CT Facial Trauma Made Easy (ish)

Gary Holdsworth – Clinical Specialist Radiographer (Neuro CT) – Mid Yorkshire Hospitals NHST.

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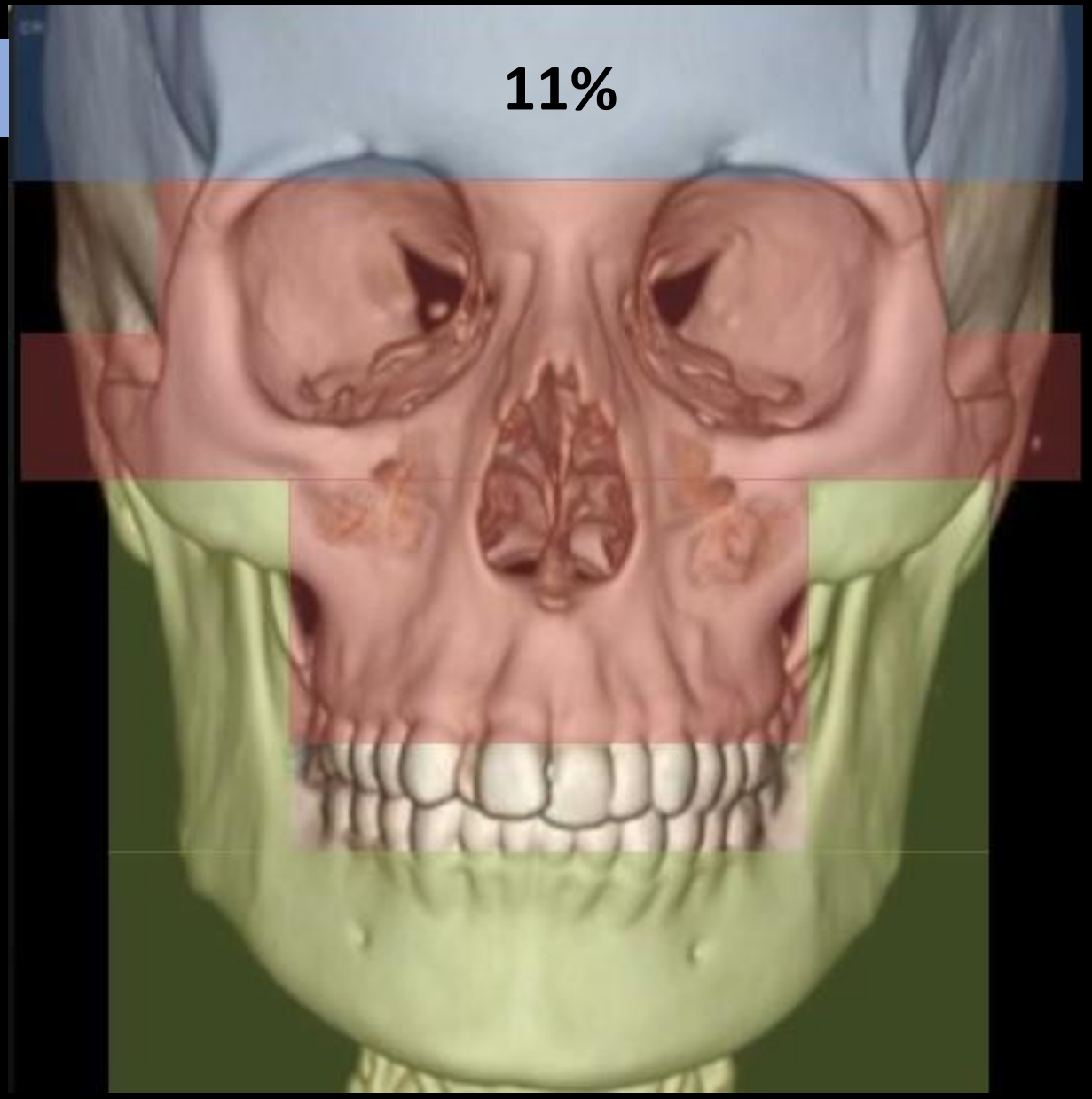
Right 28%, Left 36%, Midline 36%
Bilateral fractures 19%
One fracture pattern 52%
Panfacial injury 1%

Mundinger et al. J Craniomaxillofac Surg 2014 (n=8127)

Facial Fractures

Upper Face: frontal, superior orbit



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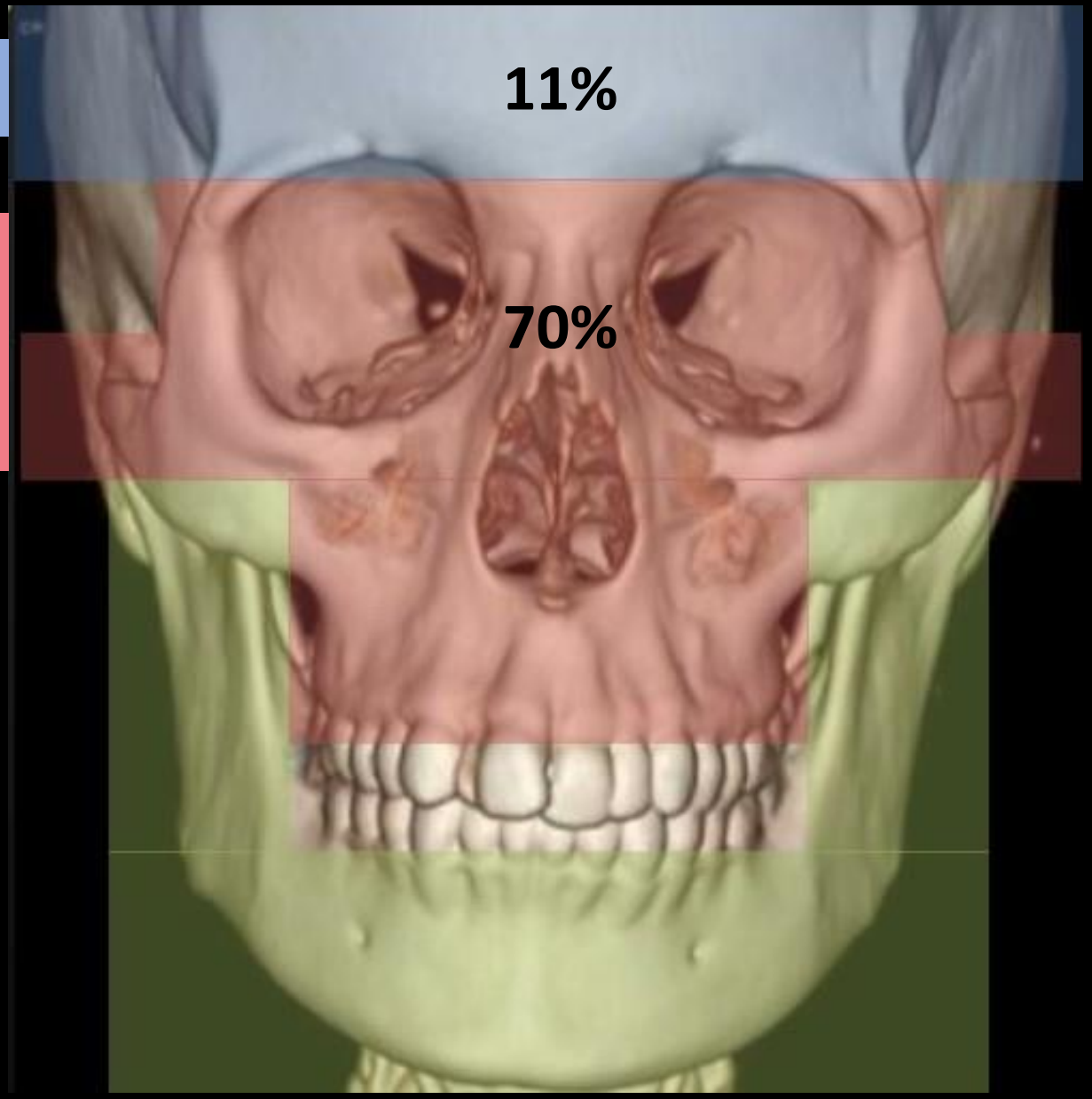
Facial Fractures

Upper Face: frontal, superior orbit

Mid Face: rest of orbit, nasal, zygoma, Le Fort, maxillary sinus, dentoalveolar, NOE, ZMC



Mundinger et al. J Craniomaxillofac Surg 2014

Facial Fractures

Upper Face: frontal, superior orbit

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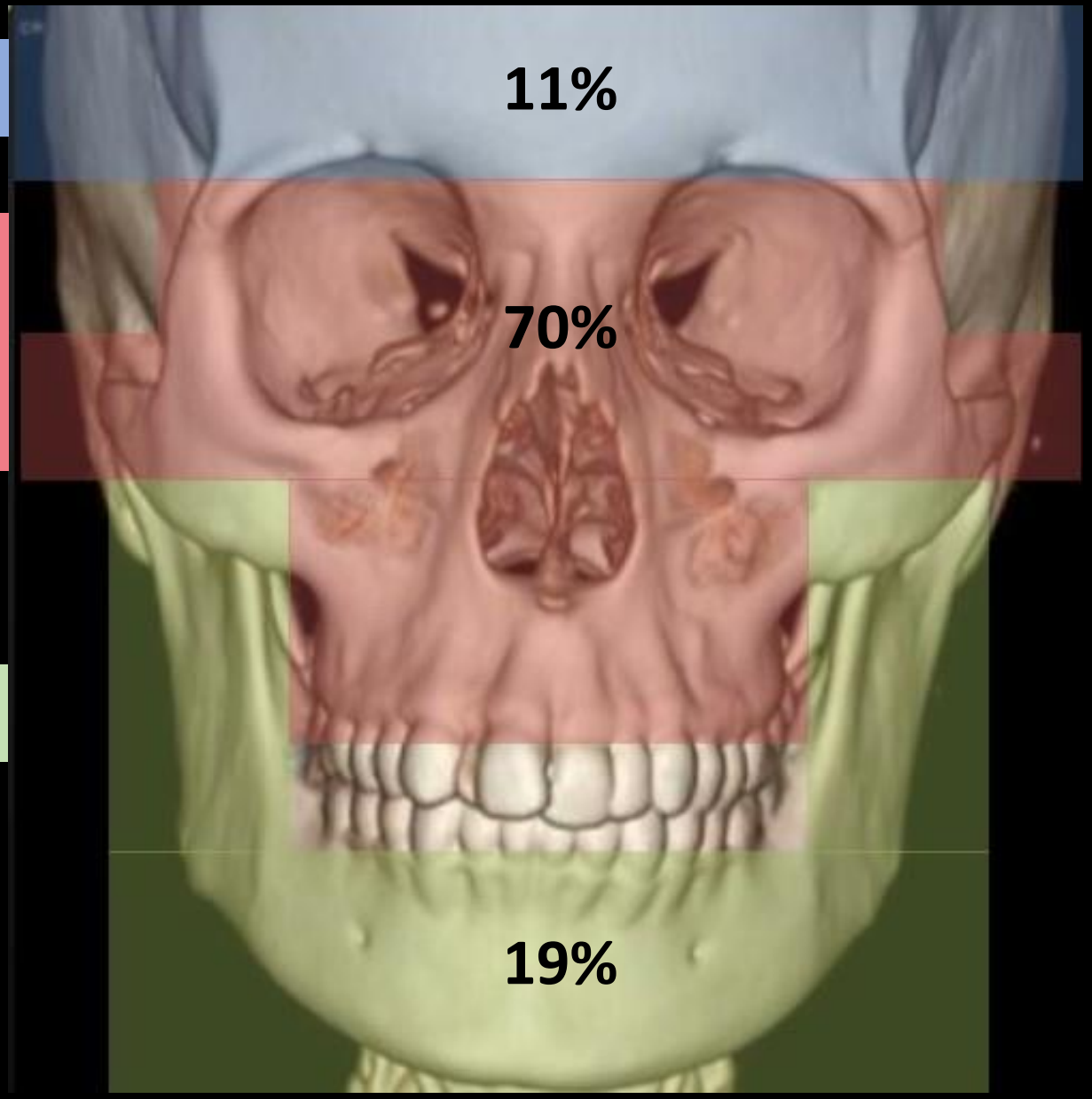
Lower Face: mandible

Mundinger et al. J Craniomaxillofac Surg 2014



Plain x-rays are relatively insensitive to facial fractures.

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CT = Gold Standard: Detection of soft-tissue and bony injuries; characterisation of soft-tissue and bony injuries; surgical planning.

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With the high definition of CT even small fractures of the facial skeleton can be visualized. In complex midface injuries, it can be difficult to know which fractures are important to point out to the surgeon.

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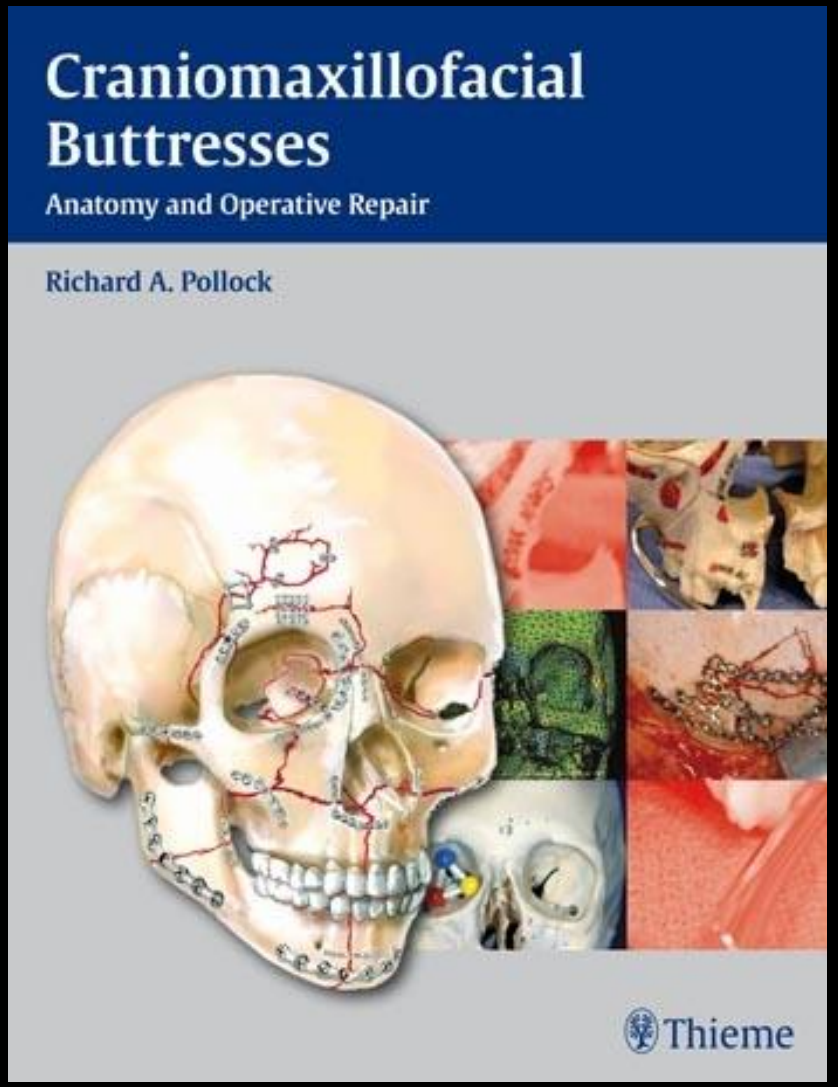
With the high definition of CT even small fractures of the facial skeleton can be visualized. In complex midface injuries, it can be difficult to know which fractures are important to point out to the surgeon.

An understanding of the anatomically relevant and surgically accessible craniofacial buttresses is critical for management of these injuries.

Mundinger et al. J Craniomaxillofac Surg 2014 (n=8127)

The "facial buttress" concept elucidates the structurally meaningful skeletal struts that play a role in facial form and function and helps identify the regions that are likely to require surgical reconstruction (it does not replace traditional anatomic terms)



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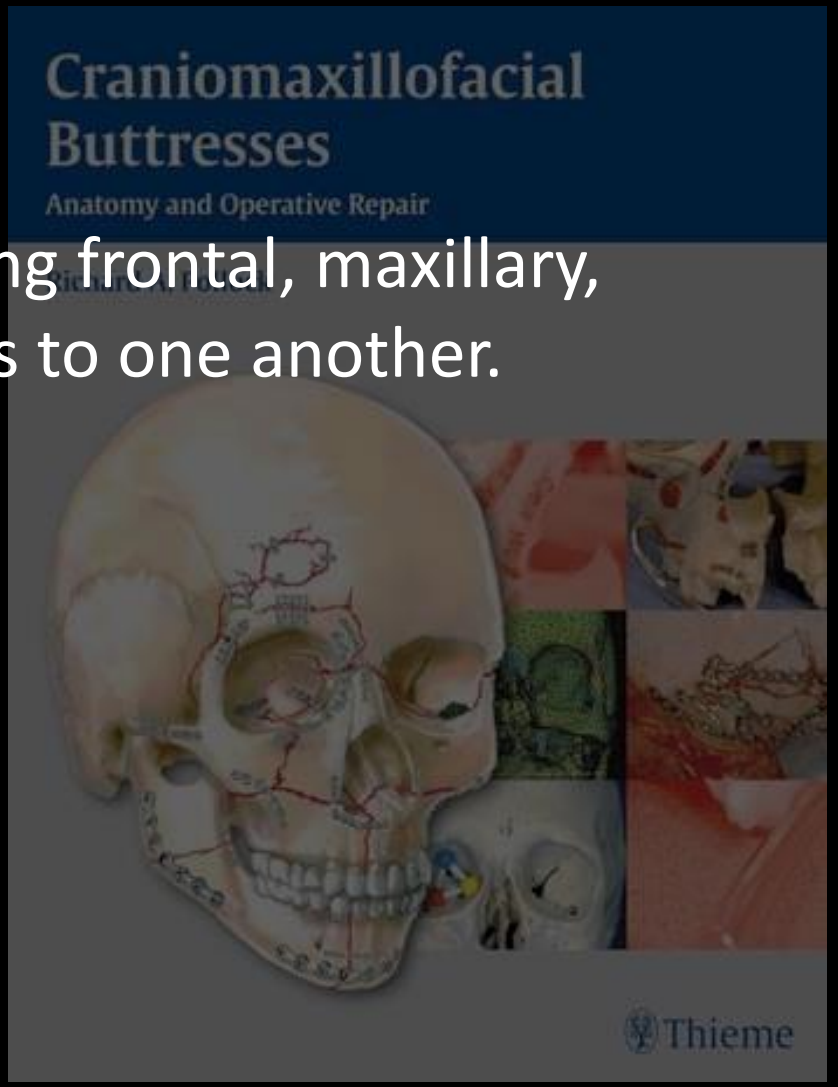
The buttress system of the midface is formed by strong frontal, maxillary, zygomatic and sphenoid bones and their attachments to one another.



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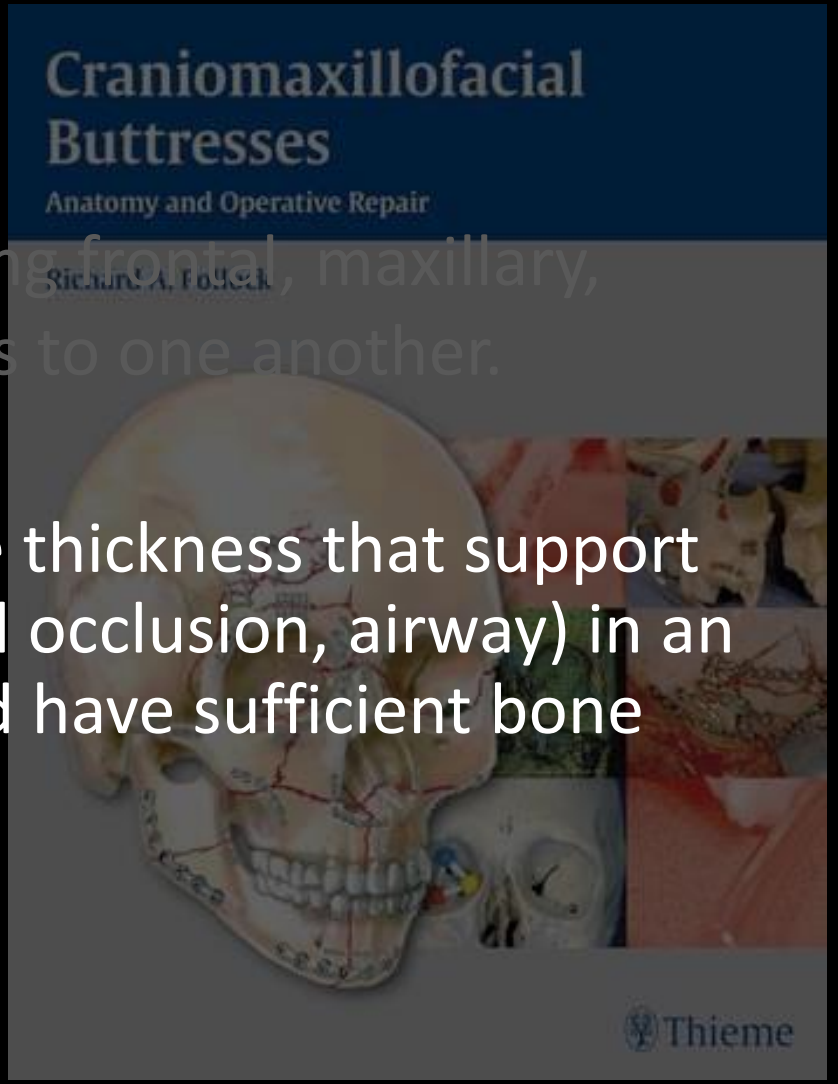
Buttresses represent areas of relative increased bone thickness that support the functional units of the face (muscles, eyes, dental occlusion, airway) in an optimal relation; they define the form of the face and have sufficient bone thickness to accommodate metal screw fixation.



