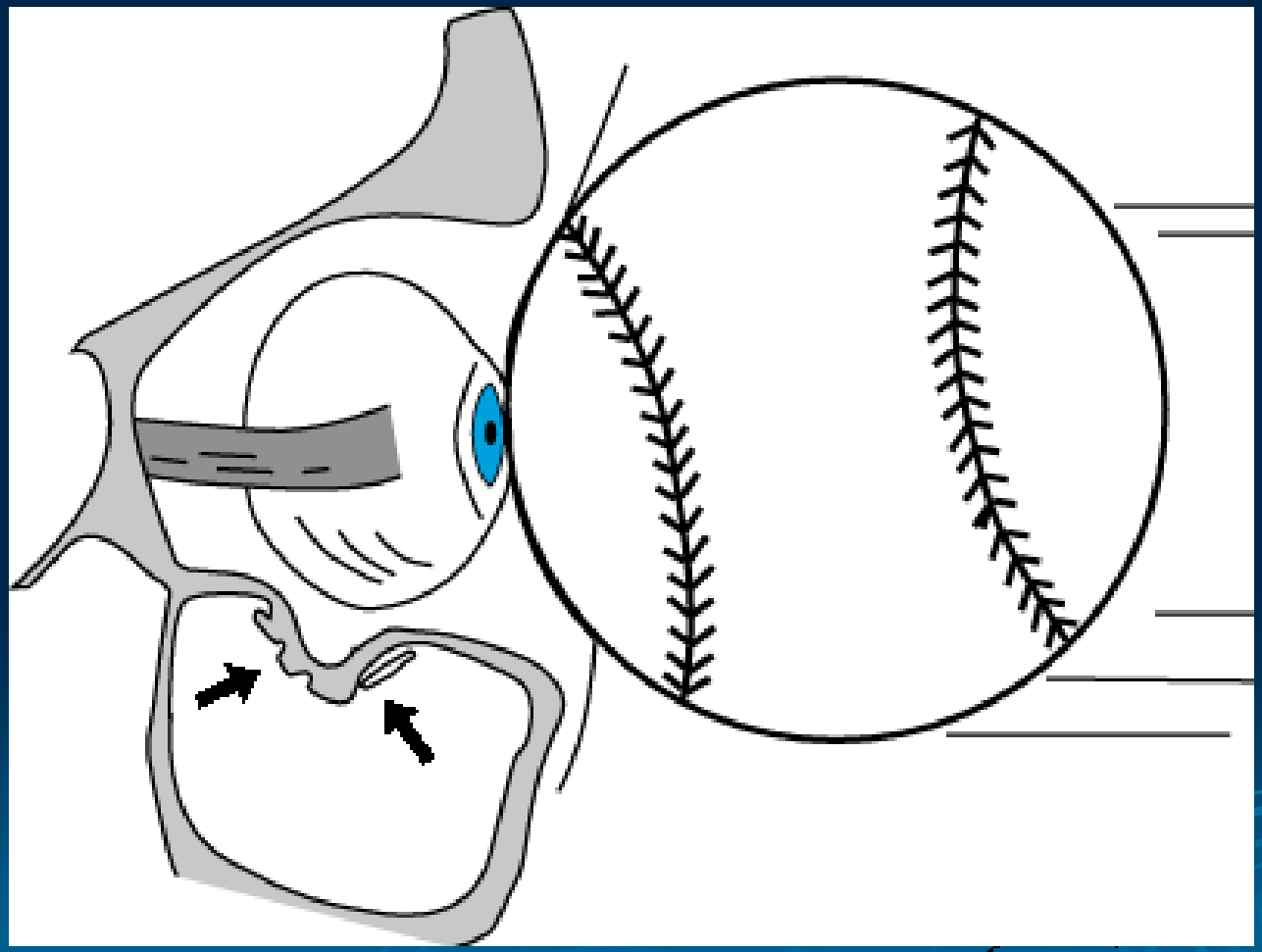
Fractures associated with other fractures of the facial skeleton (zygomaticomaxillary, naso-orbito-ethmoid, frontal-sinus, Le Fort II, and Le Fort III fracture)

Orbital apex fractures - associated with damage to the neurovascular structures of the superior orbital fissure and optic canal

SYMPTOMS:

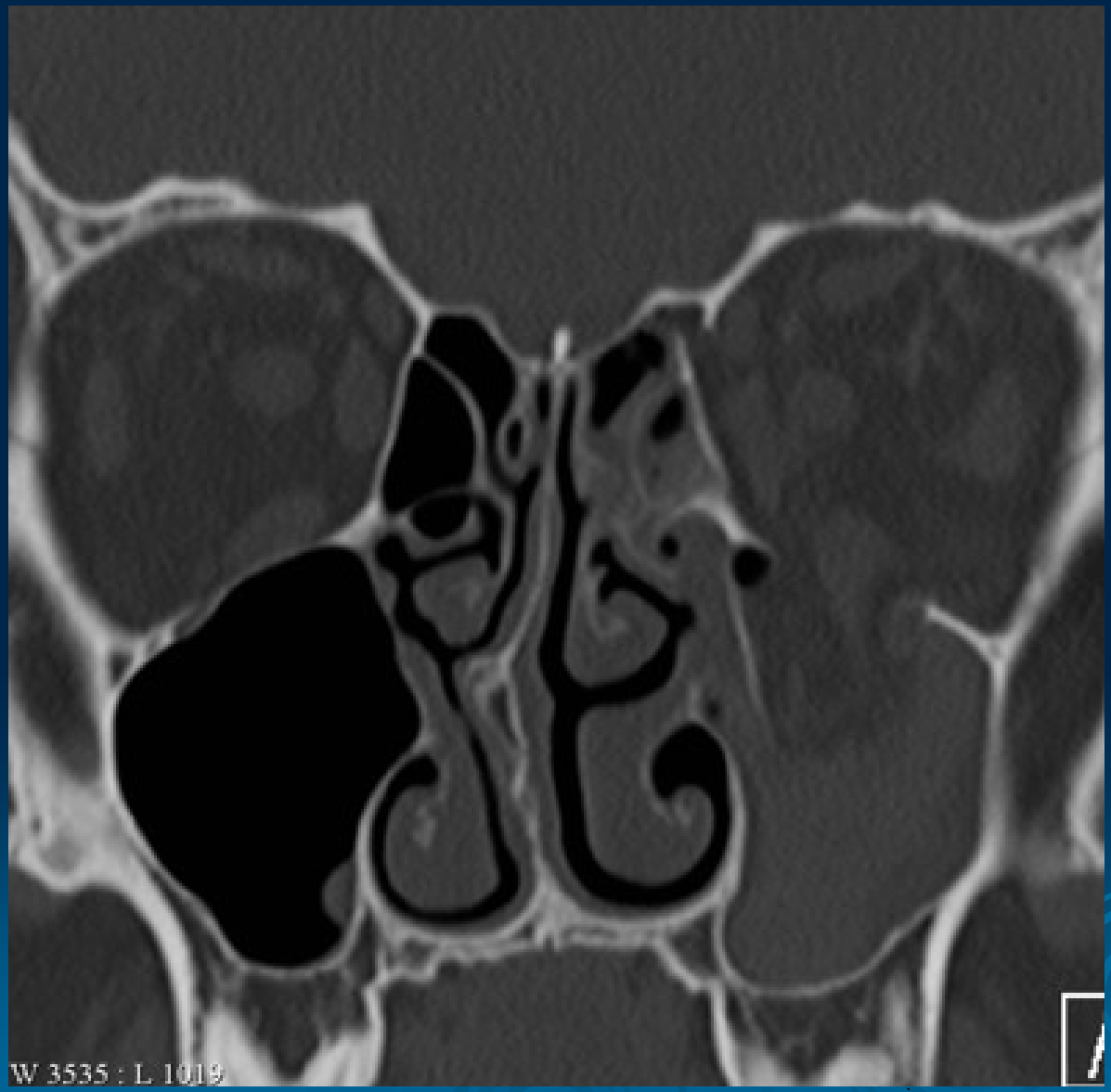
- Periocular ecchymosis and oedema
- The position of the globe should be assessed
- Enophthalmos is rarely evident in the first days after injury because of edema of the orbital tissues
- A degree of proptosis is evident early
- Hypoglobus may be seen with severe floor disruption with a subperiosteal hematoma of the roof
- Epistaxis, cerebrospinal fluid leakage, lacrimal drainage problems
- Diplopia

Isolated **blow- out** (hydraulic) orbit fr.