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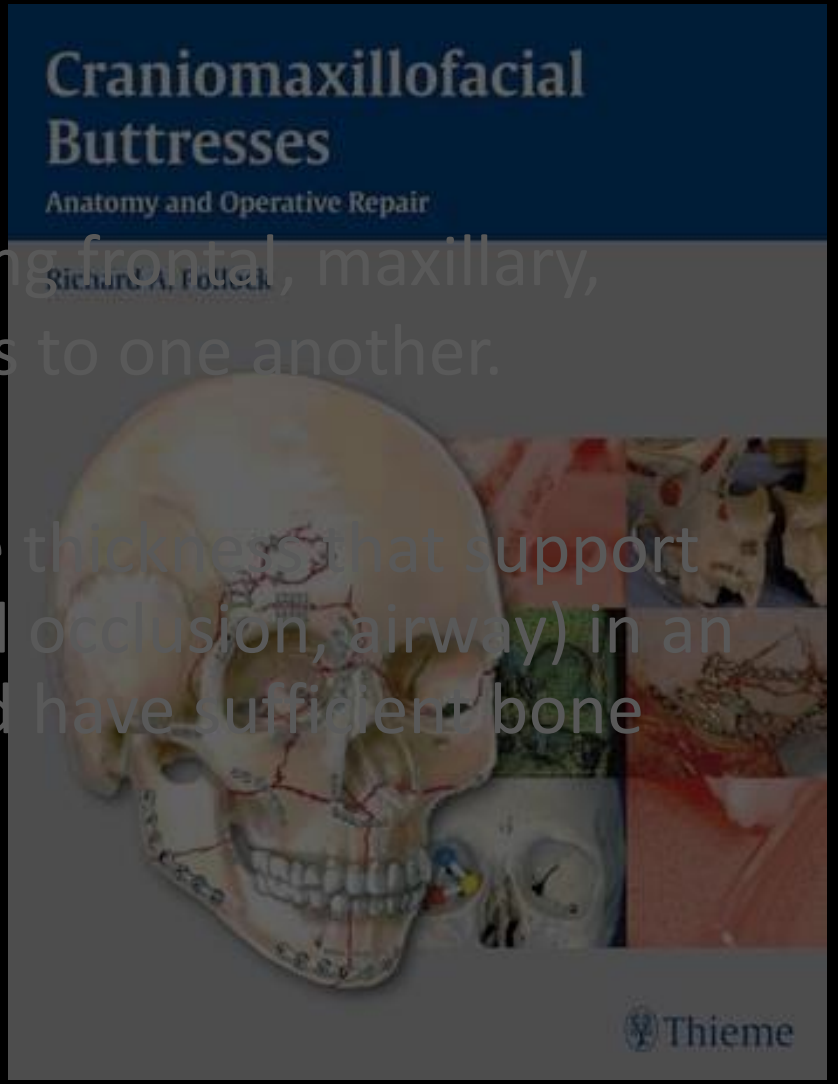
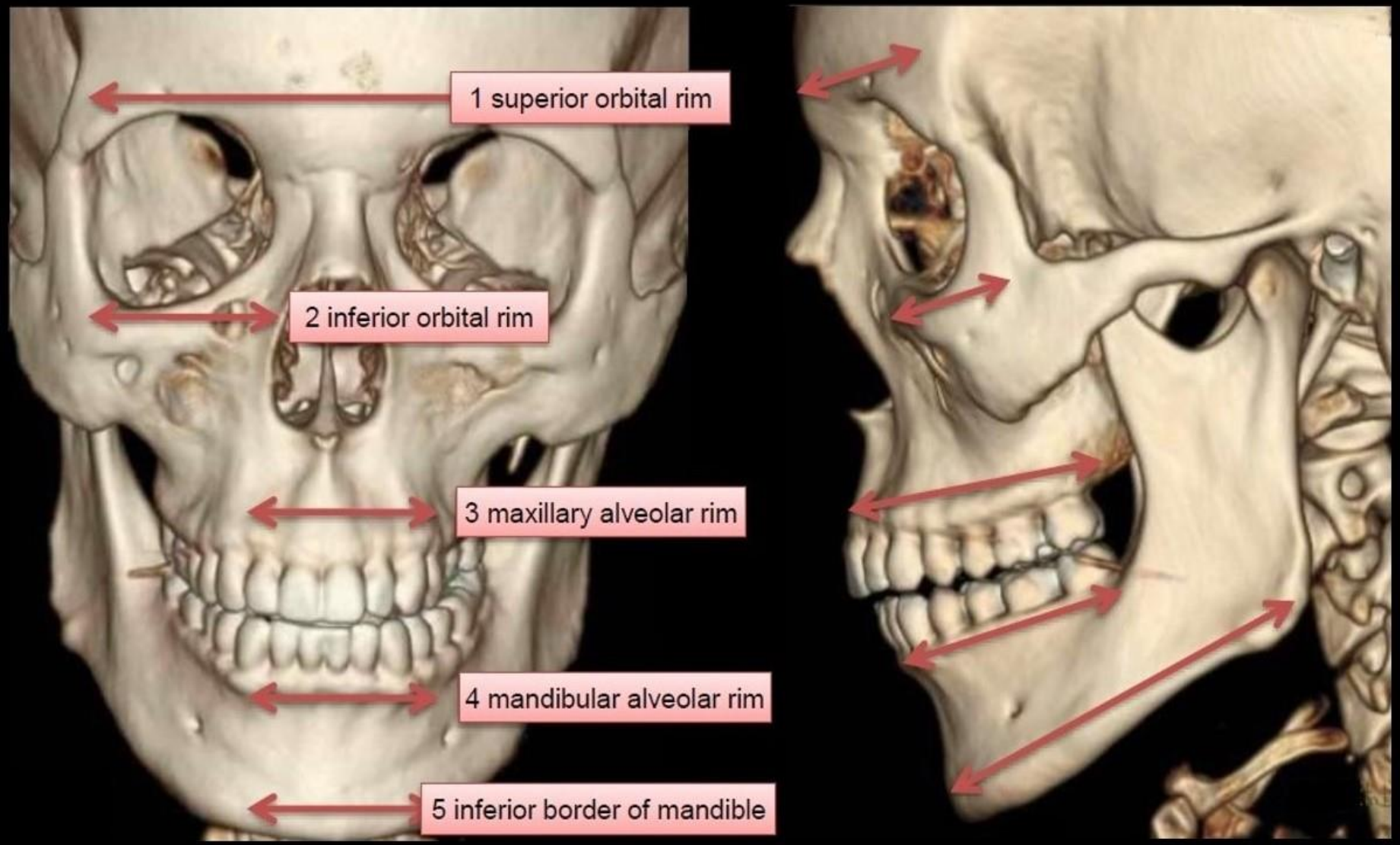
4 Vertical Buttresses (3 face; 1 mandible)
5* Horizontal Buttresses (3 face; 2 mandible)



The vertical facial buttresses

The horizontal facial buttresses



IMPORTANT!

Do not get distracted by facial injuries when reporting cranial trauma:

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Airway OK?

Focus upon Brain & Skull first.

Check craniocervical junction.

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Focus upon Brain & Skull first.

Check craniocervical junction.

Then move to the face …

CT **‘Clear Sinus Sign’**: “Absence of paranasal sinus fluid after facial trauma is a highly reliable criterion to exclude acute fractures involving the paranasal sinus walls”

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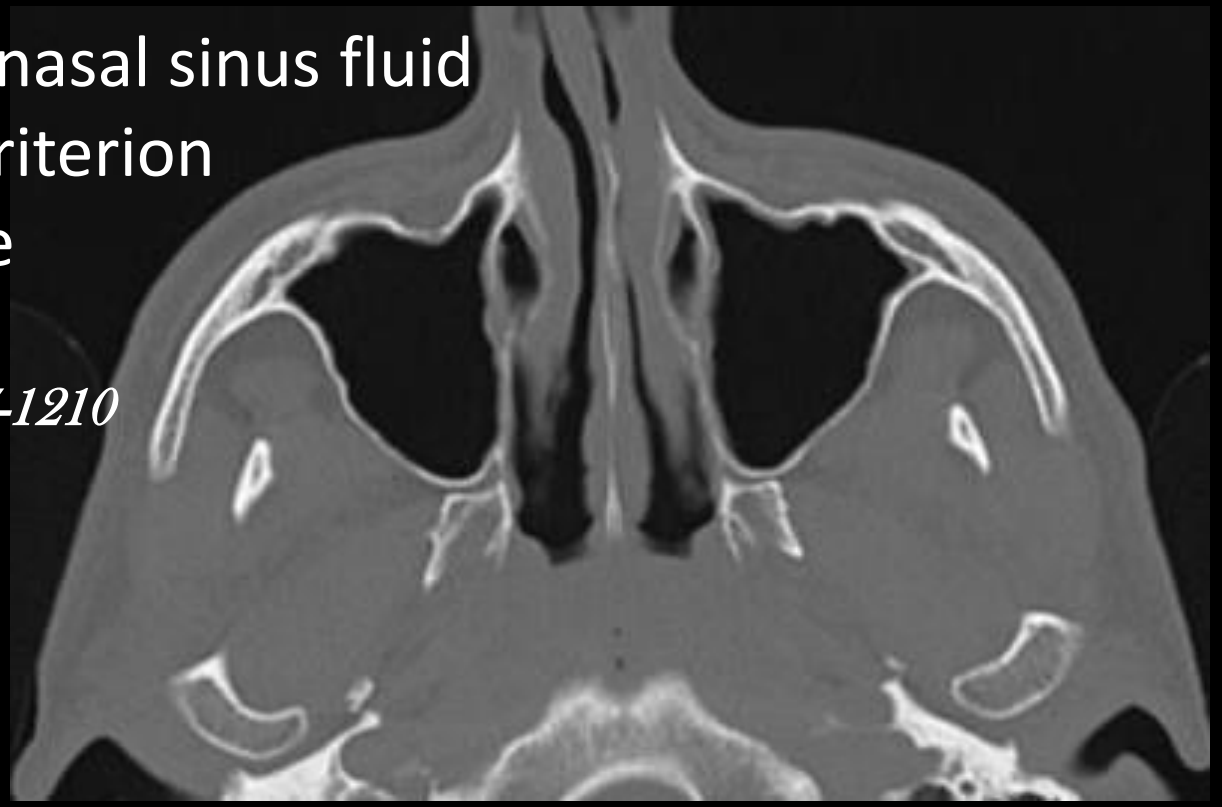

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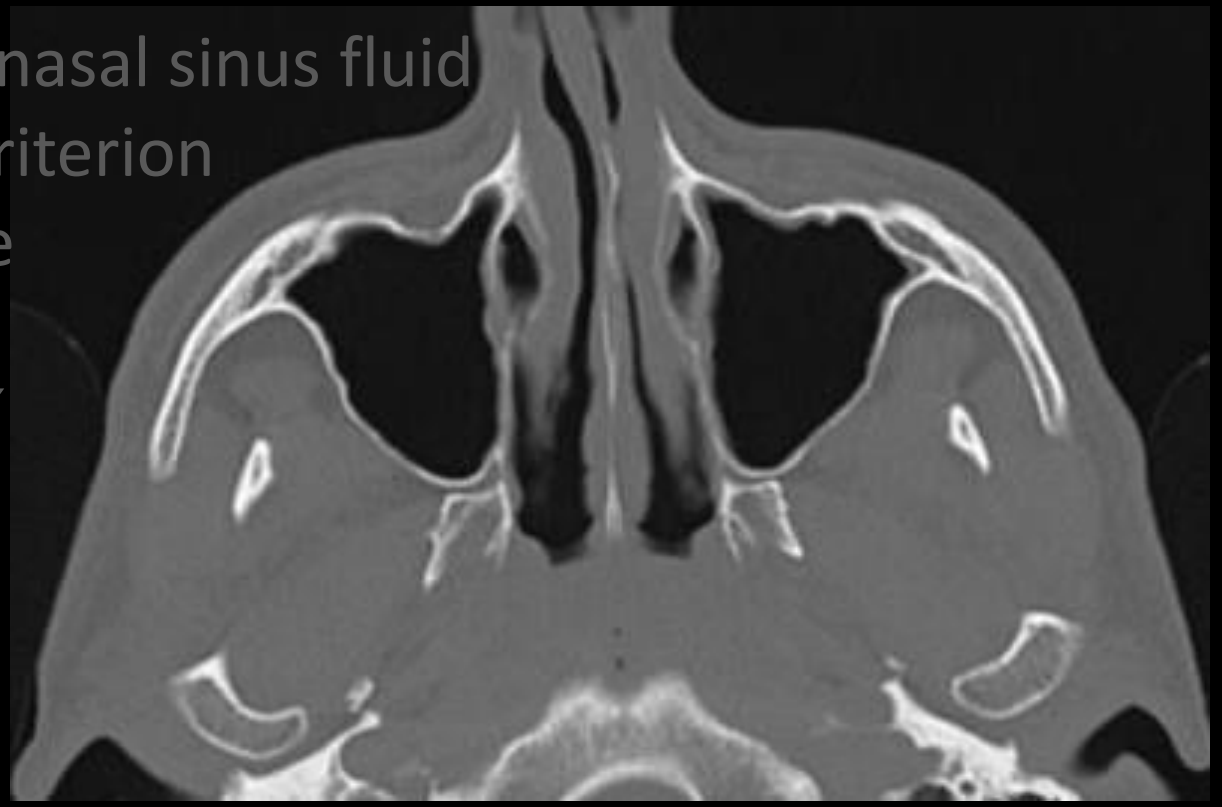

Critical Facial Injuries.

Airway compromise:

Flail Mandible

Nasal septal haematoma

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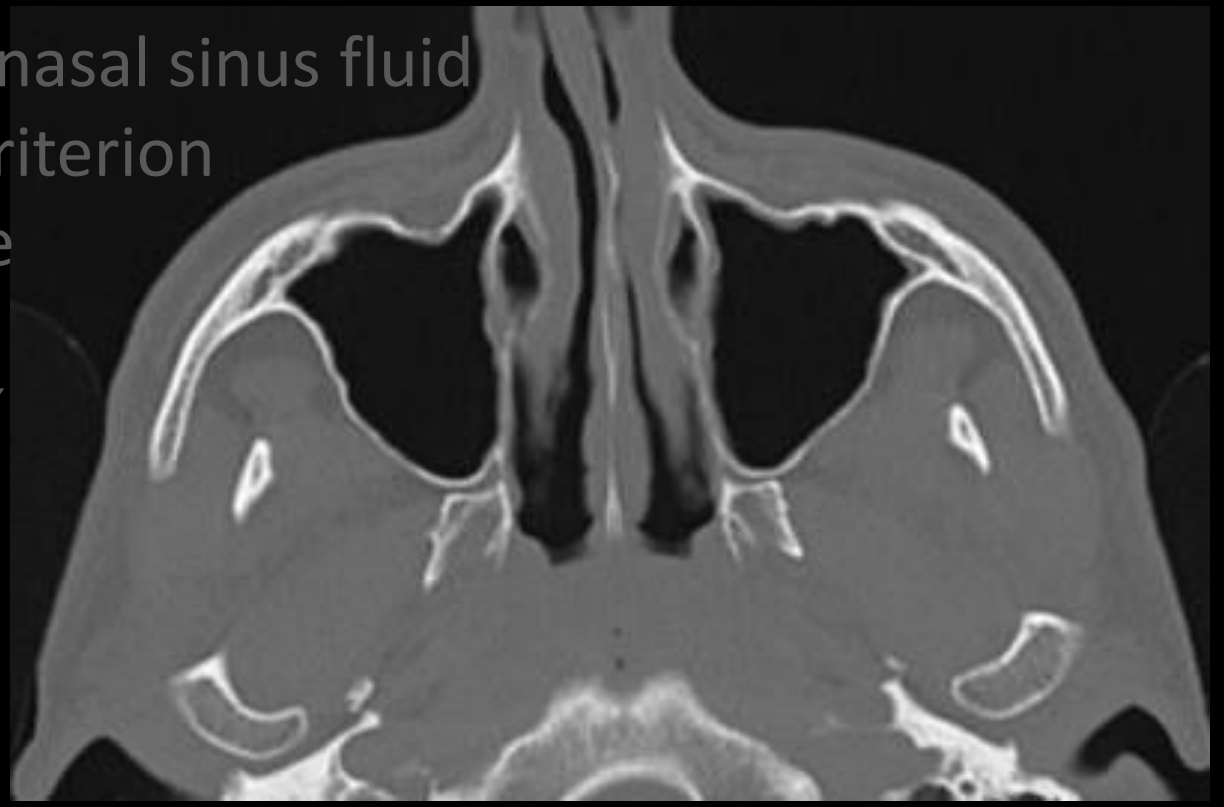
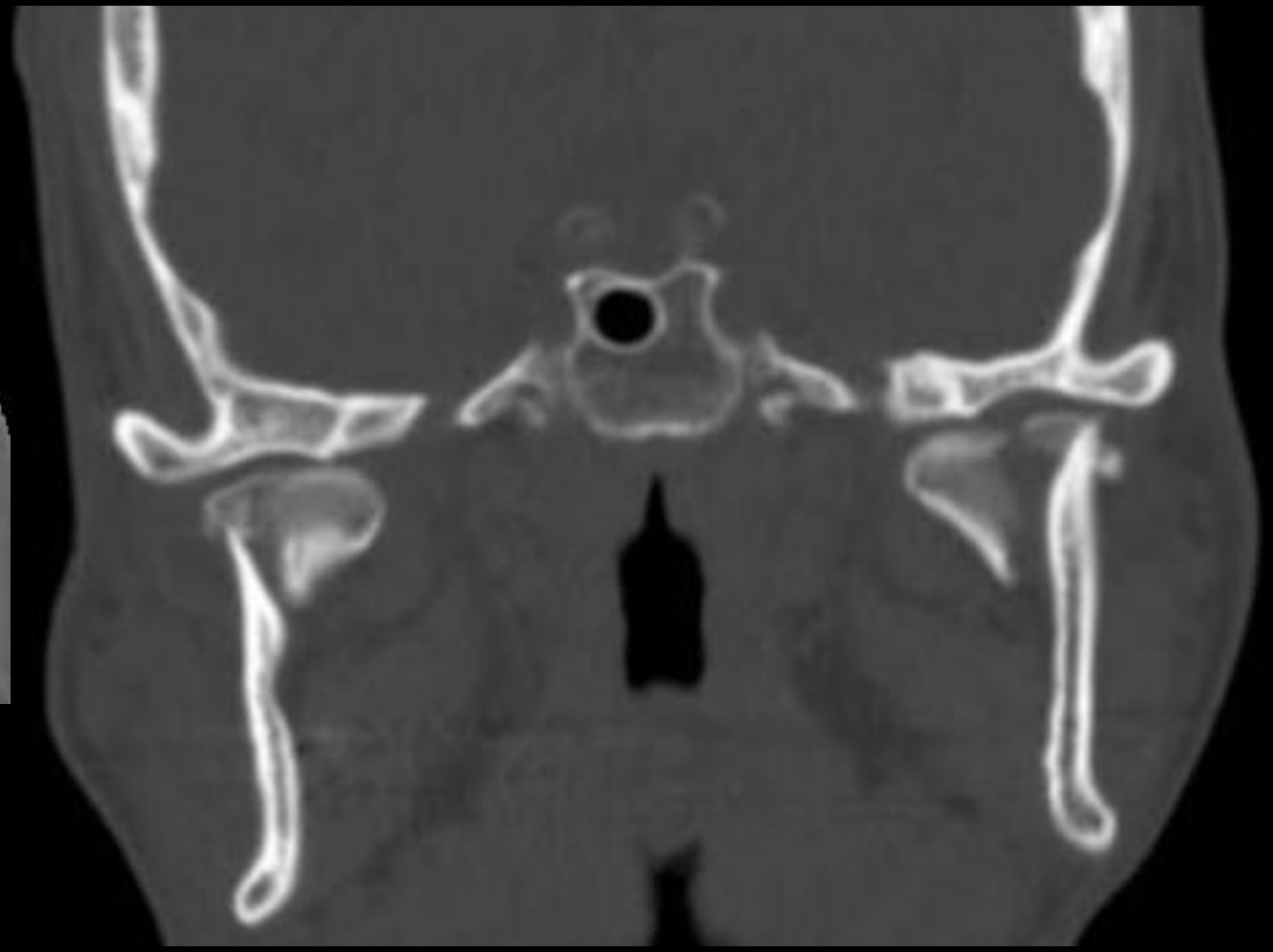


Critical Facial Injuries.

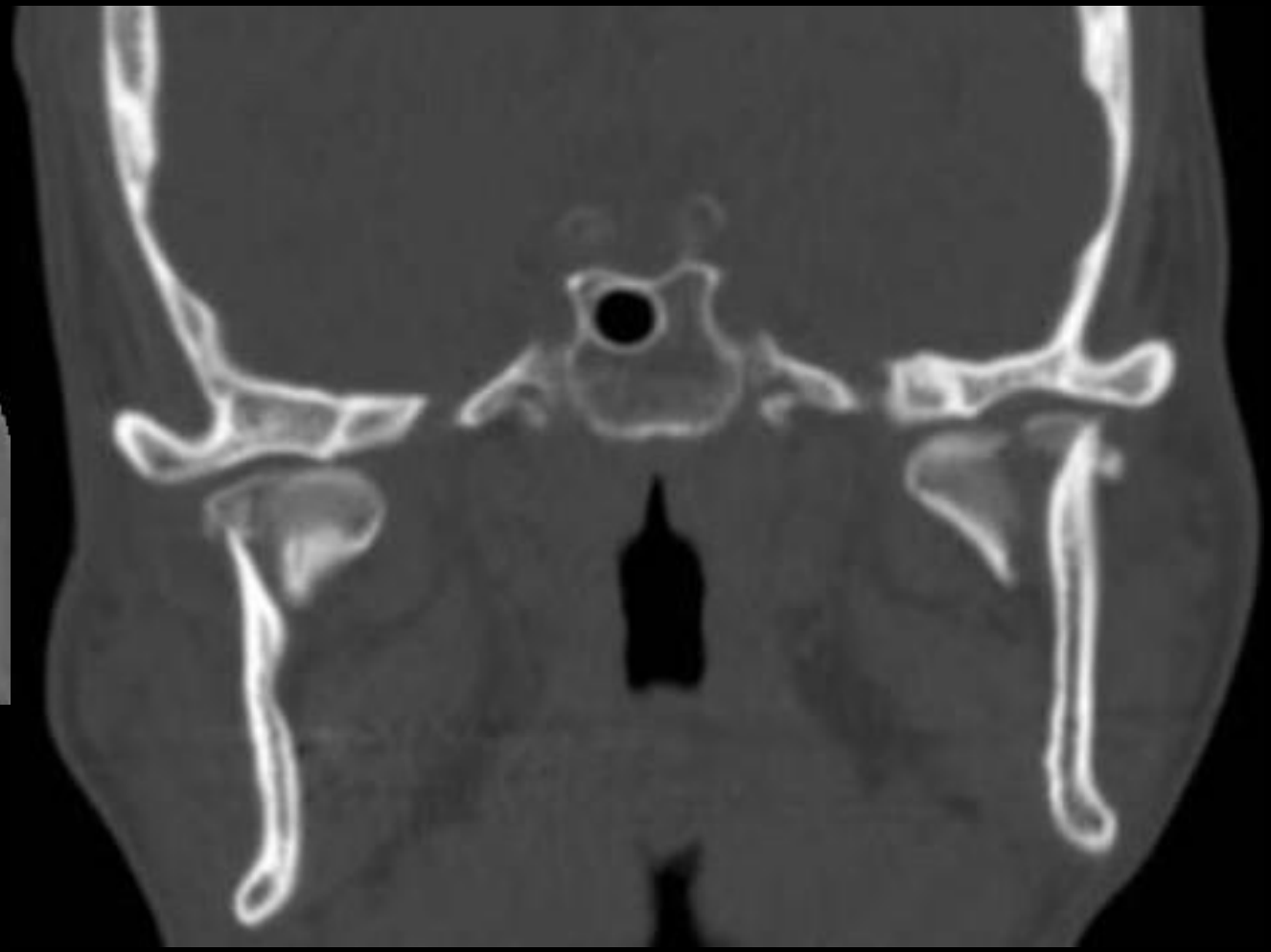
Airway compromise:	Flail Mandible
	Nasal septal haematoma
Vision:	Retro-bulbar haemorrhage
	Orbital apex fracture
	Globe injuries

Airway compromise: Flail Mandible.



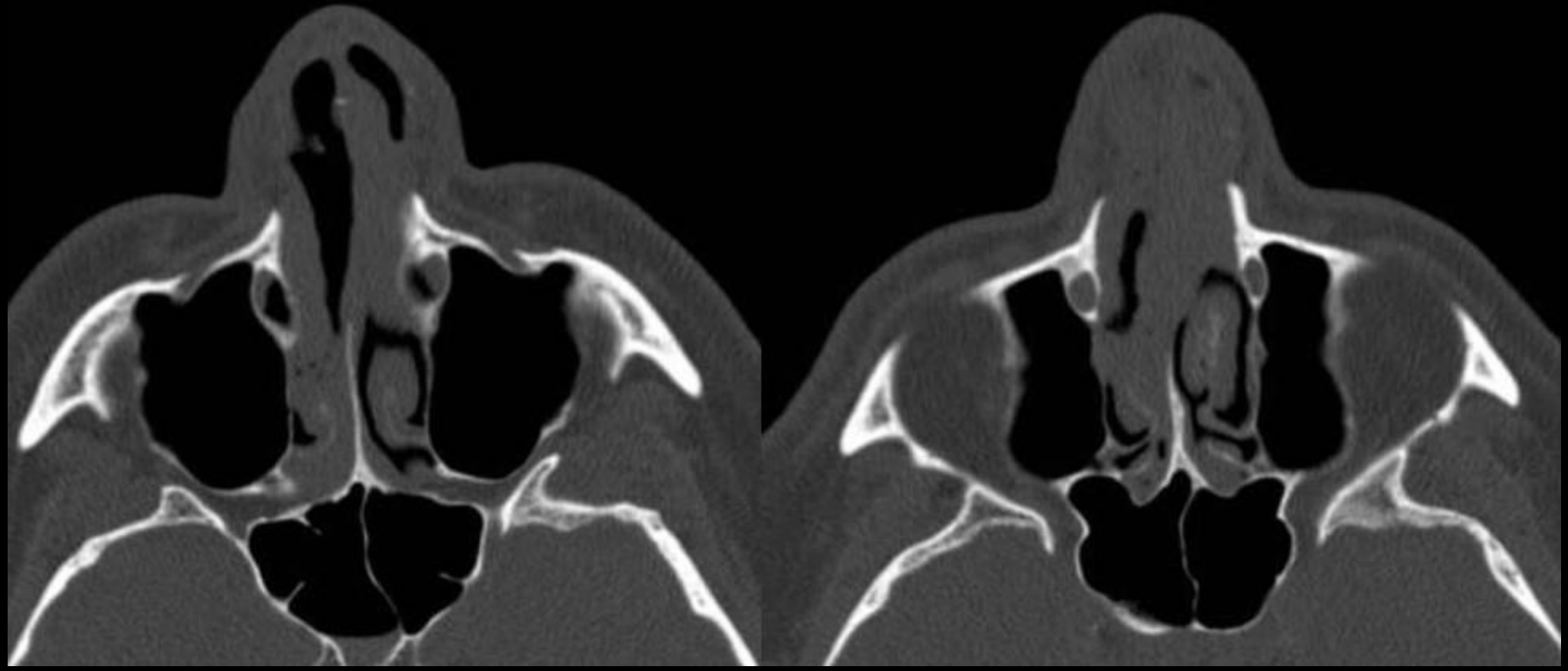
Fractures of the symphysis + bilateral condyles, rami or angles.

Airway compromise: Flail Mandible.