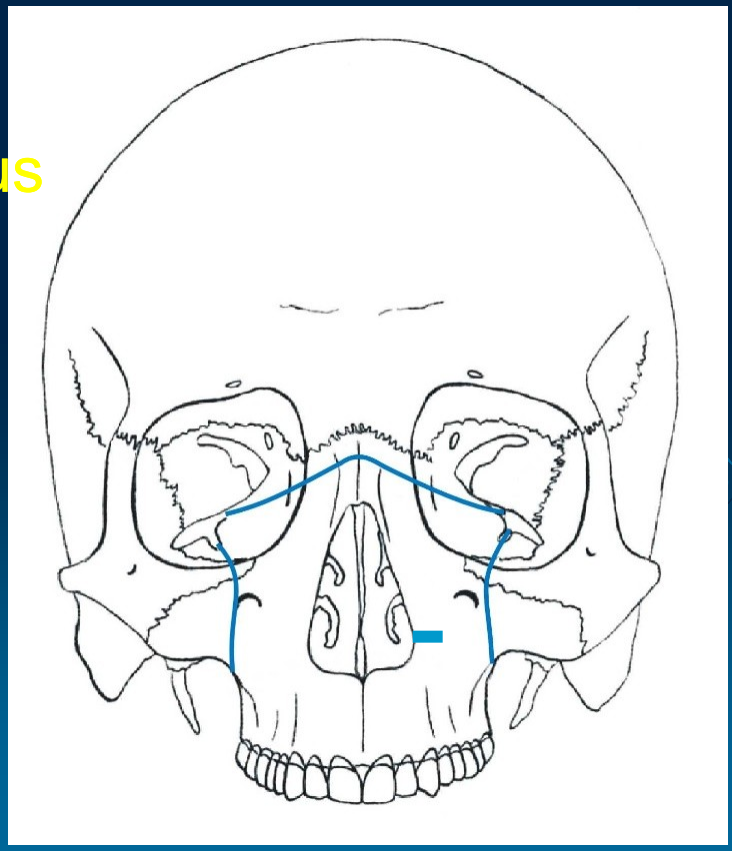
CT

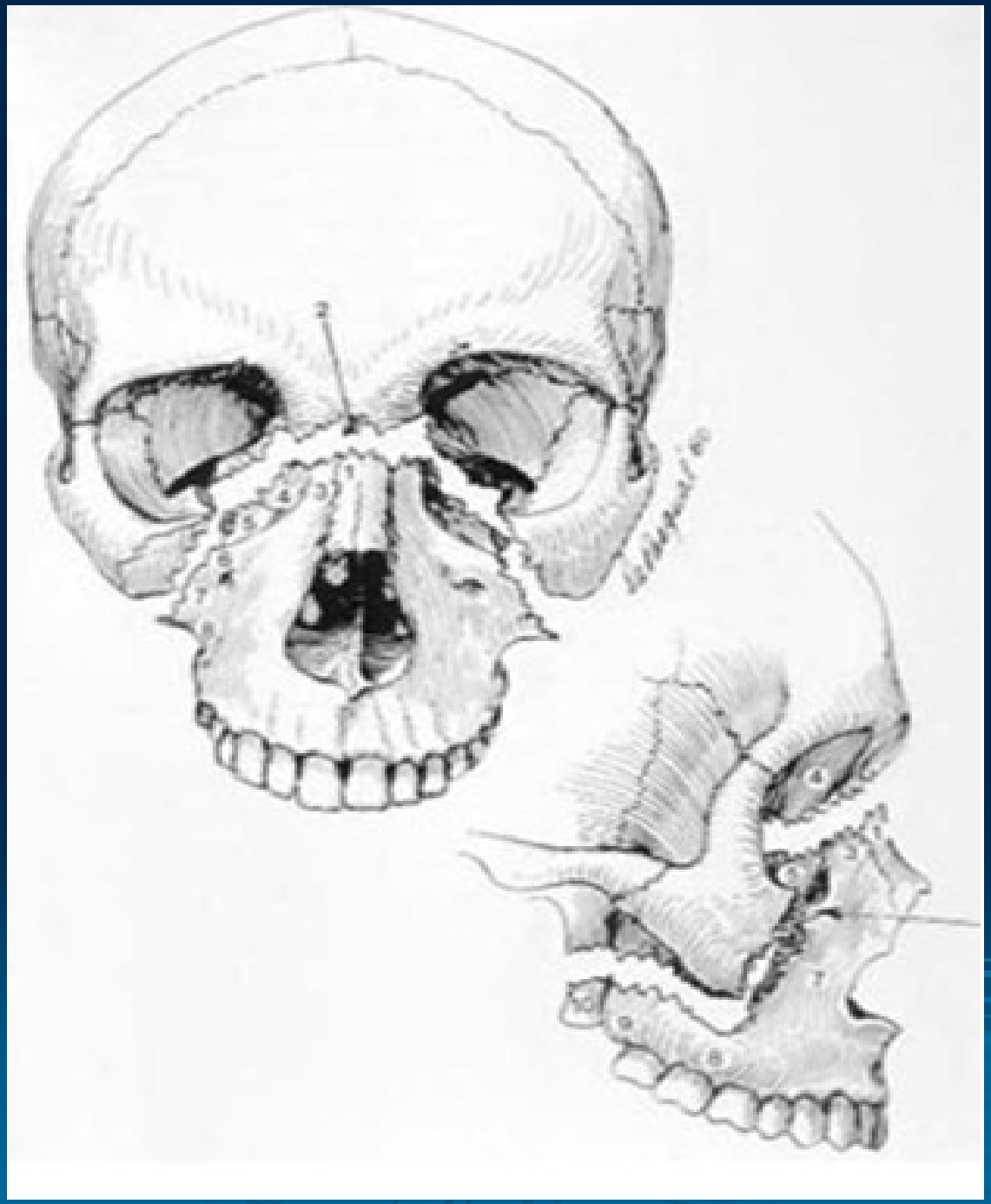
Blow-out orbital fracture



d) Le Fort II fractures (pyramidal)

below the nasofrontal suture
→ the frontal processes of the maxilla
→ the lacrimal bones and inferior orbital floor and rim
→ the inferior orbital foramen
→ the anterior wall of the maxillary sinus
→ the pterygomaxillary fissure
→ the pterygoid plates