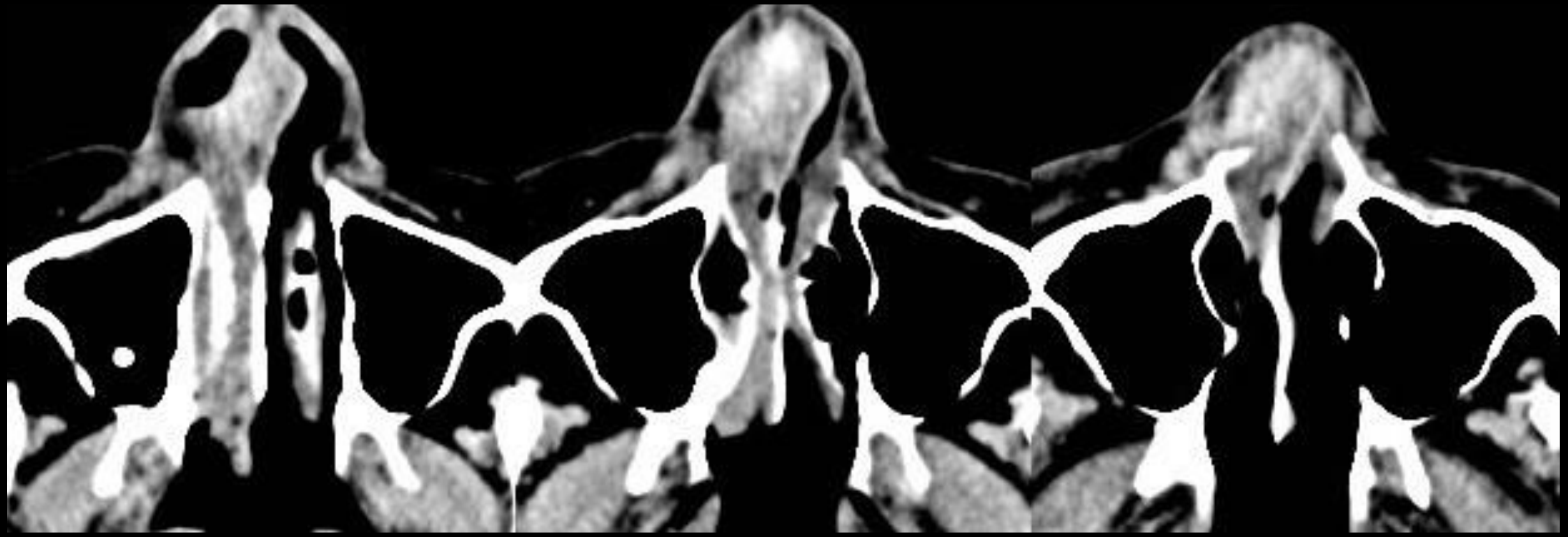
Fractures of the symphysis + bilateral condyles, rami or angles. Can potentially compromise airway; concomitant pharyngeal haematoma. Tongue position not maintained.

Airway compromise: Nasal Septal Haematoma.



Potentially compromise nasal airway; life-threatening epistaxis.

Airway compromise: Nasal Septal Haematoma.



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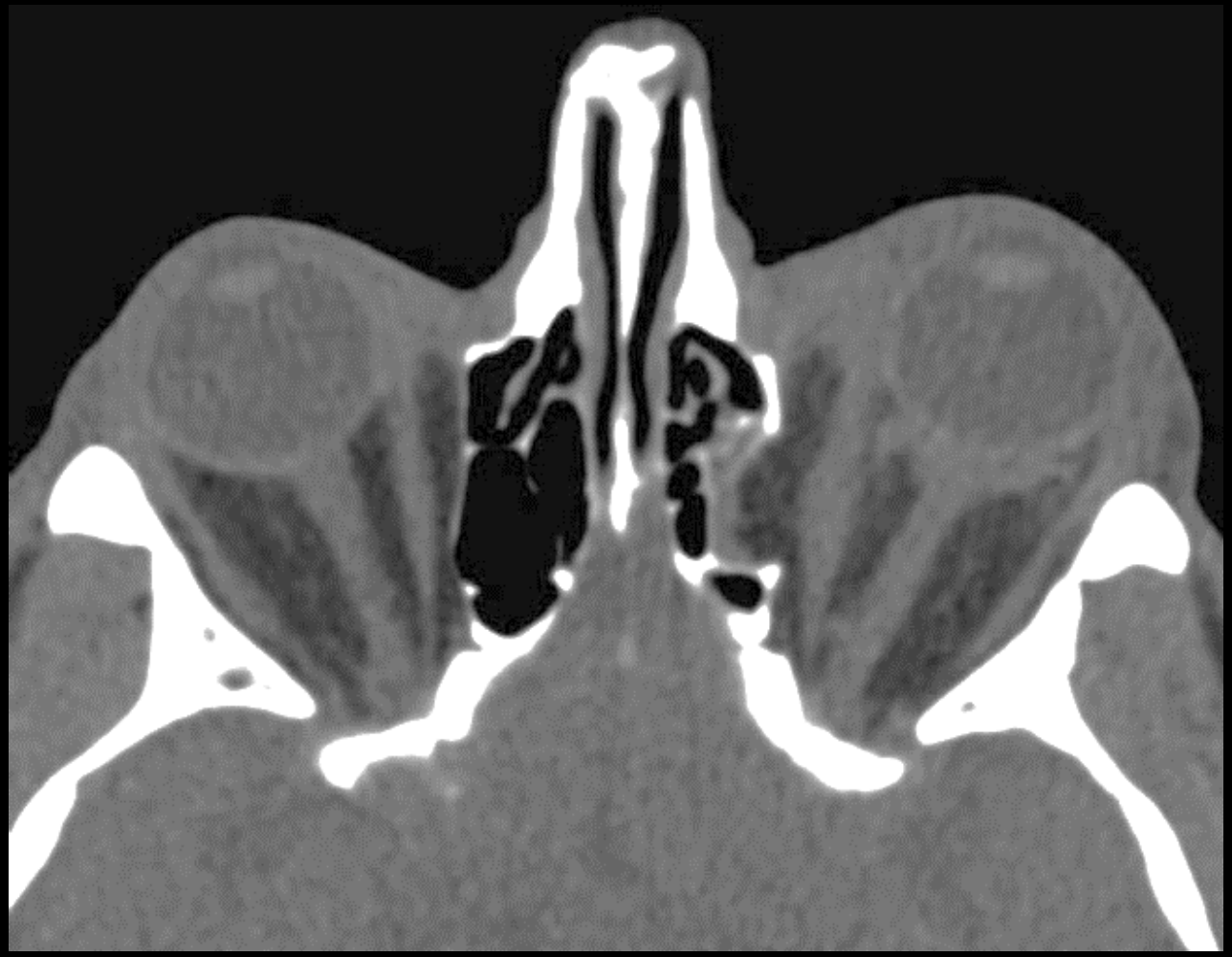
Vision: Retrobulbar Haemorrhage.



Proptosis, ‘tented’ posterior sclera, stretched optic-nerve.
Bleeding from infraorbital or ethmoidal arteries

Vision: Orbital Apex Fracture

Impingement on optic nerve; traumatic optic neuropathy and vision loss.

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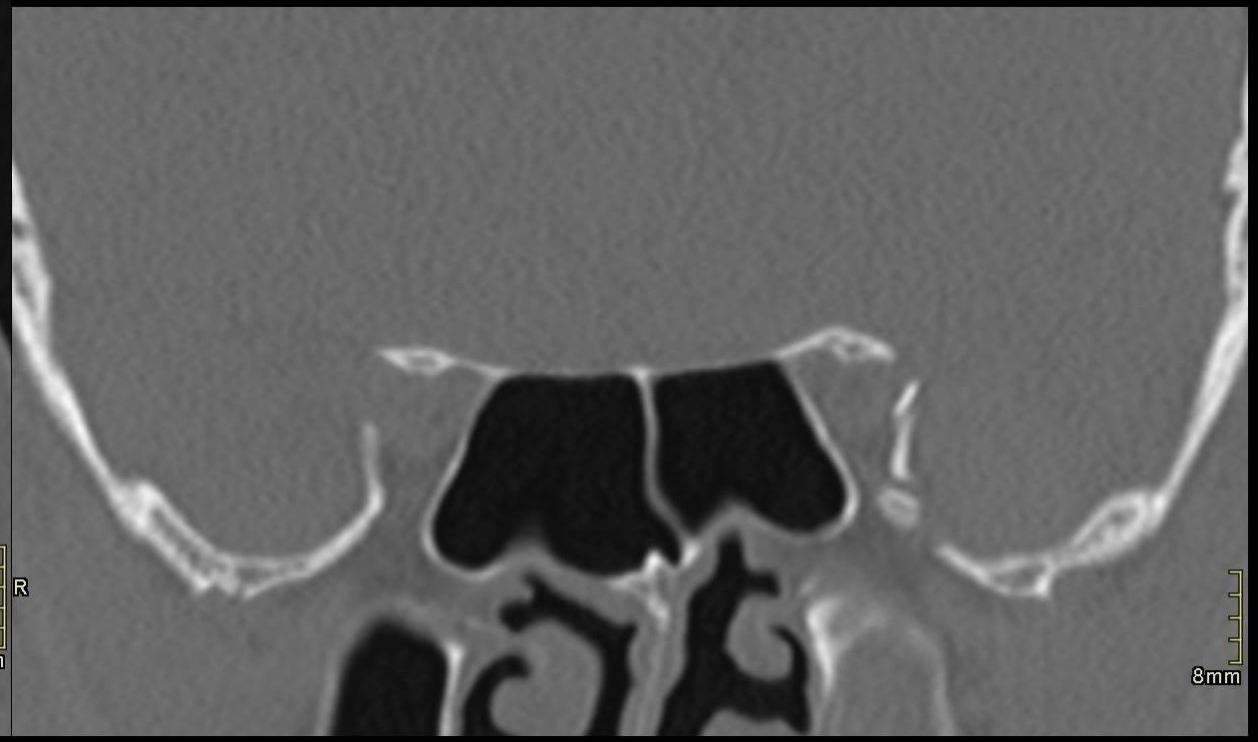

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Vision: Globe Rupture

Full thickness tear of sclera or cornea. Anterior surface common, but posterior occult on clinical exam.

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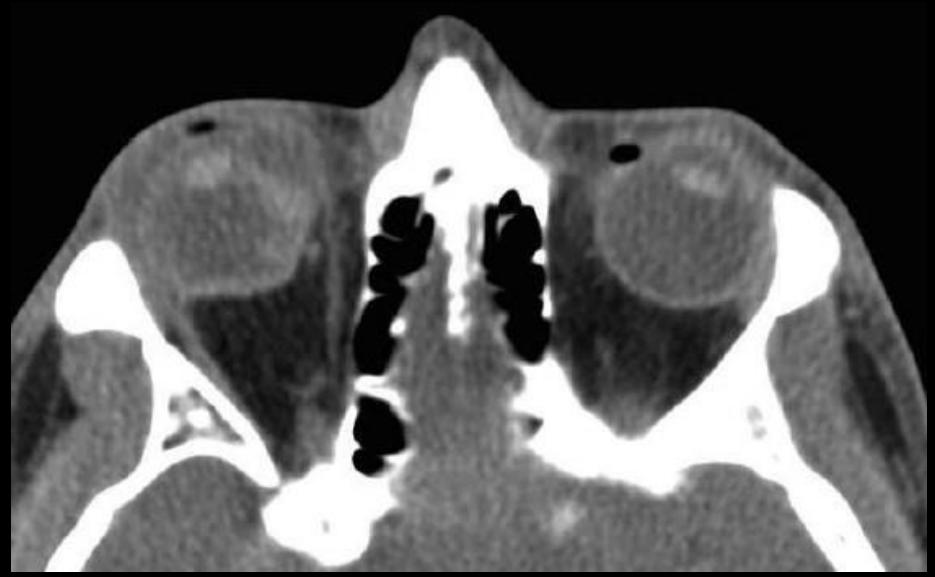

‘Flat-tire’ sign
Scleral discontinuity

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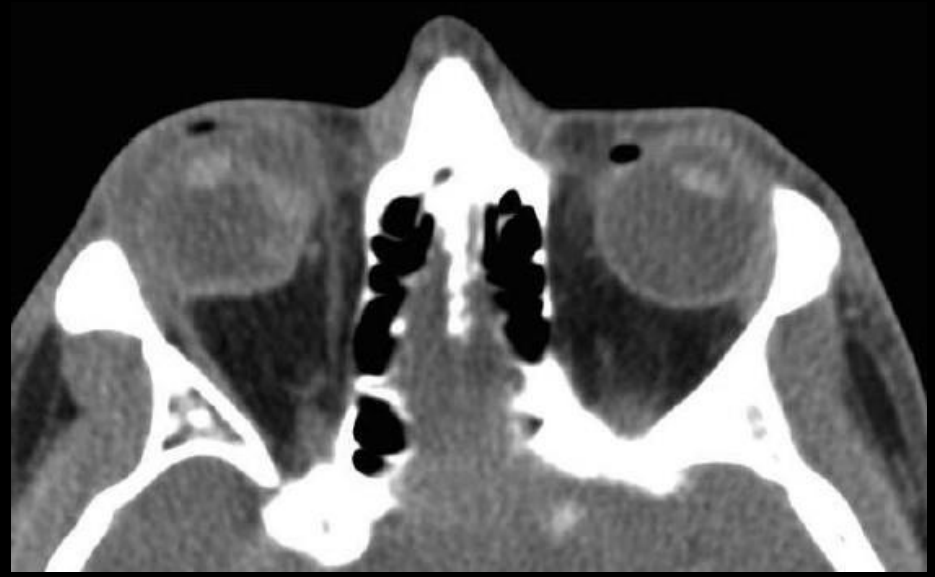

Intra-ocular FB's?

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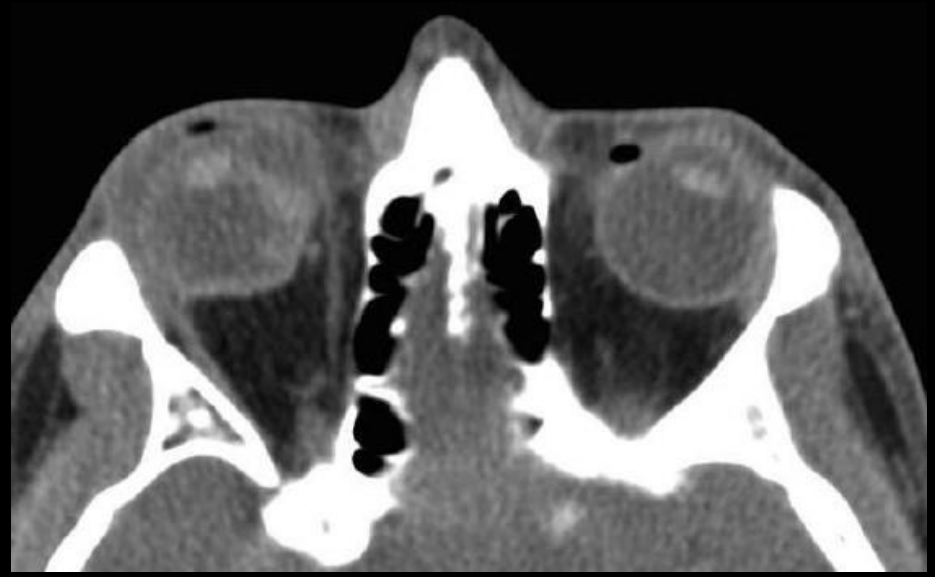

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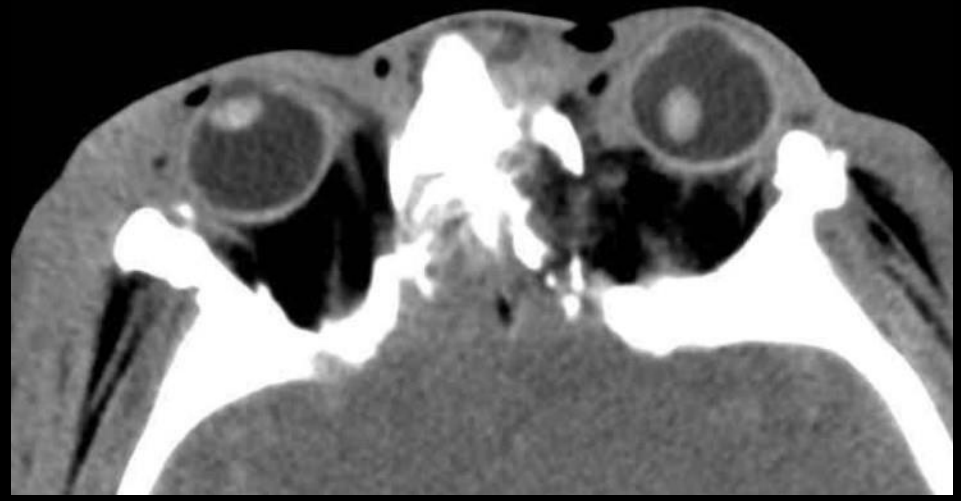


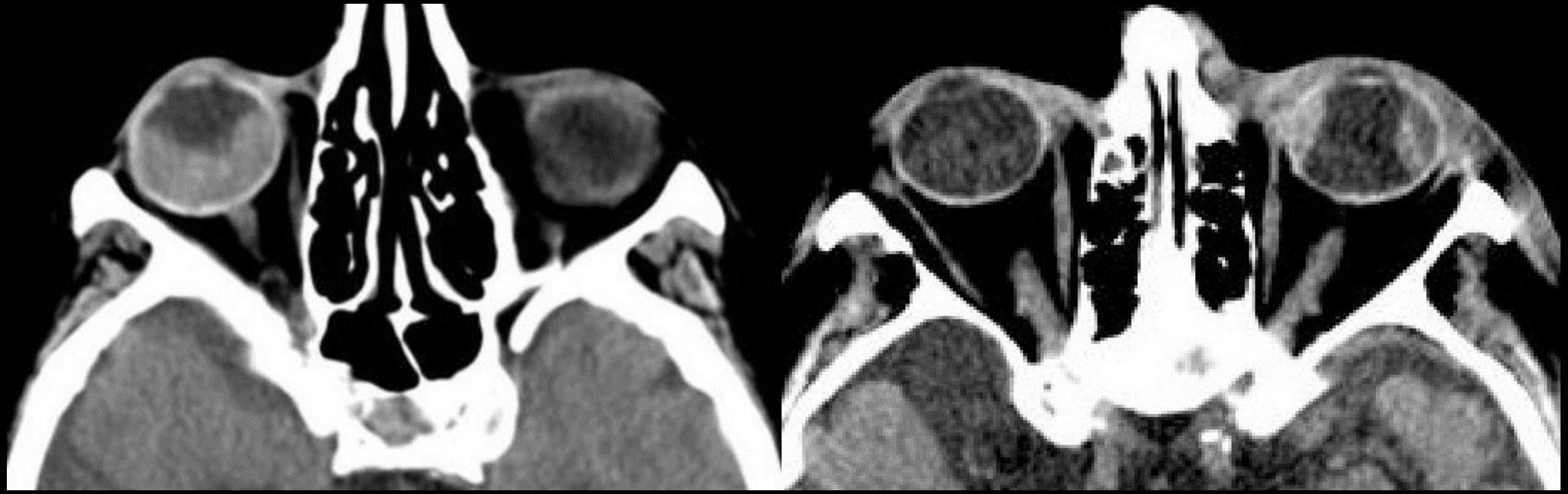
'Flat-tire' sign
Scleral discontinuity
Intra-ocular air

Lens dislocation.
Acute lens oedema
(30 HU lower than normal side) = Traumatic Cataract

Vision: Detachments

Retinal detachment (separated from choroid) – ‘V-shaped’, apex at optic disc

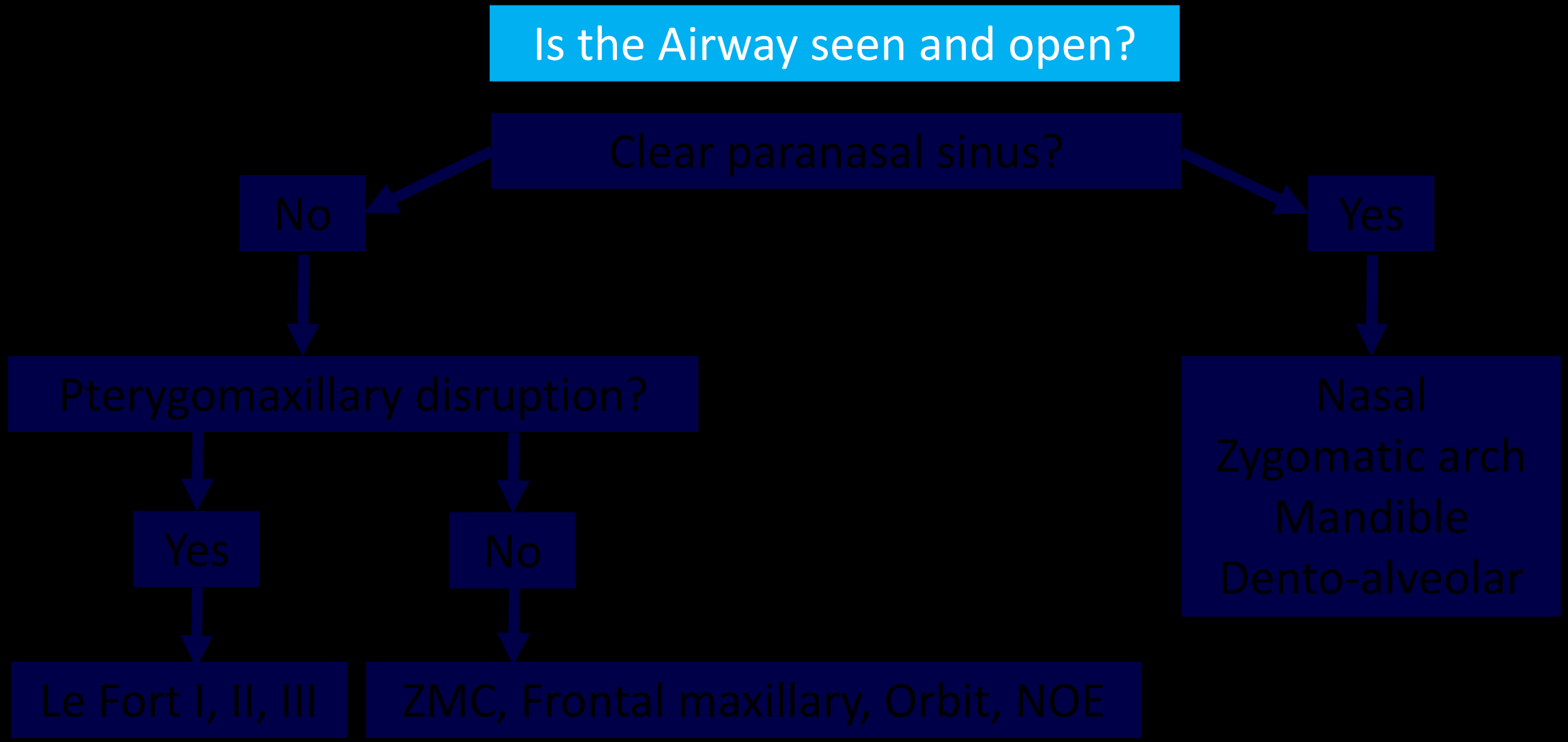
Vision: Detachments



Retinal detachment (separated from choroid) – ‘V-shaped’, apex at optic disc

Choroidal detachment (separated from sclera) – ‘lens-shaped’

Suggested approach … the search for CRITICAL FINDINGS!



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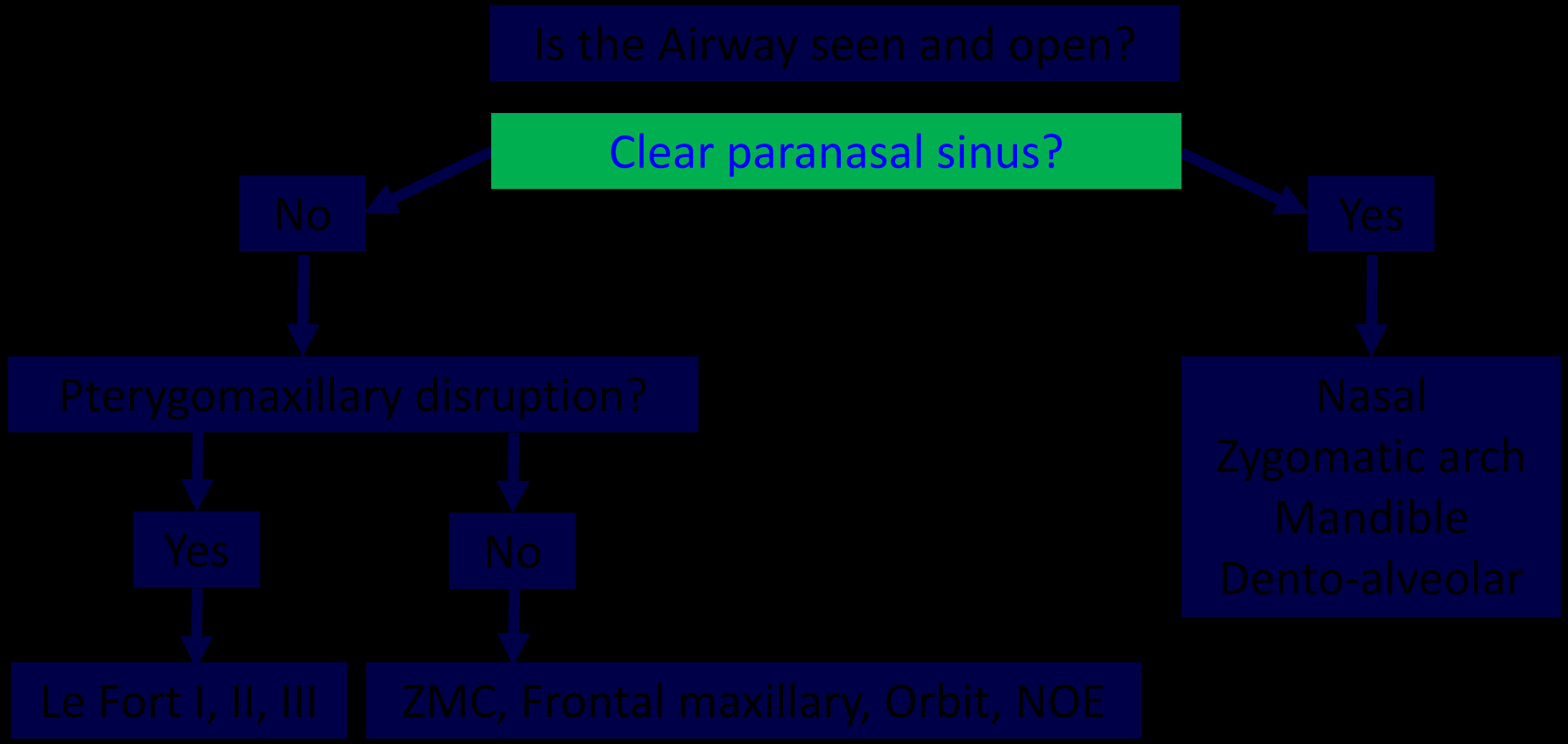

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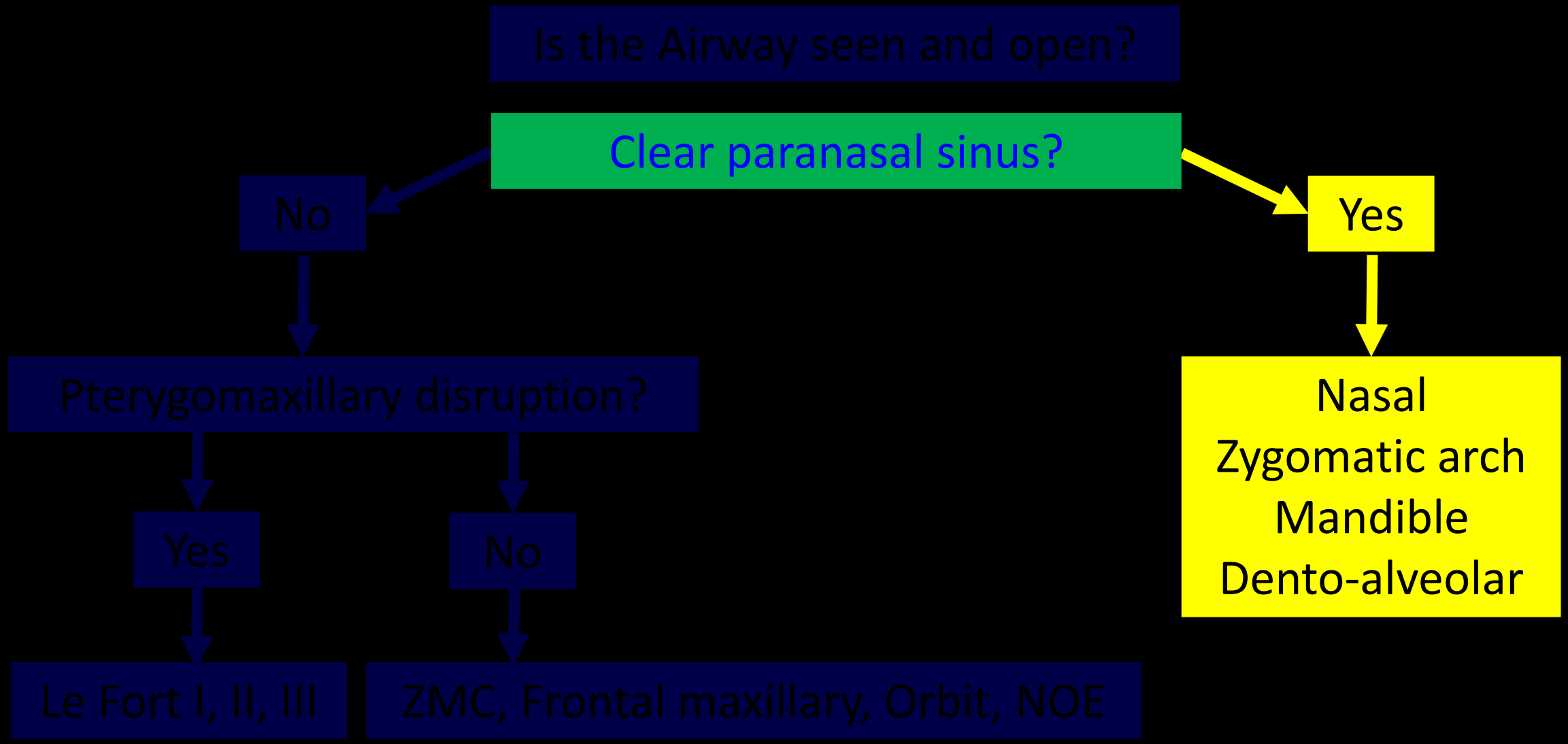
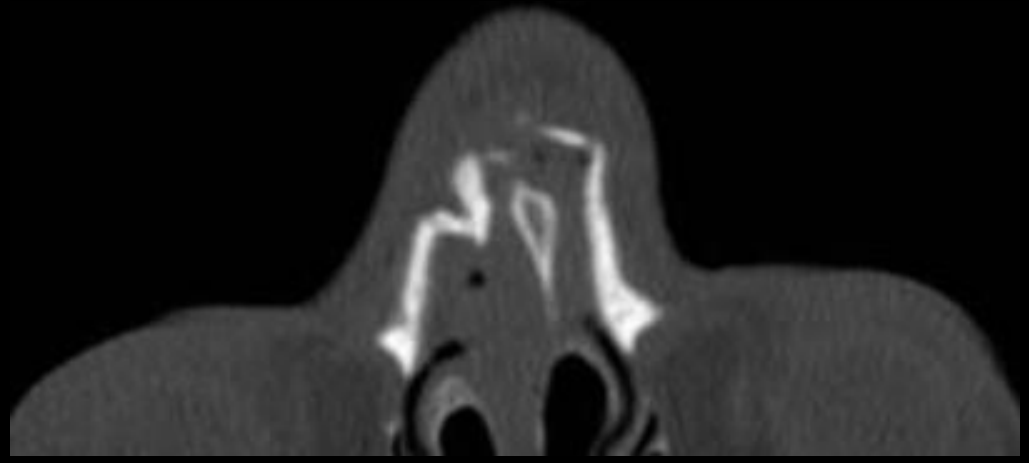


Nasal Fracture

Unilateral vs bilateral, simple vs comminuted;
if comminuted, telescoping or depression?
Septum involved?
Haematoma?



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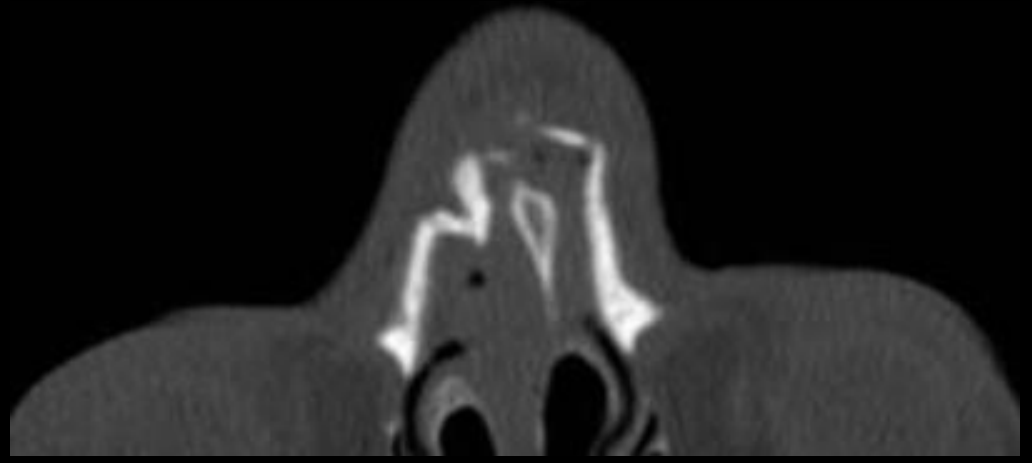

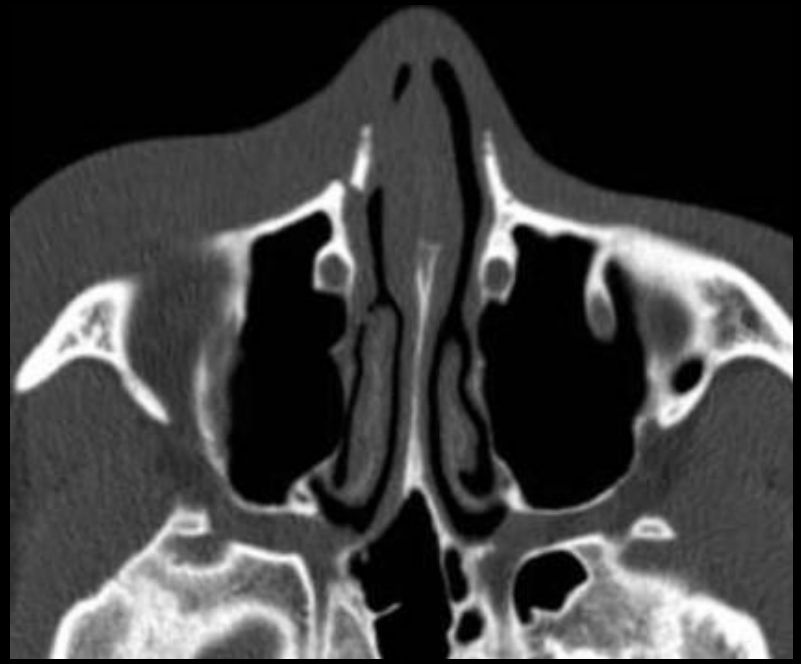

Frontal Process of Maxilla Fracture

Part of a more complex fracture?

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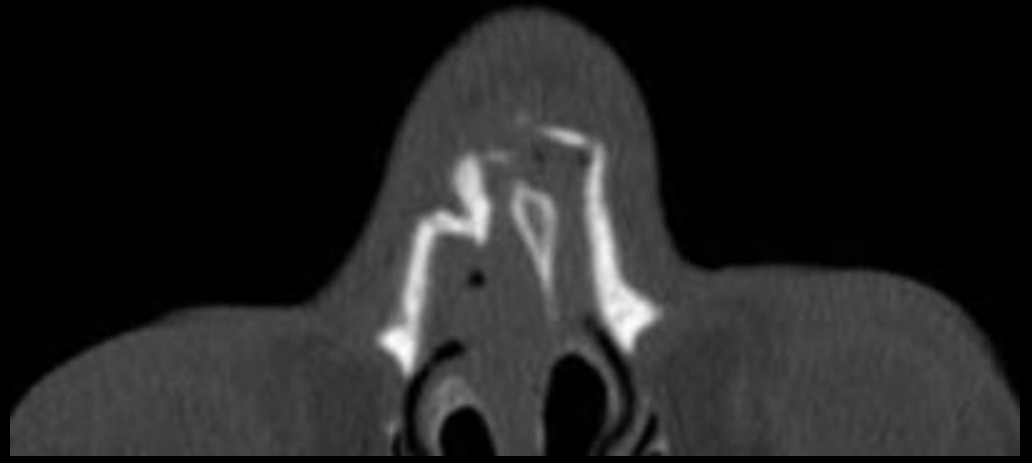

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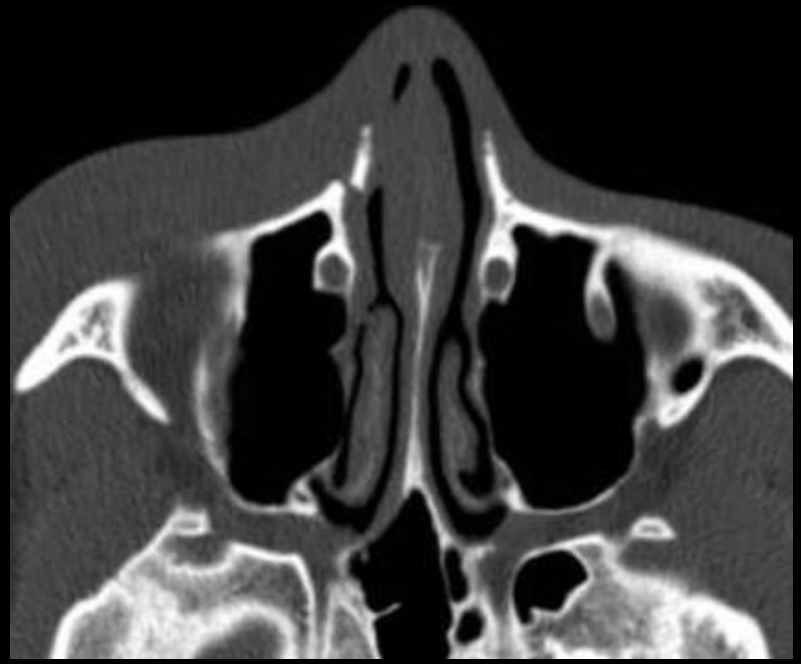
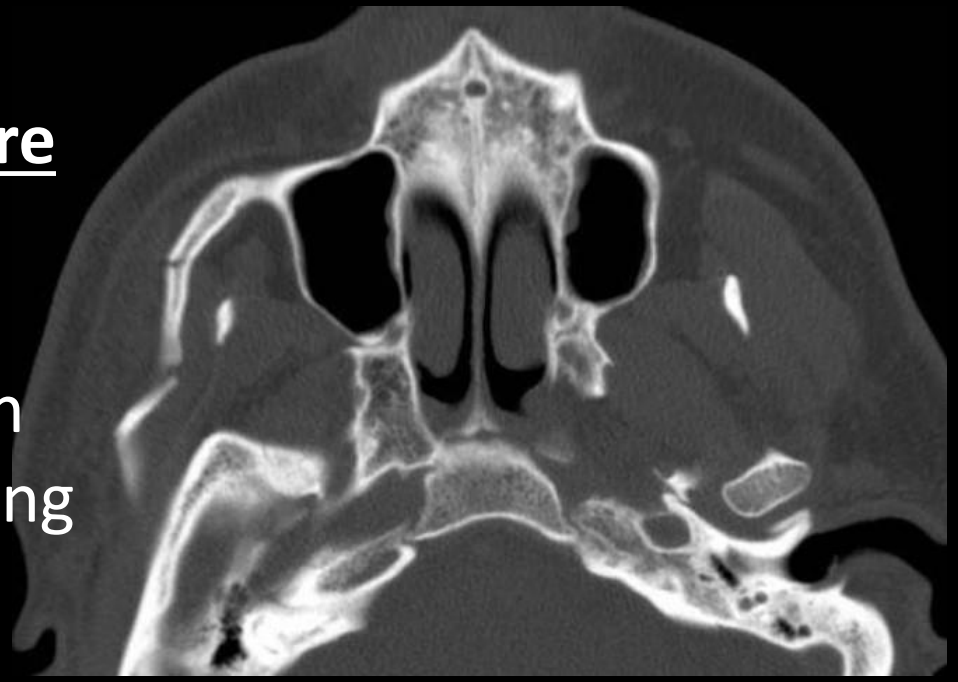
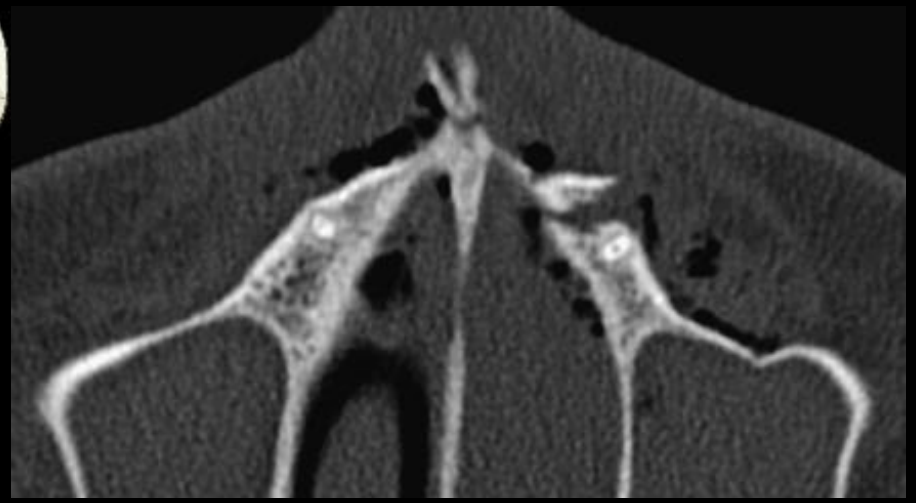


Zygomatic Arch Fracture

Three fracture lines, depressed middle fragment. Limit motion of mandible by impinging on coronoid process or masseter origins





Dento-alveolar Fracture

Any portion of the alveolar process.

Malaligned and displaced tooth.

Tooth injuries: luxation, subluxation, avulsion, and fracture.

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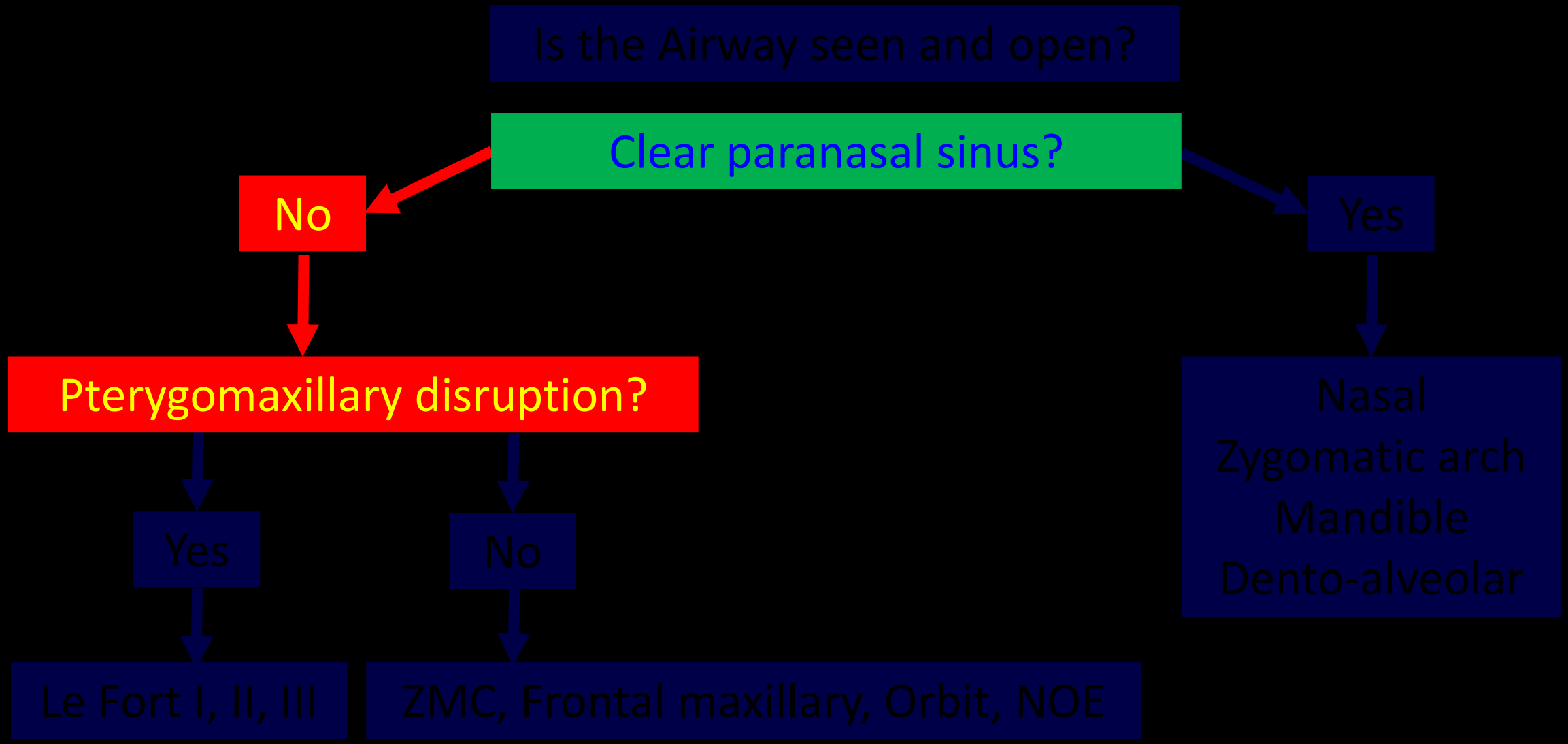

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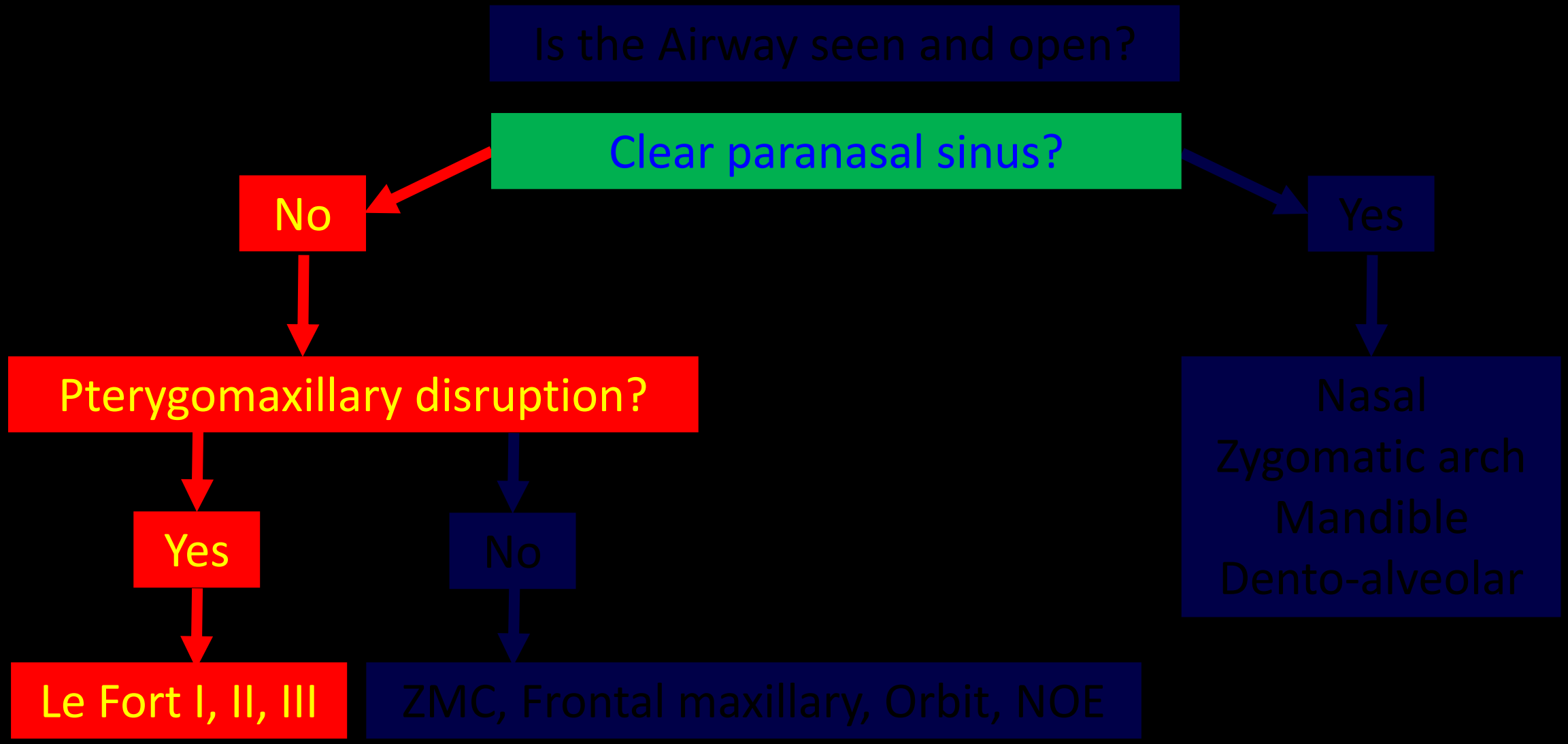

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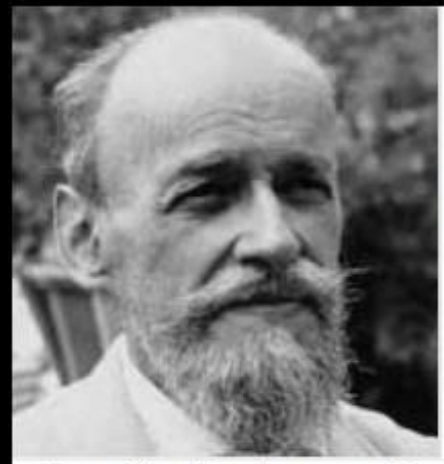