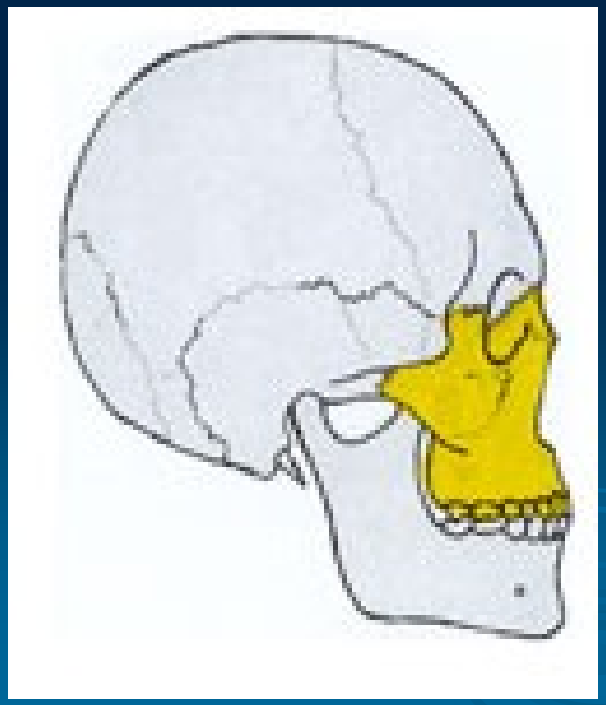


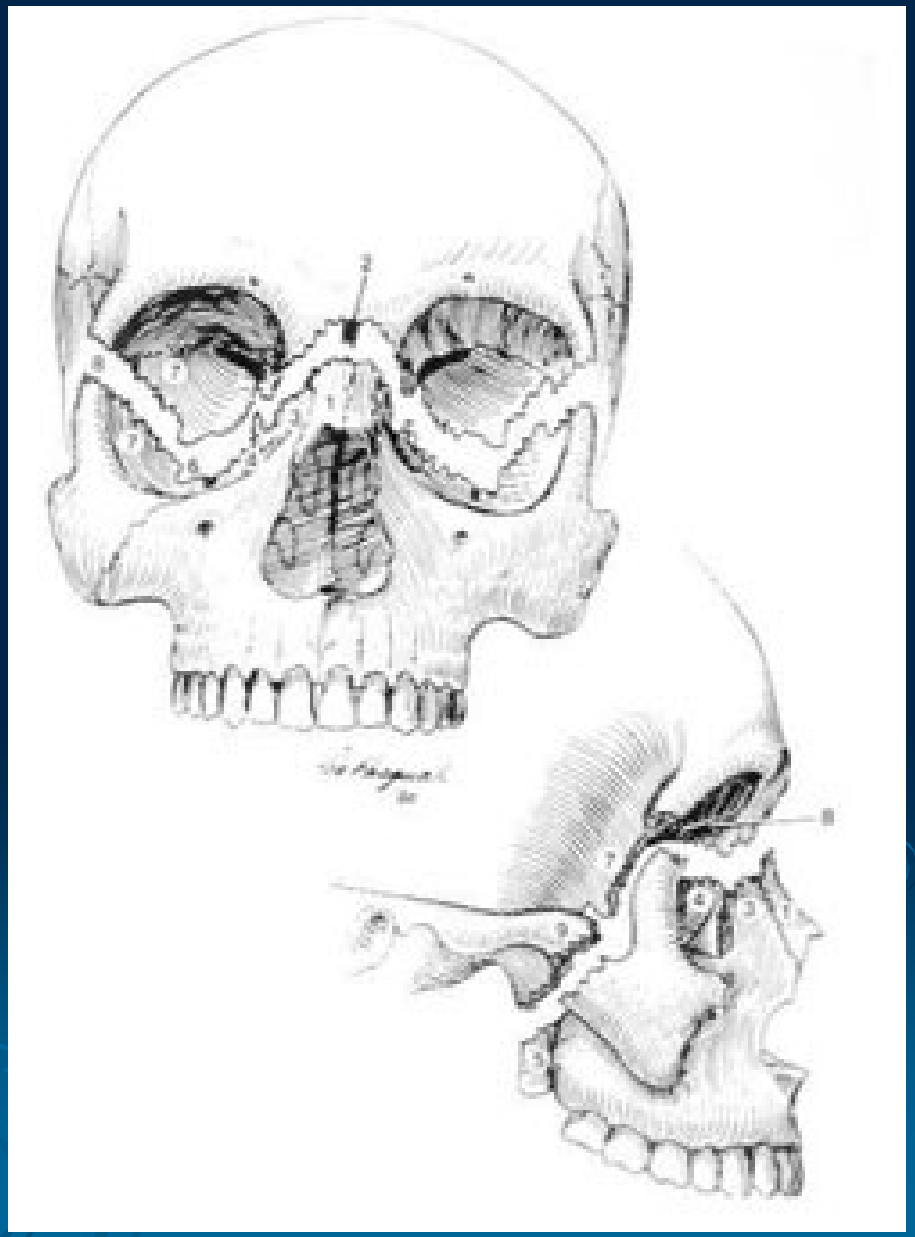


e) Le Fort III fractures (transverse)

The nasofrontal and frontomaxillary sutures
→ along the medial wall of the orbit
→ through nasolacrimal groove and ethmoid bones
→ along the floor of the orbit
→ along the inferior orbital fissure
→ through the lateral orbital wall, zygomaticofrontal junction and the zygomatic arch

Intranasally: through the base of the perpendicular plate of the ethmoid, through the vomer, and through the interface of the pterygoid plates to the base of the sphenoid





Classification of midfacial fractures.

Central fractures

- Fracture of the alveolar process
- Transverse fracture with horizontal separation of the nasal floor and maxillary sinus (LeFort type I or Guerin fracture)
- Transverse fracture with separation of the entire maxillary (LeFort type II or Wassmund types I and II)
- Sagittal fracture (median and paramedian)
- Fractures of the nasal skeleton (naso-maxillary and naso-ethmoidal complex)
- Mixed fractures

Centro-lateral fractures

- Transverse fractures characterised by complete separation of the facial skeleton and the malar from the skull base (LeFort type II or Wassmund types III and IV)

Lateral fractures

- Fractures of the zygomatic-orbital-maxillary complex
- Isolated orbital walls and floor fractures (blow-out)

In clininical access we distinguish:

1. fractures with traumatic changes of **occlusion**
   (fr. of alveolar proces maxillae;
   Le Fort I, II, III; …)

2. fr. without traumatic changes of **occlusion**
   (isolated fr. of nasal bones, nasal setum fr.,
   blow out fr., …)

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