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French surgeon

René Le Fort was a French surgeon from Lille remembered for creating a classification for fractures of the face. Wikipedia

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Died: 30 March 1951, Lille, France

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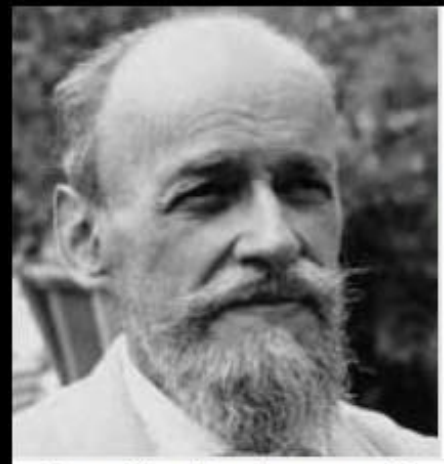

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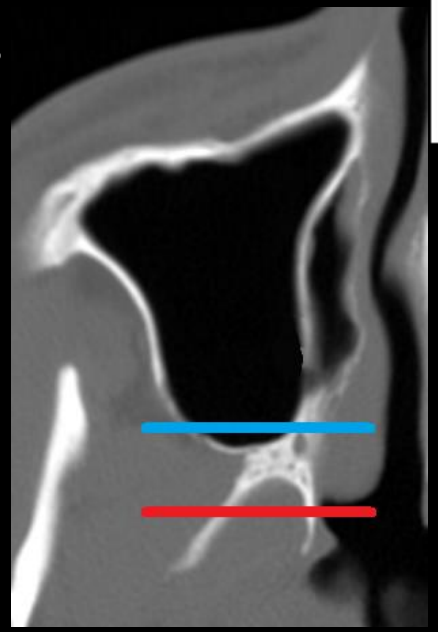

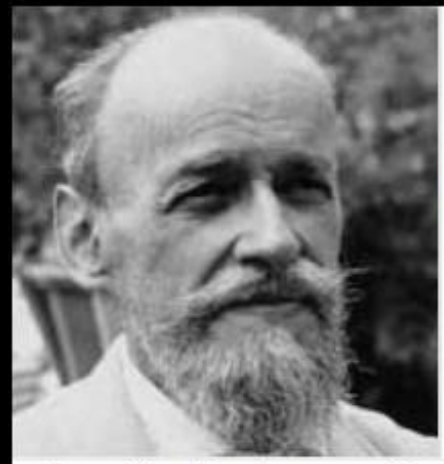

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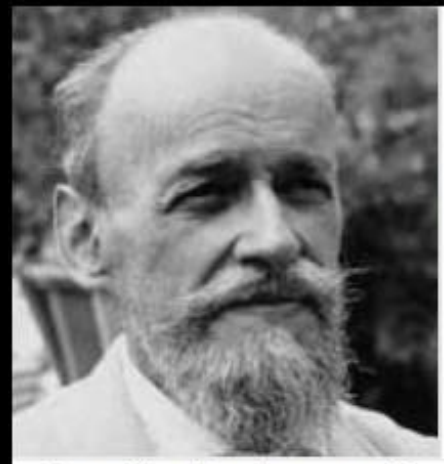

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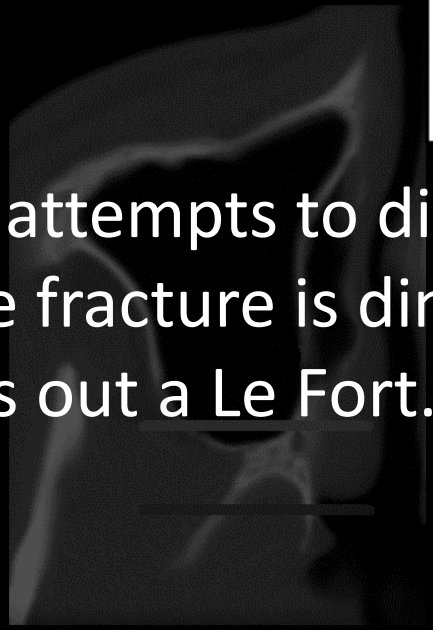
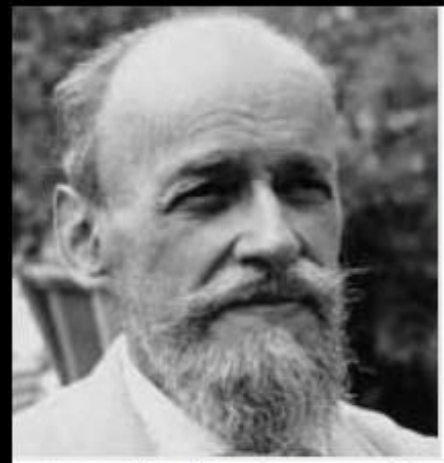


The Le Fort classification system attempts to distinguish according to the plane of injury. Isolated pterygoid plate fracture is diminishingly rare; the absence of pterygomaxillary disruption rules out a Le Fort.

Le Fort fractures involve the midface, which results in separation of all, or a portion, of the midface from the skull base. In order to be separated from the skull base, the pterygomaxillary buttress must be disrupted. This can occur either through the posterior walls of the sinus or, most commonly, through the pterygoid plates themselves.



René Le Fort

French surgeon

René Le Fort was a French surgeon from Lille remembered for creating a classification for fractures of the face. Wikipedia

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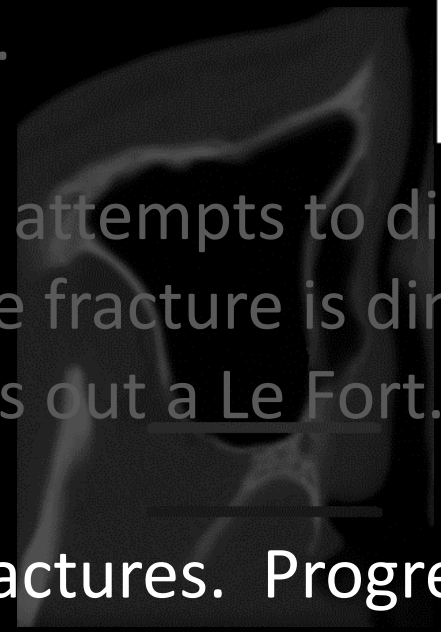

Among the most severe facial fractures. Progressively severe category from I to III.

Modified Le Fort classifications by Marciani RD 1993

Le Fort I	- Low Maxillary Fractures
I a	- Low maxillary fracture/multiple segments
Le Fort II	- Pyramidal
II a	- Pyramidal and nasal fractures
II b	- Pyramidal and naso-orbito-ethmoidal (NOE) Fracture
Le Fort III	- Craniofacial dysjunction
III a	- Craniofacial dysjunction and nasal fractures
III b	- Craniofacial dysjunction and NOE
Le Fort IV	- Le Fort II or III fracture and cranial base fracture
IV a	- Supra-orbital fracture
IV b	- Anterior cranial fossa and supra-orbital rim fracture
IV c	- Anterior cranial fossa and orbital wall fracture

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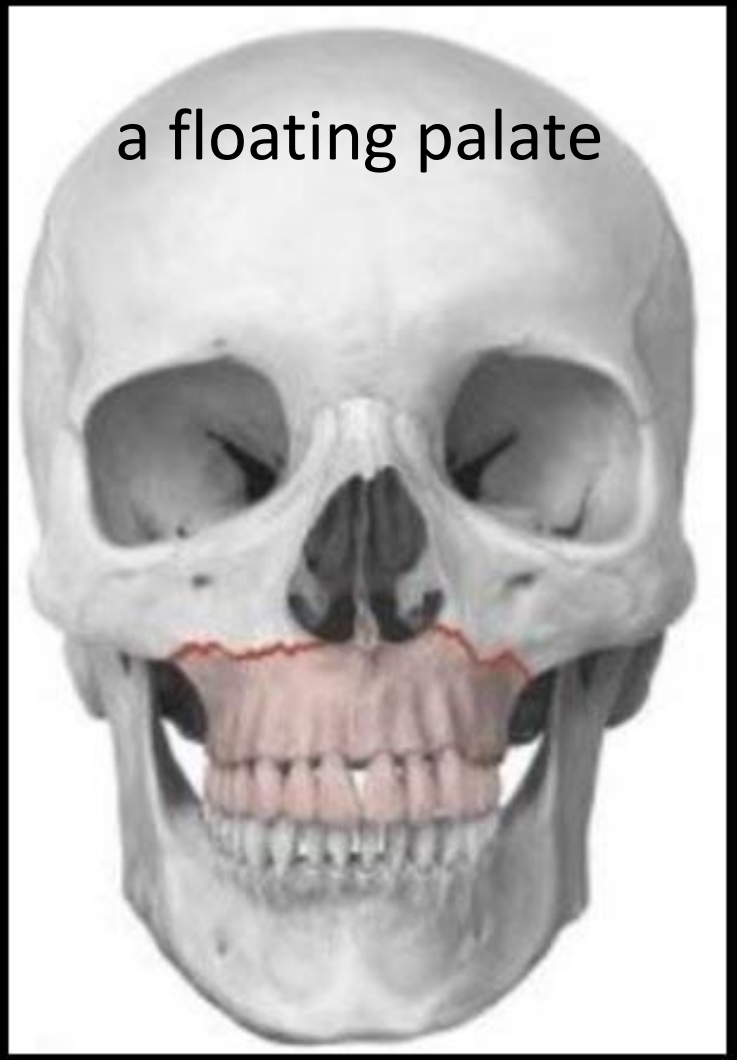
Le Fort fractures

Le Fort I

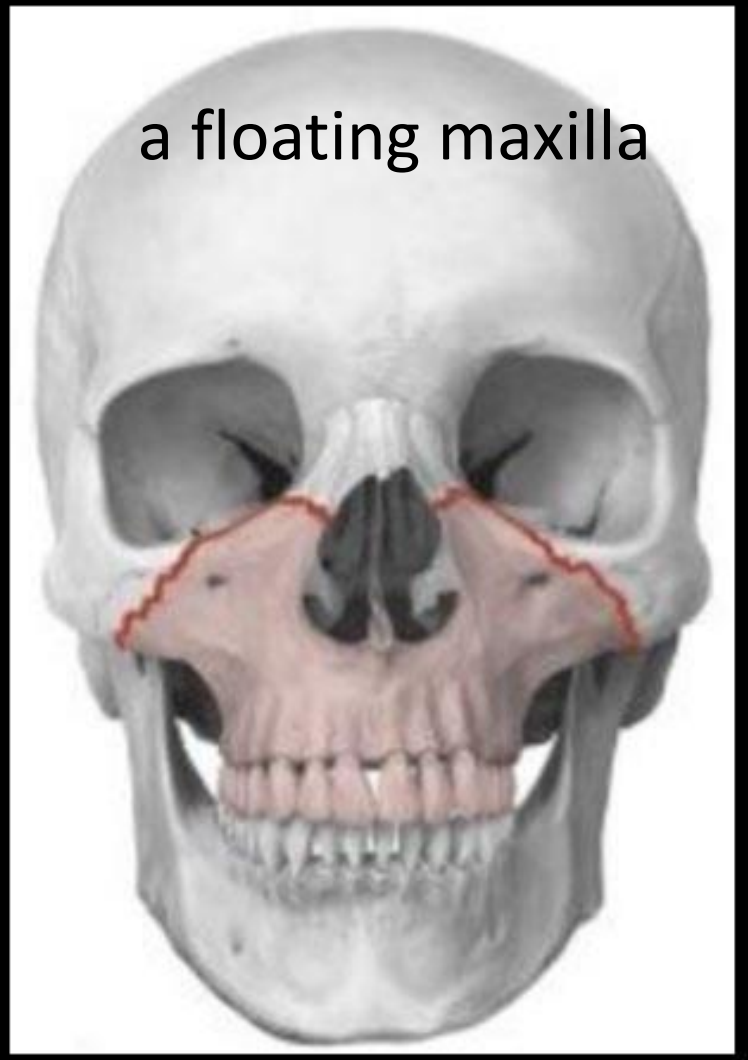
Le Fort II

Le Fort III

Le Fort fractures



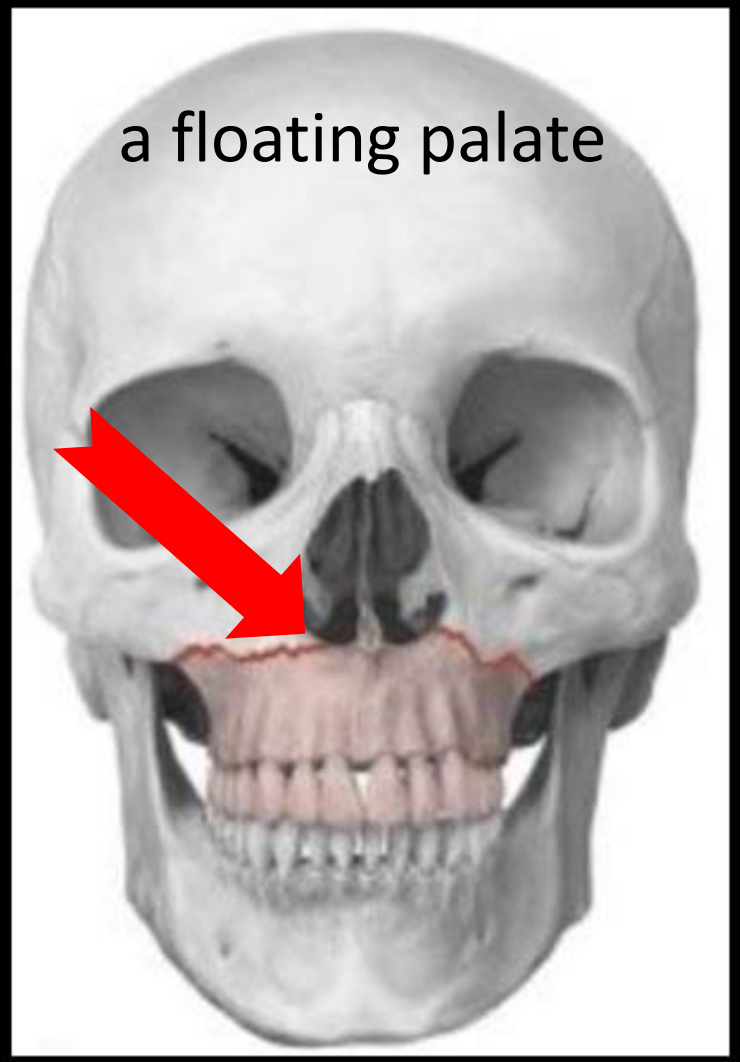
Le Fort I



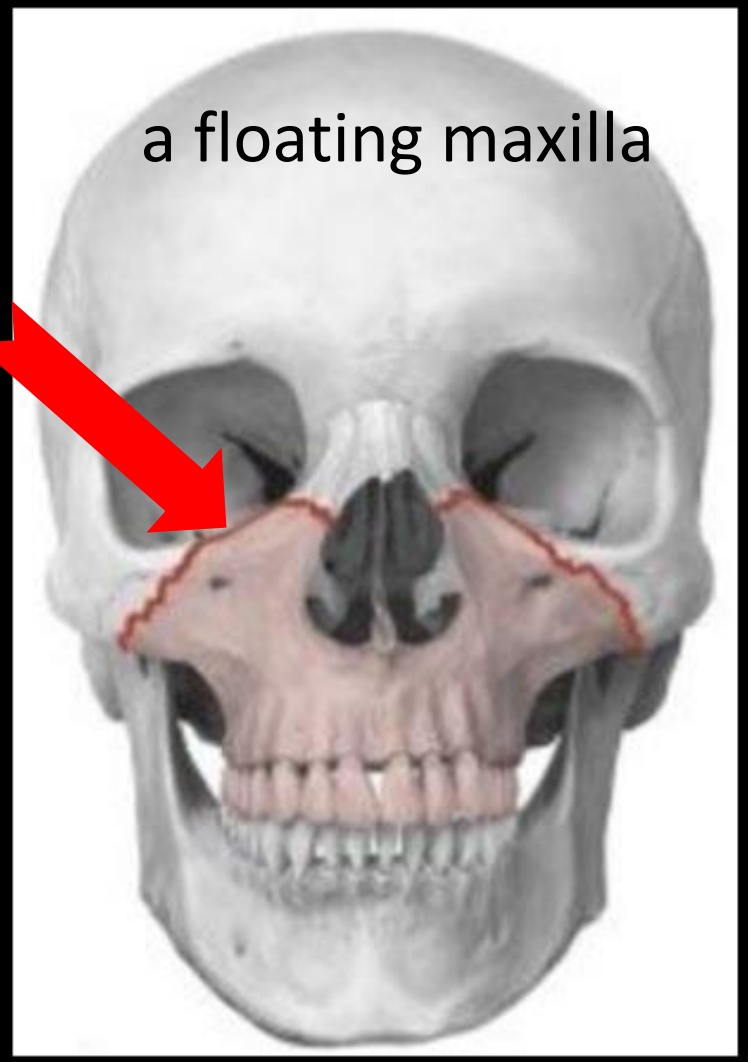
Le Fort II

Le Fort III

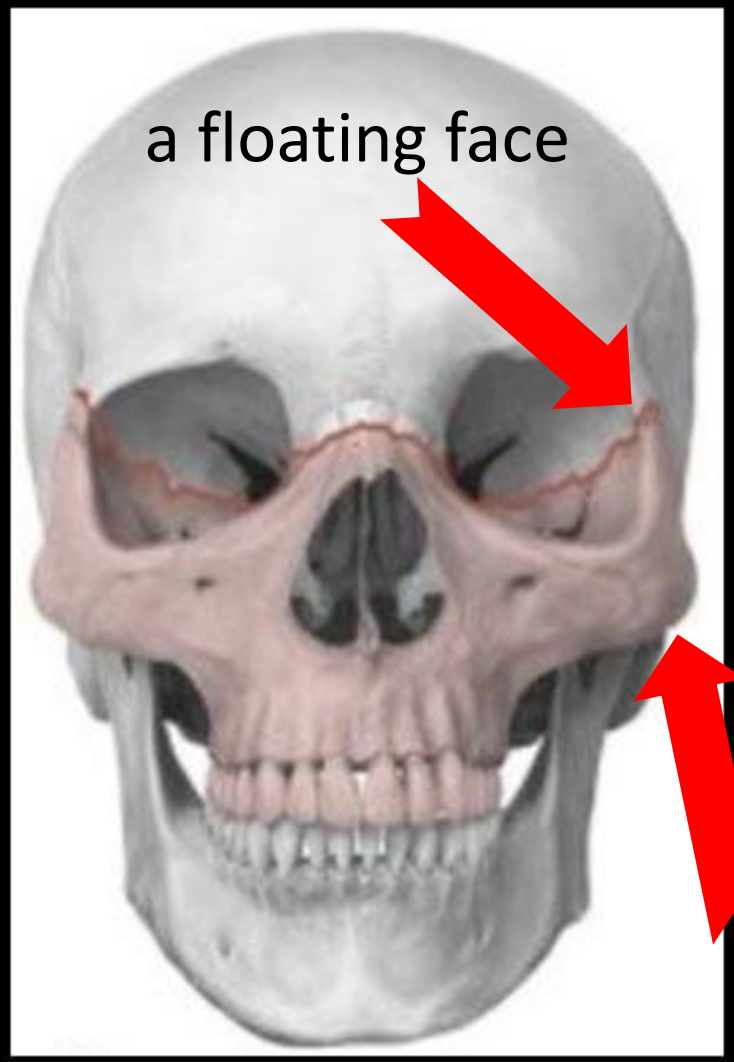
Le Fort fractures



Le Fort I

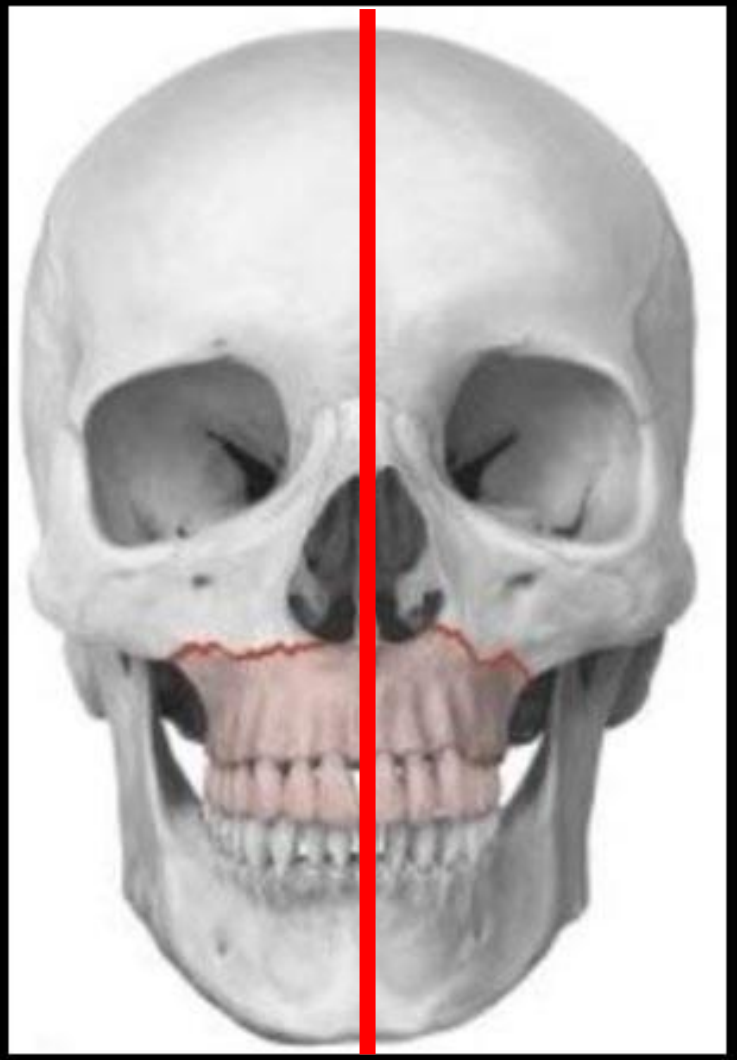


Le Fort II

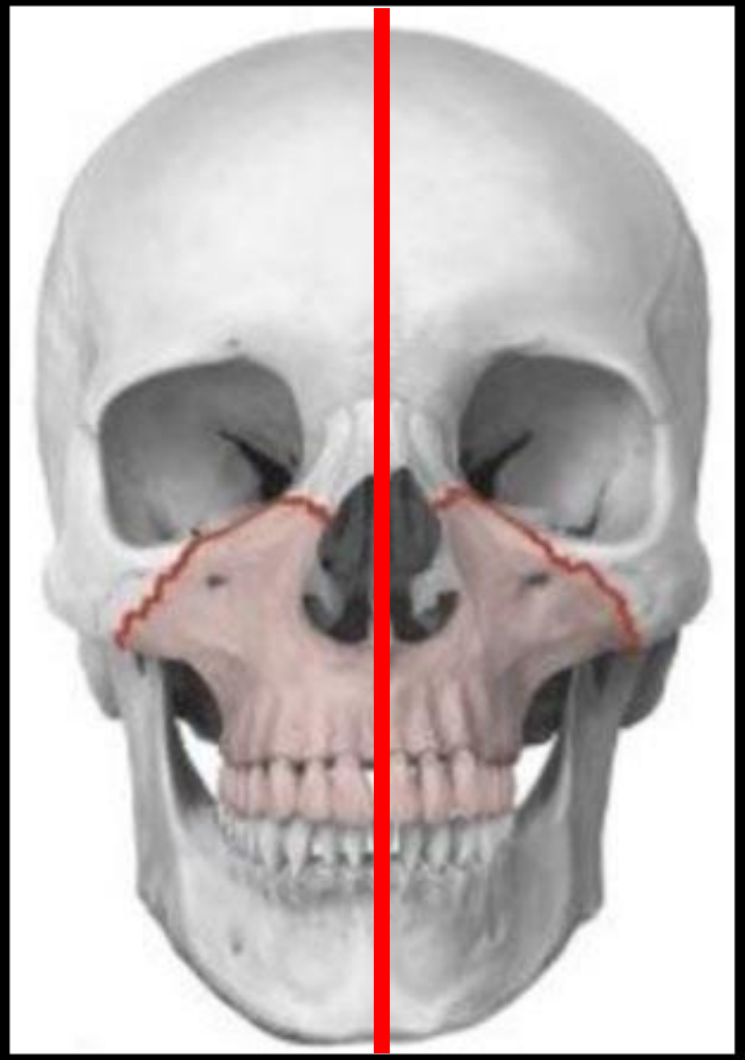


Le Fort III

Le Fort fractures



Le Fort I



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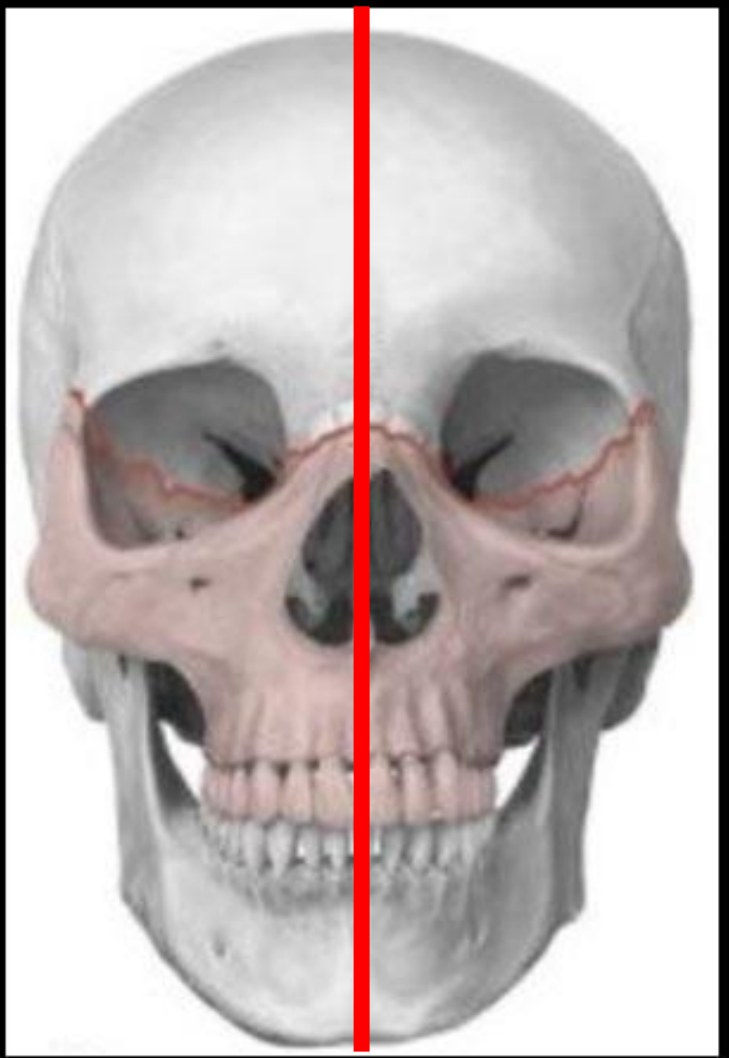

Le Fort III

Le Fort fractures

Le Fort I (left)

Le Fort I & II

Le Fort II & III

Le Fort fractures

The hard palate is an important posterior extension of the lower transverse buttress of the Maxilla (maxillary alveolar rim). A displaced unilateral Le Fort fracture is possible only if the palate is fractured sagittally or parasagittally.

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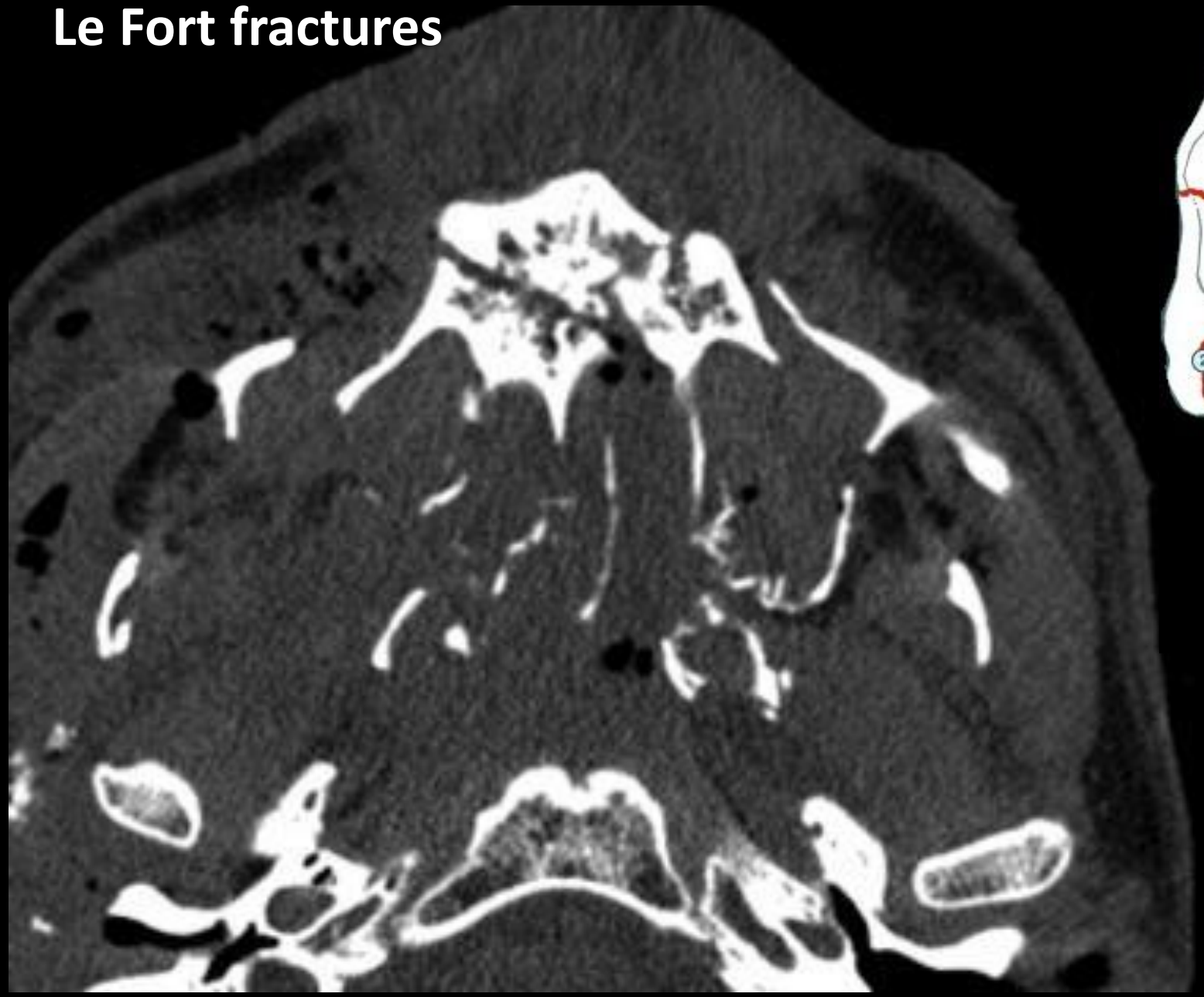
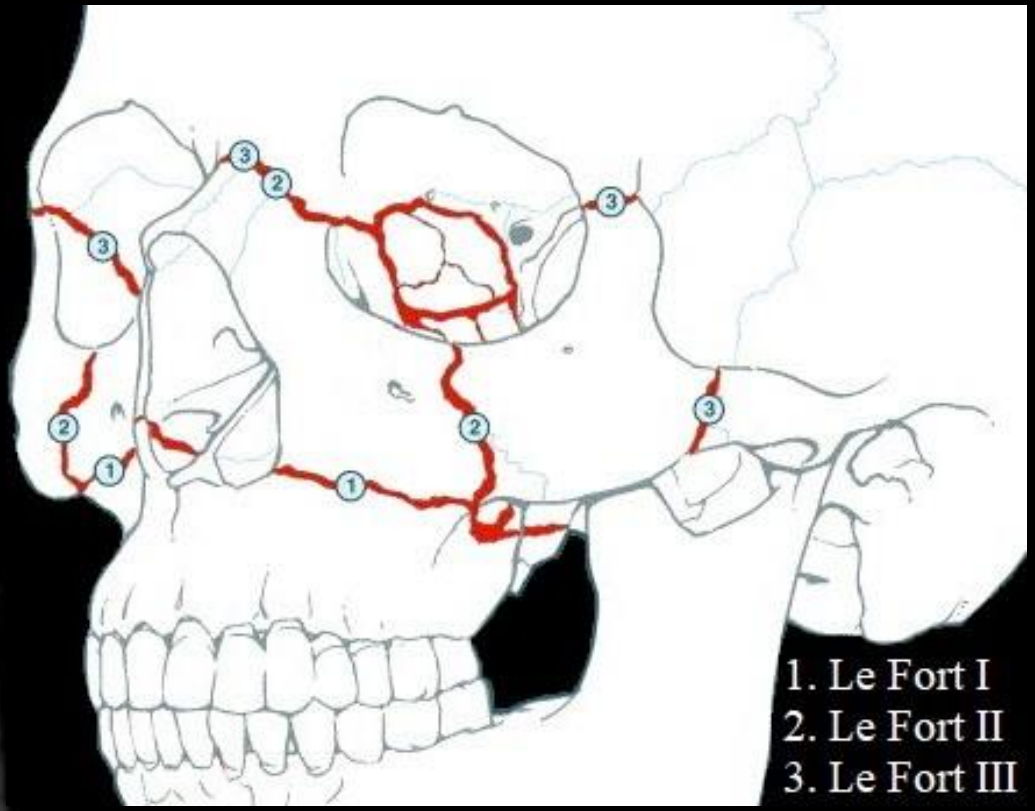
Le Fort fractures





Le Fort fractures

Multiplanar CT: axial, coronal and sagittal images – need to work on all 3!

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Is the anterolateral margin of the nasal fossa fractured? Yes –> Type 1 fracture

Is the infraorbital rim fractured? Yes –> Type 2 fracture

Le Fort fractures

Multiplanar CT: axial, coronal and sagittal images – need to work on all 3!

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Is the anterolateral margin of the nasal fossa fractured? Yes –> Type 1 fracture

Is the infraorbital rim fractured? Yes –> Type 2 fracture

Is the lateral orbital wall and zygomatic arch fractured? Yes –> Type 3 fracture

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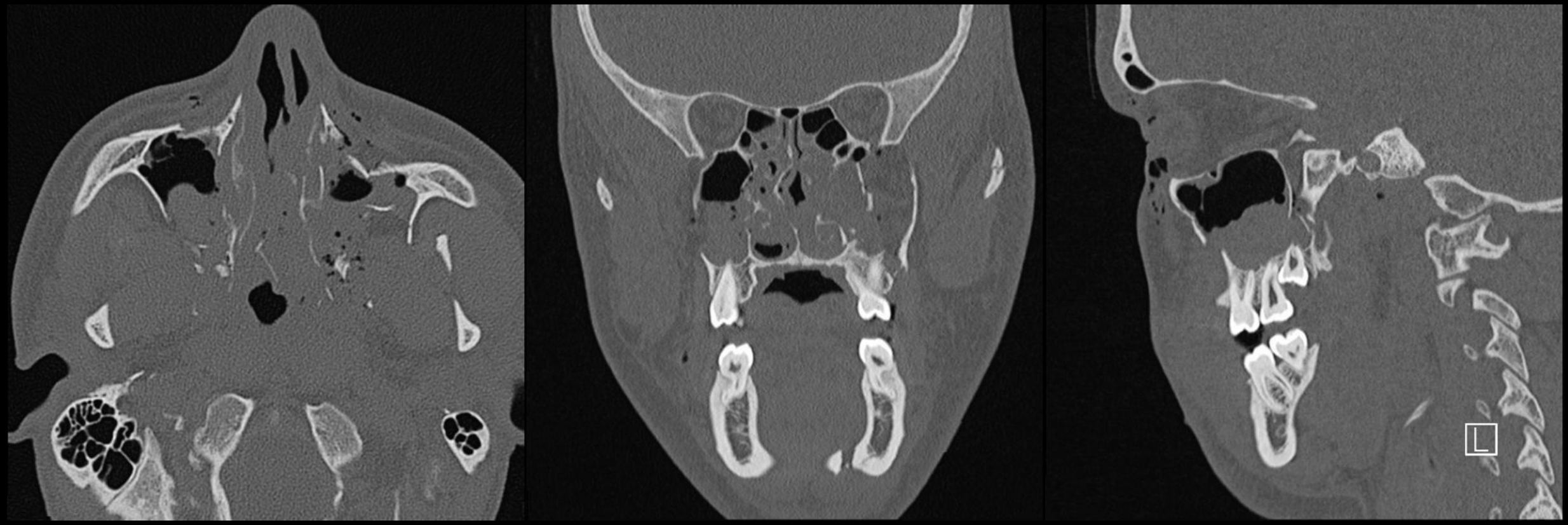
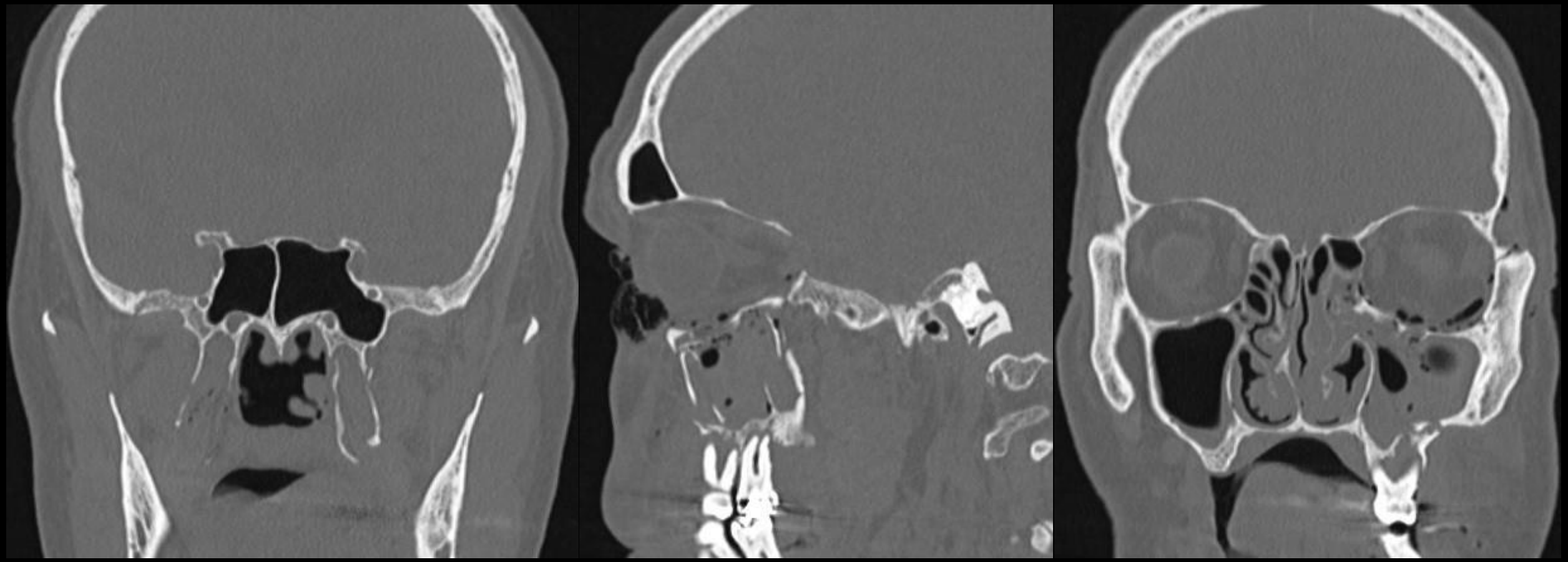
Remember: any combination is possible; for example, there may be type 2 on one side and type 3 on the other; a type 1 and type 2 on the same side etc

Le Fort fractures



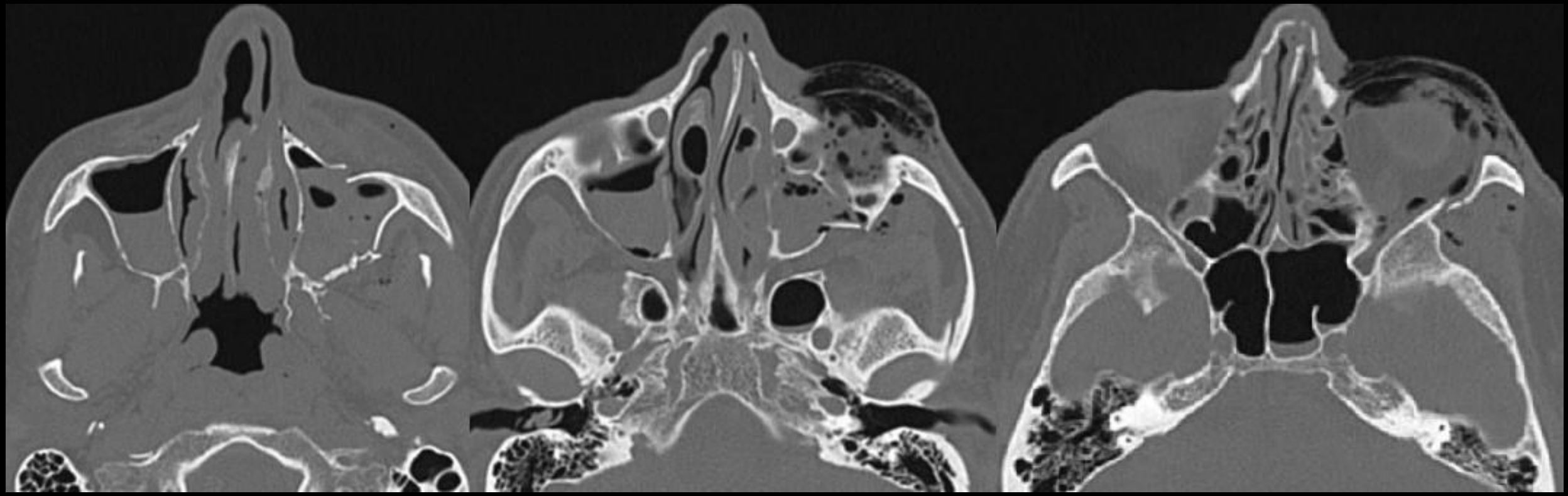
Le Fort I – transverse fracture of inferior maxillae (all walls of the maxillary sinus except the superior wall/roof), **anterolateral margins of the nasal fossa**, nasal septum.

Le Fort fractures



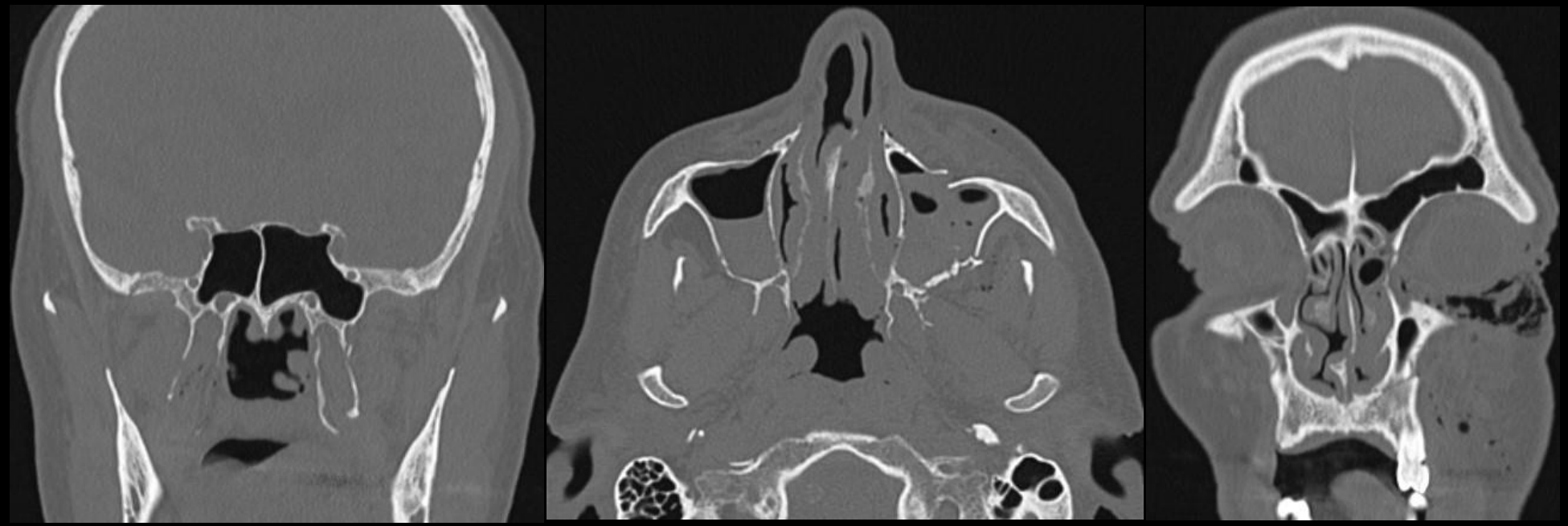
Le Fort II – Pyramid shaped. Fractures of maxillary sinuses (anterior, lateral wall), **inferior orbital rim**, orbital floor, nasofrontal suture

Le Fort fractures

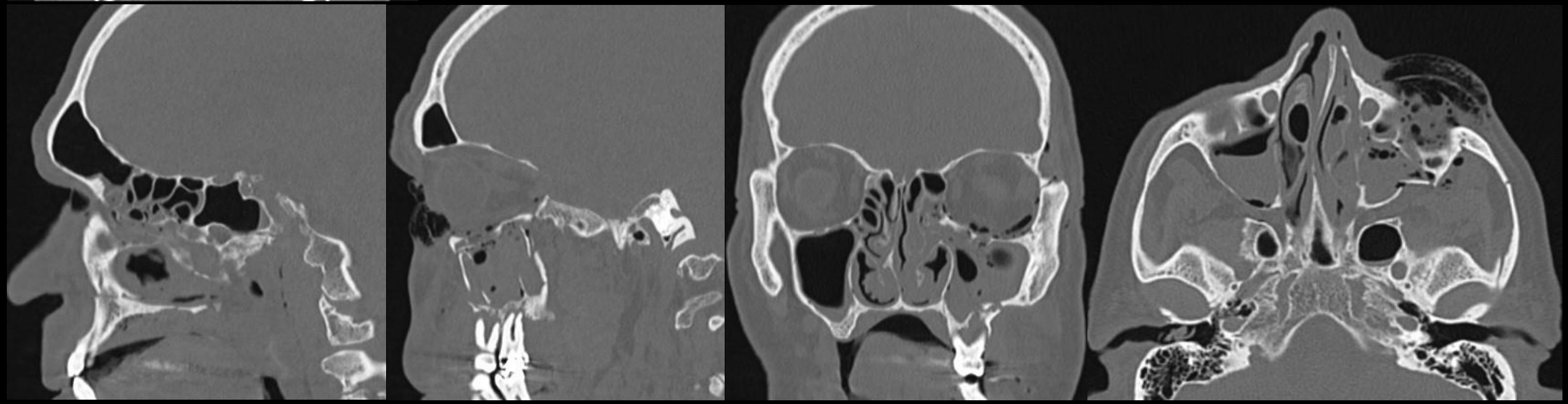


Le Fort III – Fractures of the nasofrontal suture, maxillofrontal suture, **lateral orbital wall** and **zygomatic arch**/zygomaticofrontal suture

Le Fort fractures



Le Fort I, II & III



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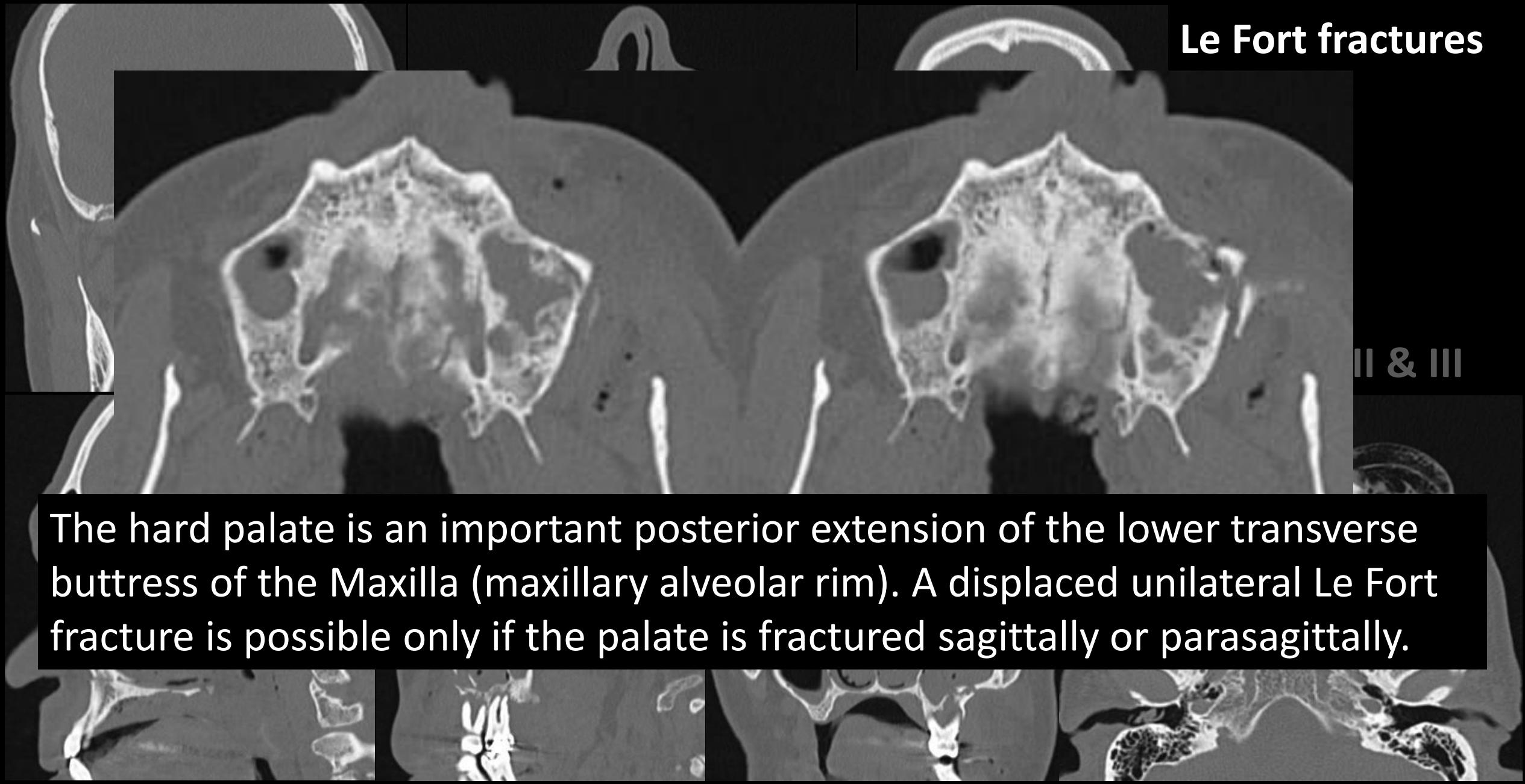

II & III

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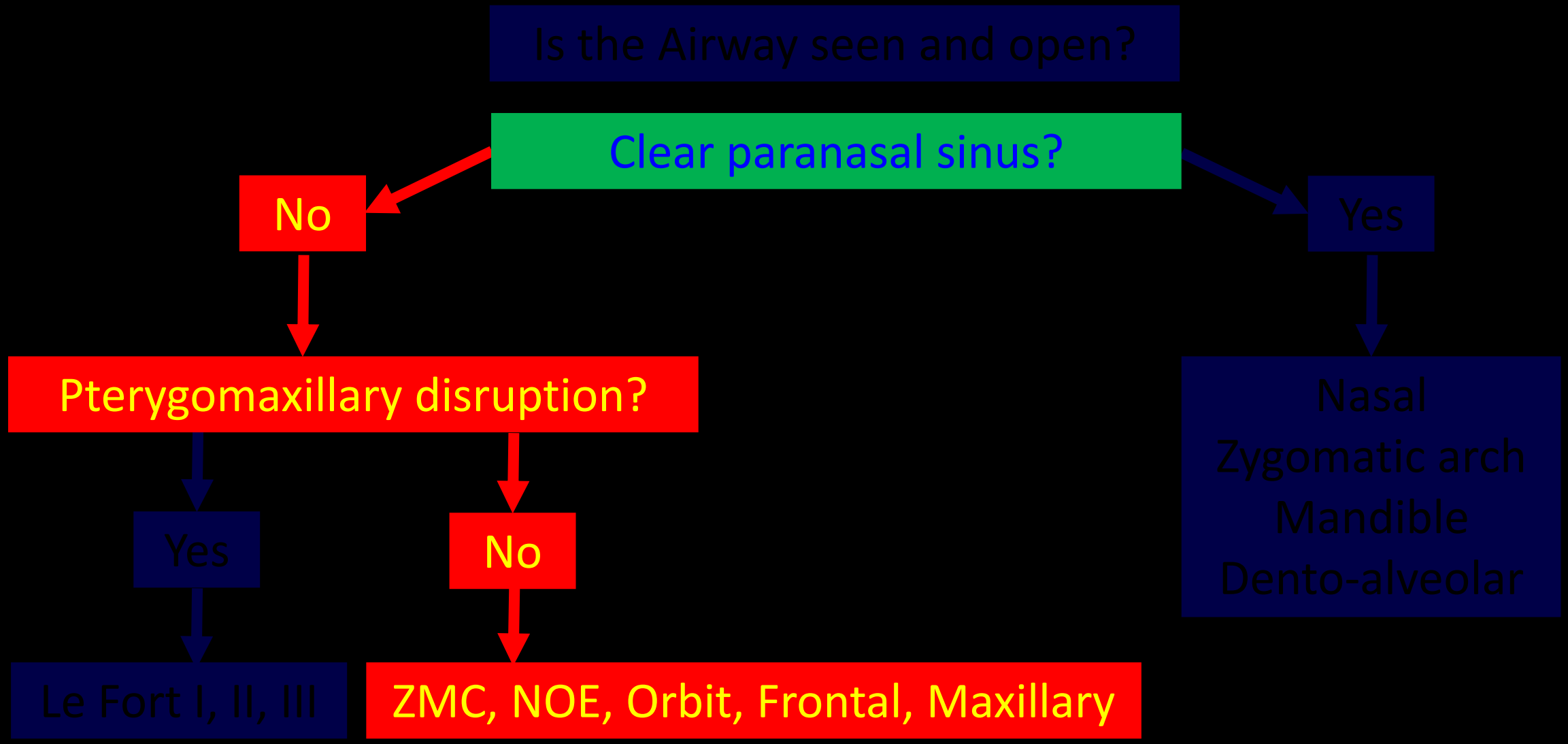
Suggested approach … the search for CRITICAL FINDINGS!



Zygomaticomaxillary Complex (ZMC) Fractures

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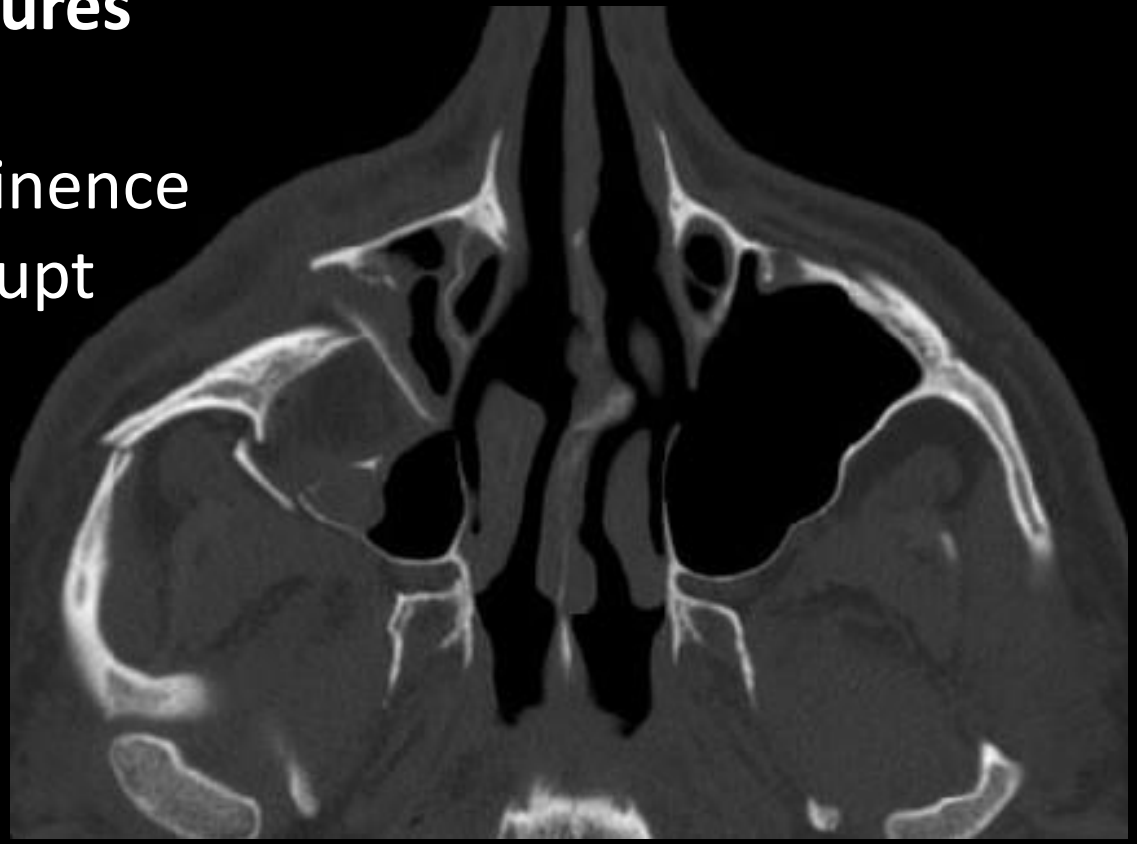
4 principle fracture lines: lateral orbital rim, zygomatic arch, zygomaticomaxillary buttress, inferior orbital rim. They are the 2nd most common facial bone fracture after the nasal bones, and are also known as a tripod, tetrapod, quadripod, malar or trimalar fracture.

Zygomaticomaxillary Complex (ZMC) Fractures

Results from a direct blow to the malar eminence with distinct fracture components that disrupt the anchoring of the zygoma.



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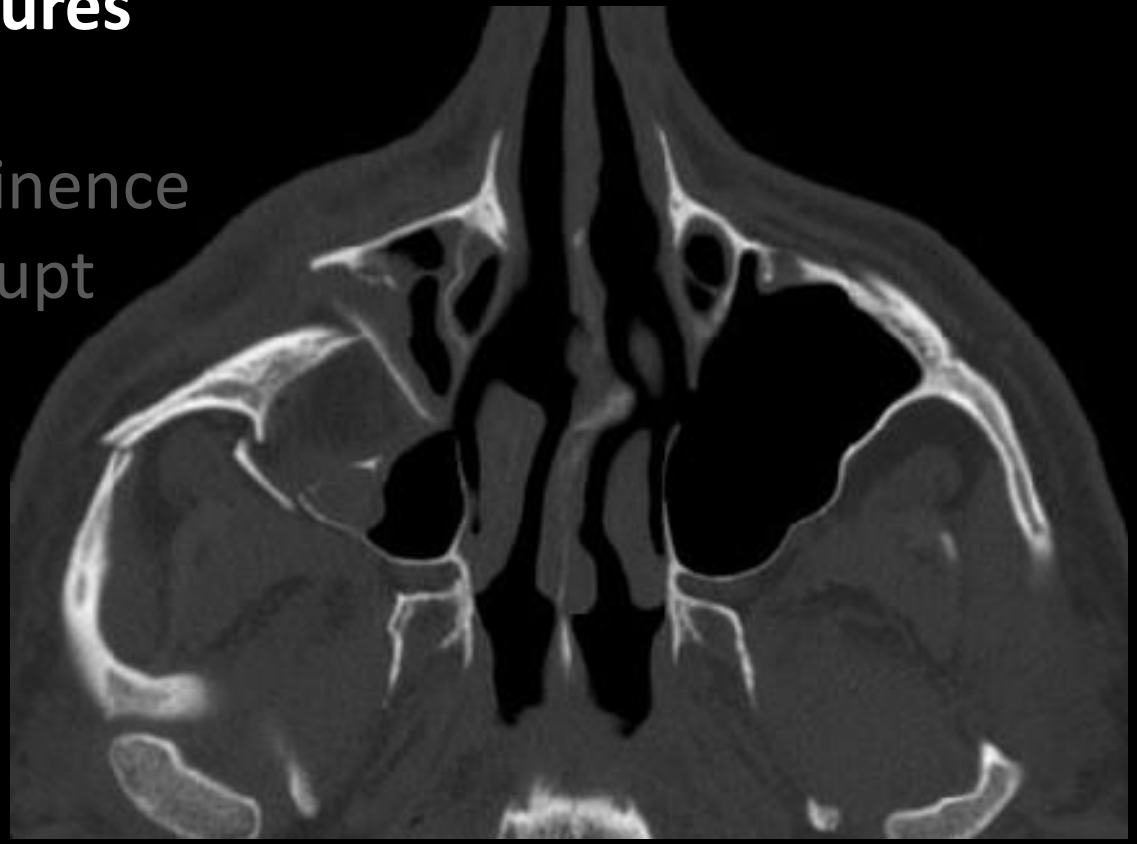
Additionally, the fracture components may result in impingement of the temporalis muscle = trismus;



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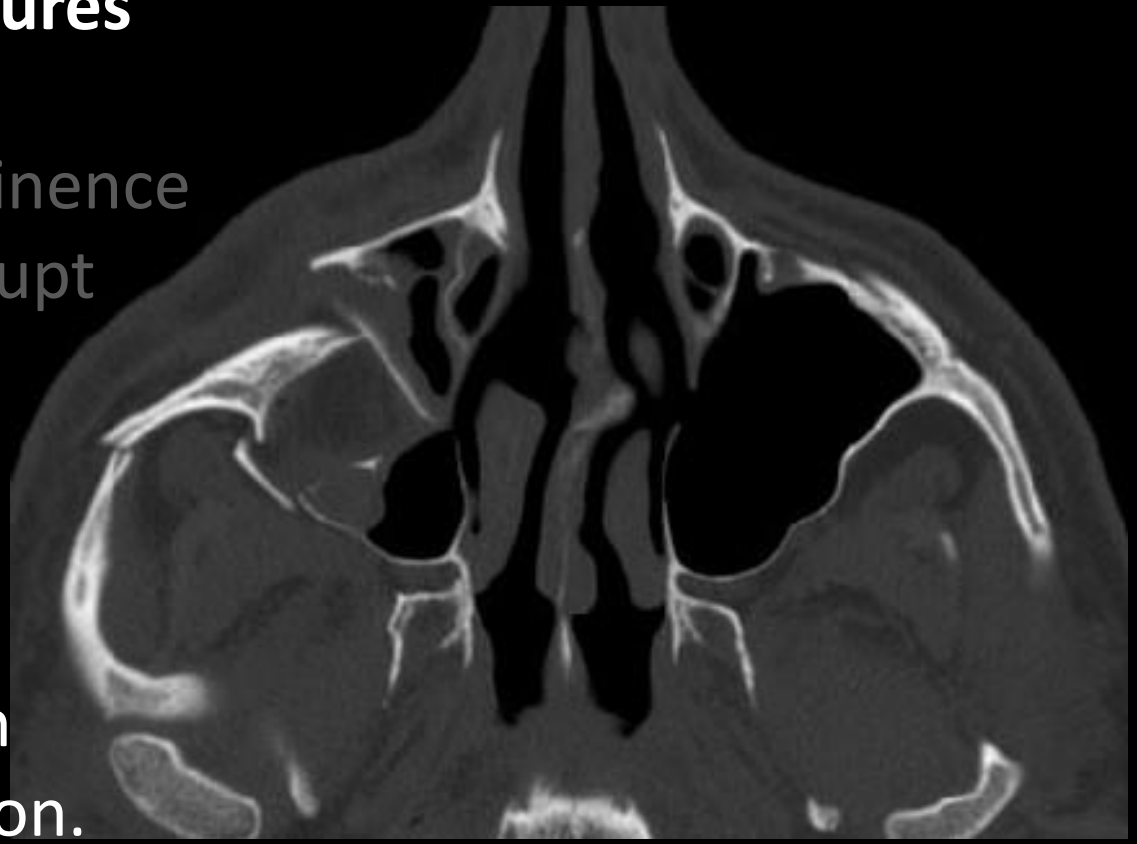

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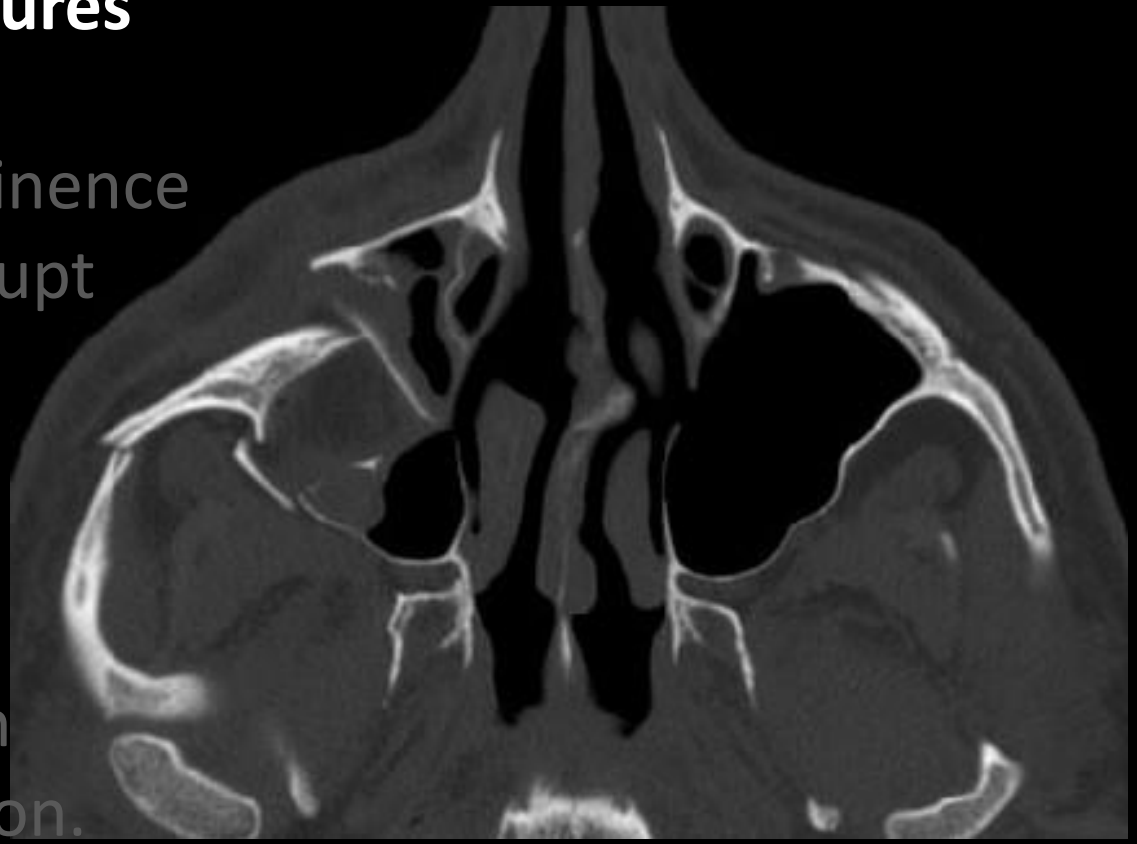
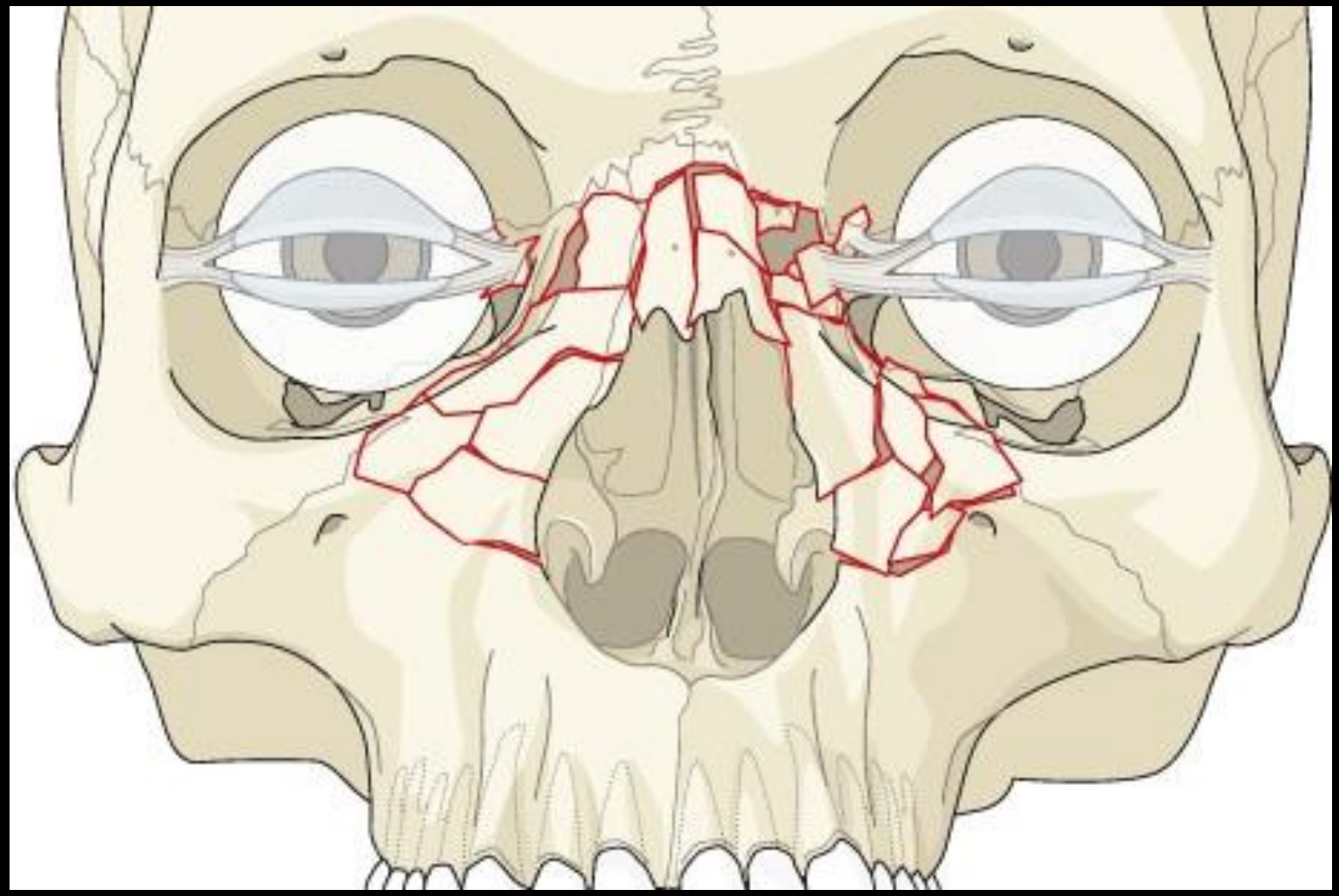


N.B. 2 x orbital rims are fractured: Orbital volume? Globe? Nerve? Extra ocular muscles? Orbital apex?

Naso-orbitoethmoid (NOE) fractures

Comminution of both naso-maxillary buttresses results in fractures involving the nasal bones and septum, ethmoid sinuses, and medial orbital walls.



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Telecanthus secondary to medial canthal tendon injury (*Markowitz & Manson classification system = whether this tendon is disrupted or not*) Reports should try to comment on the degree of comminution of the nasomaxillary buttress, specifically in the region of the lacrimal fossa, where the medial canthus attaches.

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Nasofrontal duct disruption and subsequent frontal mucocoele formation

Nasofrontal duct injury is suggested if base of frontal sinus is fractured &/or the anterior ethmoid complex.

Ravinda VM et al. Surg Neurol Int 2015; 6:141
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Surgical obliteration of the frontal sinus might be needed to prevent mucocele formation.

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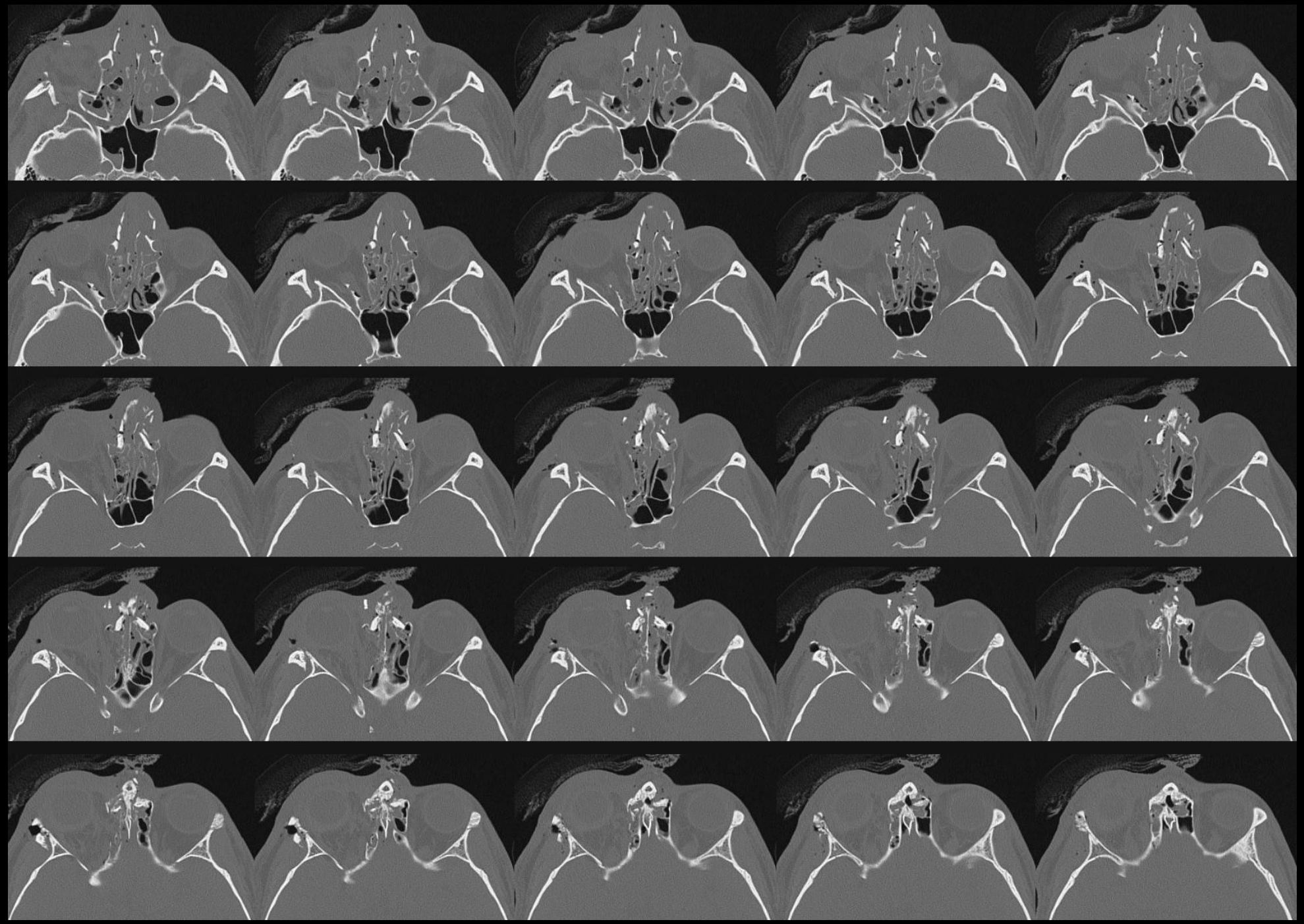
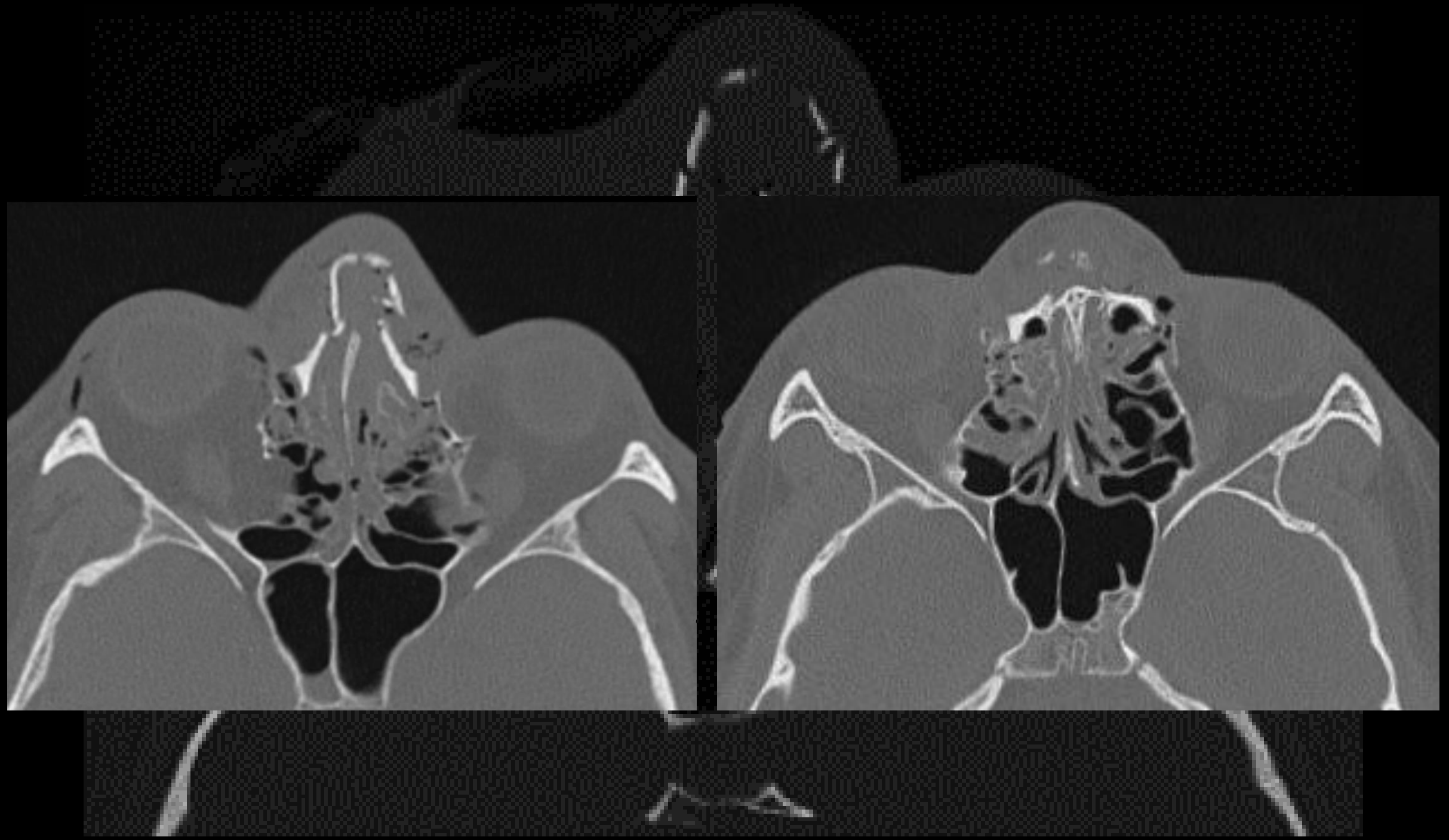
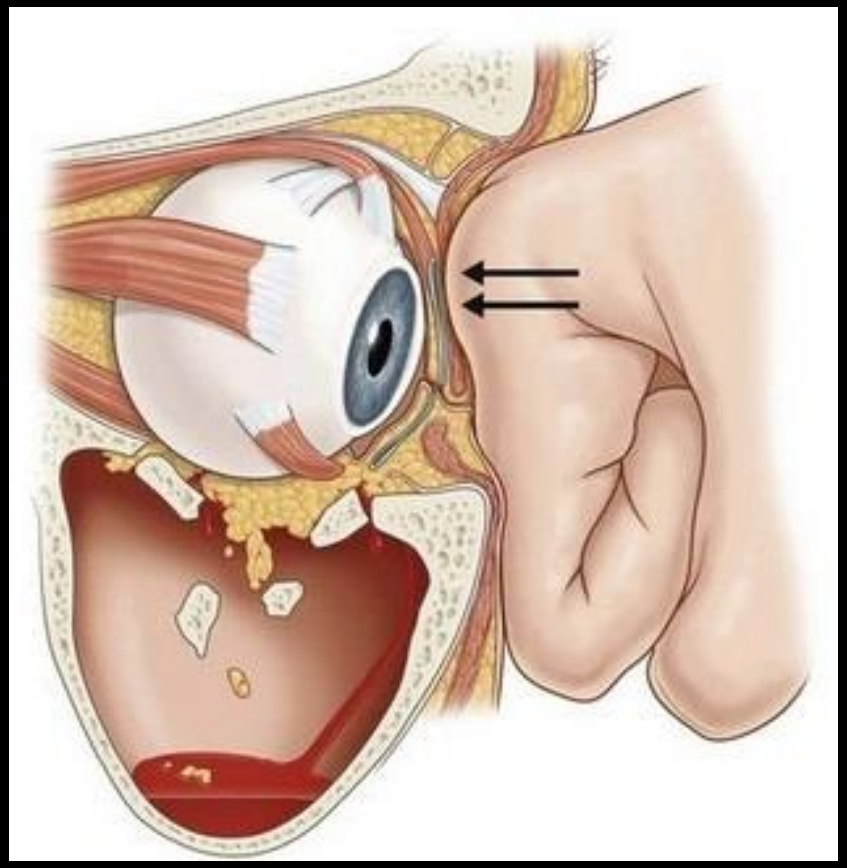
CSF rhinorrhoea due to fracture through the cribriform plate





Orbit fractures

Orbital blow-out fractures occur when there is a fracture of one of the walls of orbit but the orbital rim remains intact (‘pure’) (‘impure’ = if the orbital rim is fractured).



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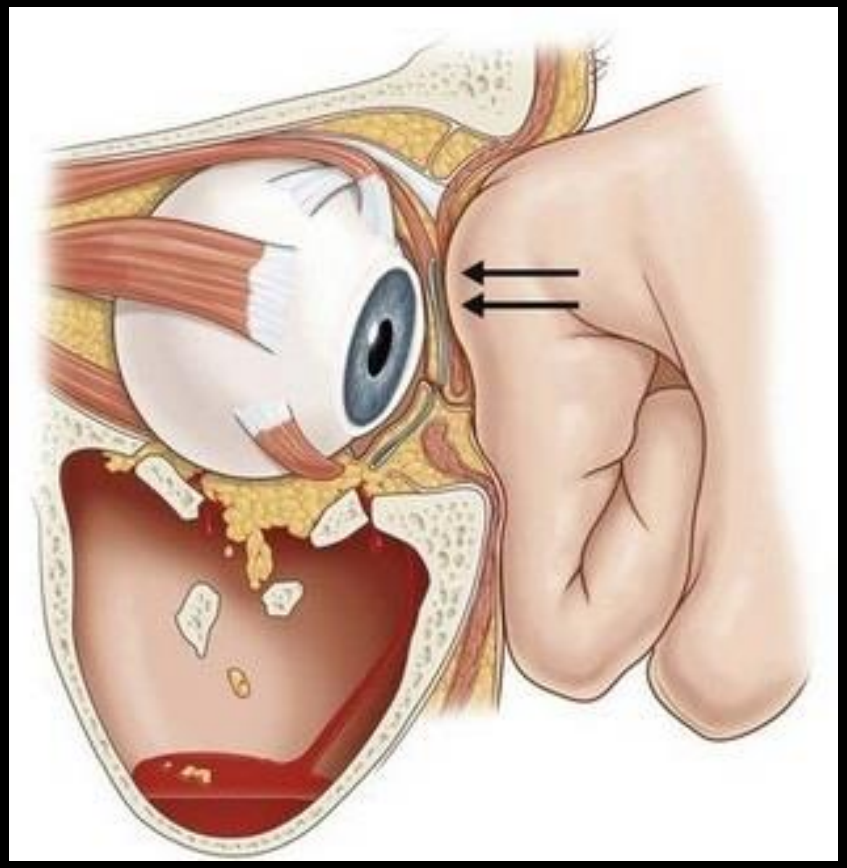

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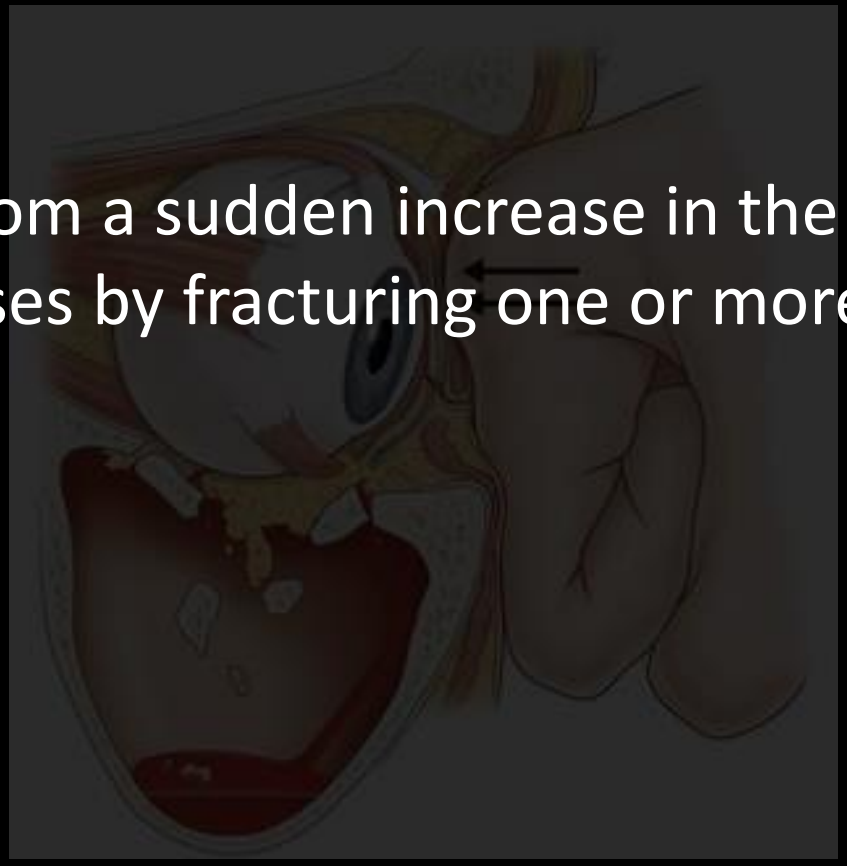

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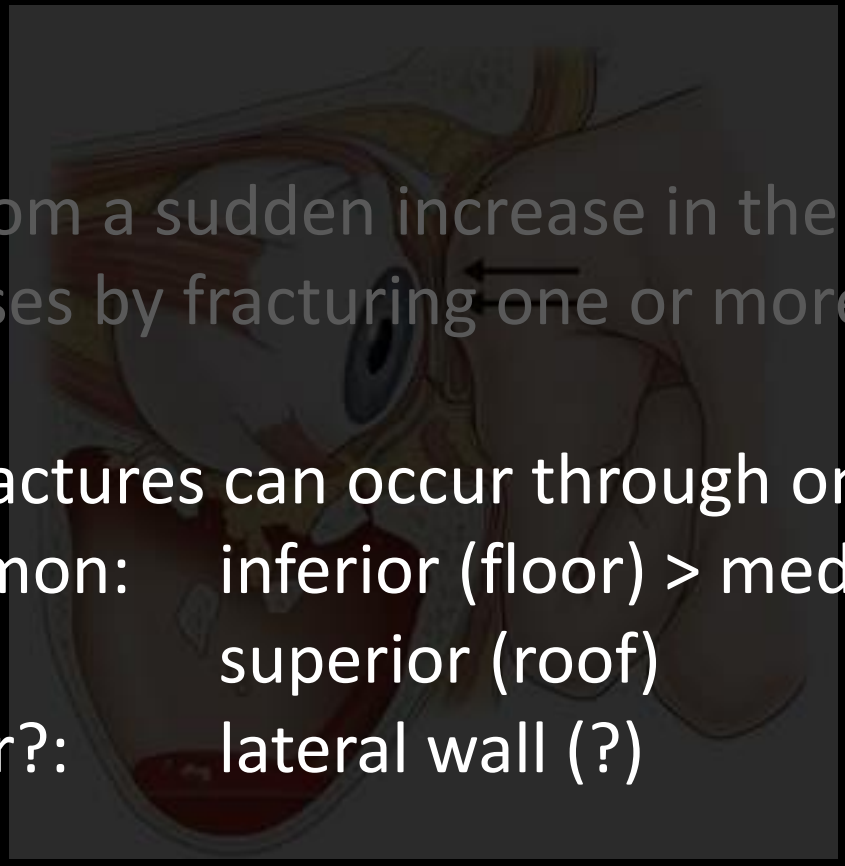

Resulting from a sudden increase in the intra-orbital pressure which decompresses by fracturing one or more of the bounding walls of the orbit.

Blow-out fractures can occur through one or more of the walls of the orbit:

Common:	inferior (floor) > medial wall (lamina papyracea)
Rare:	superior (roof)
Never?:	lateral wall (?)

Orbit fractures

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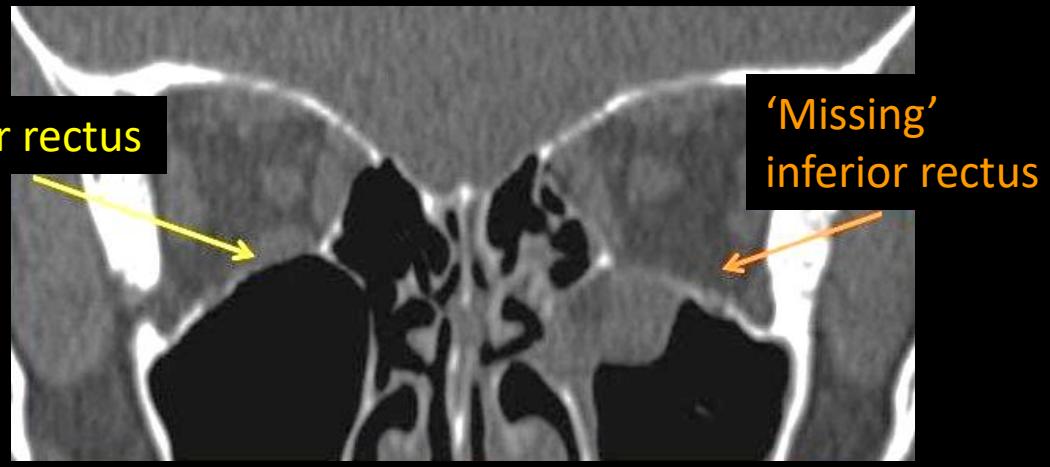
In the young, the fracture may spring back into place (known as a ‘trapdoor fracture’).



Yano H, Minagawa T, Masuda K & Hirano A. Urgent rescue of “missing rectus” in blowout fracture. Journal of Plastic, Reconstructive & Aesthetic Surgery (JPRAS). 2009: 62 (9); 301-304

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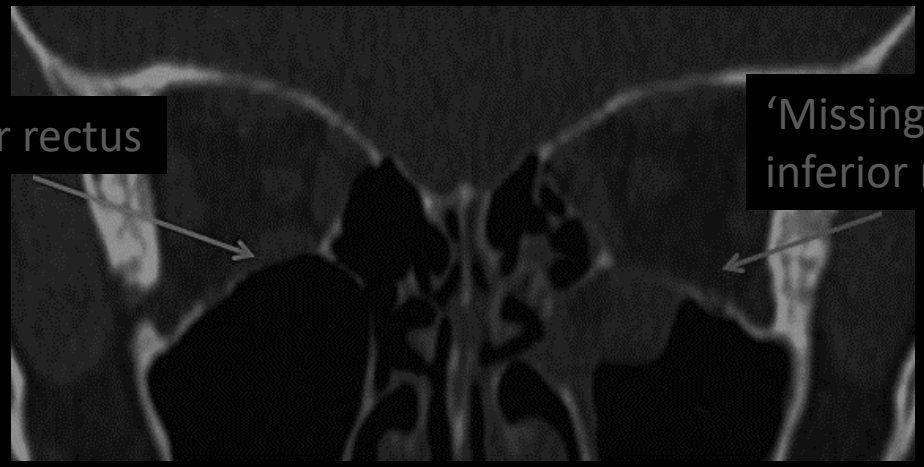

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Most fractures occur in the floor posterior and medial to the infraorbital groove.

In approximately 50% of cases, inferior blow-out fractures are associated with fractures of the medial wall

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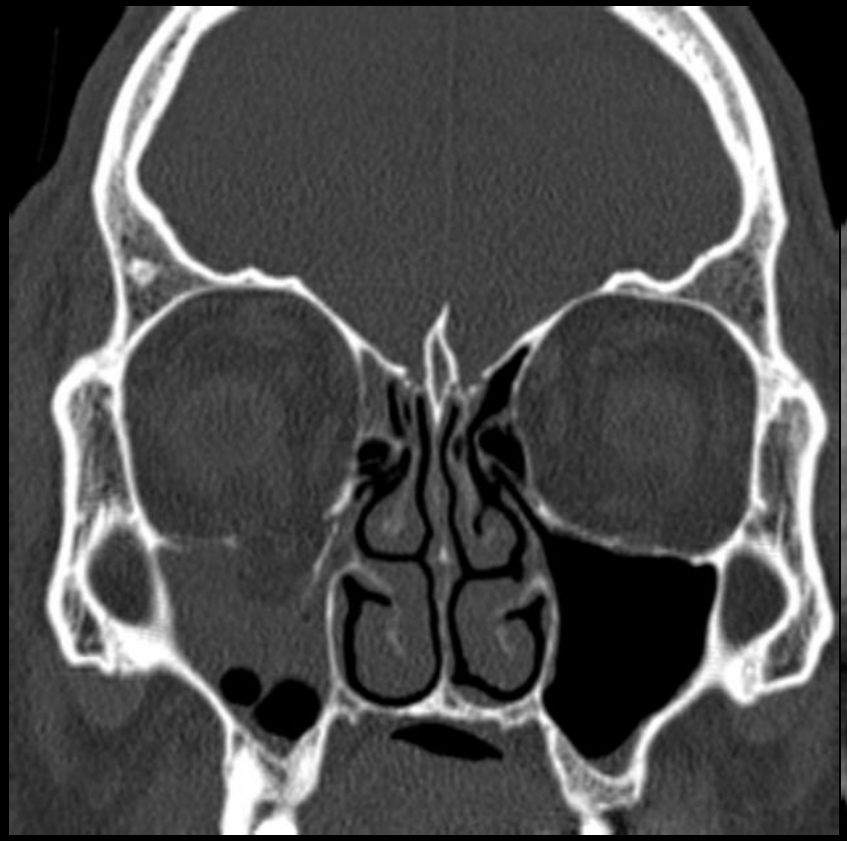
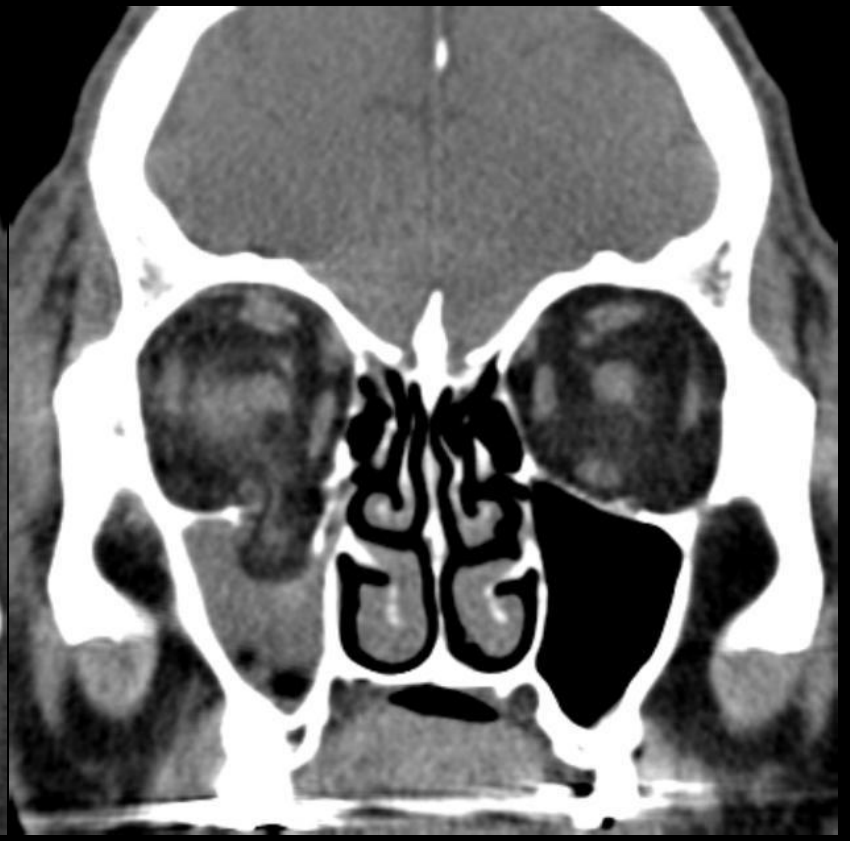
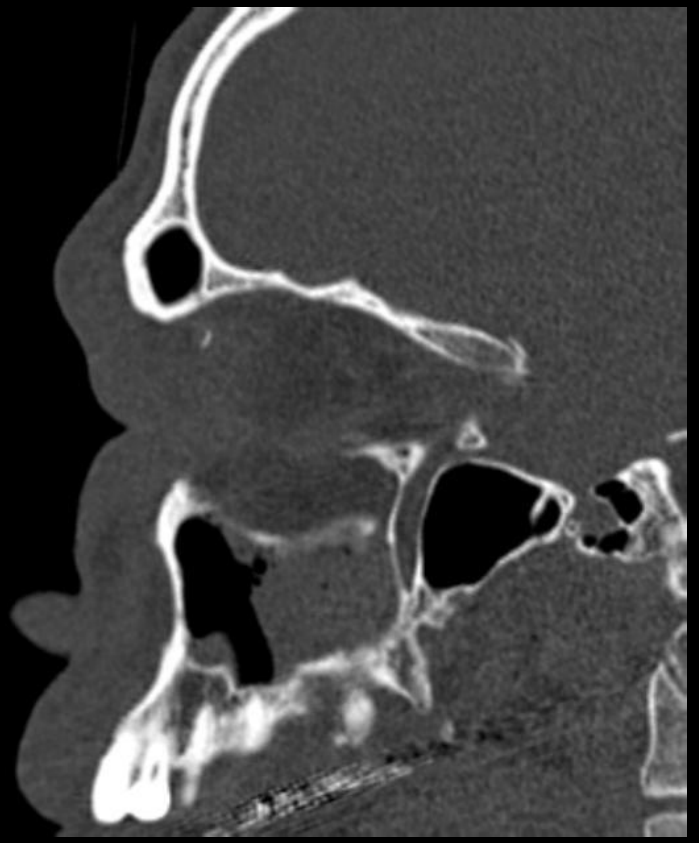
Orbit fractures

Inferior blow-out fractures

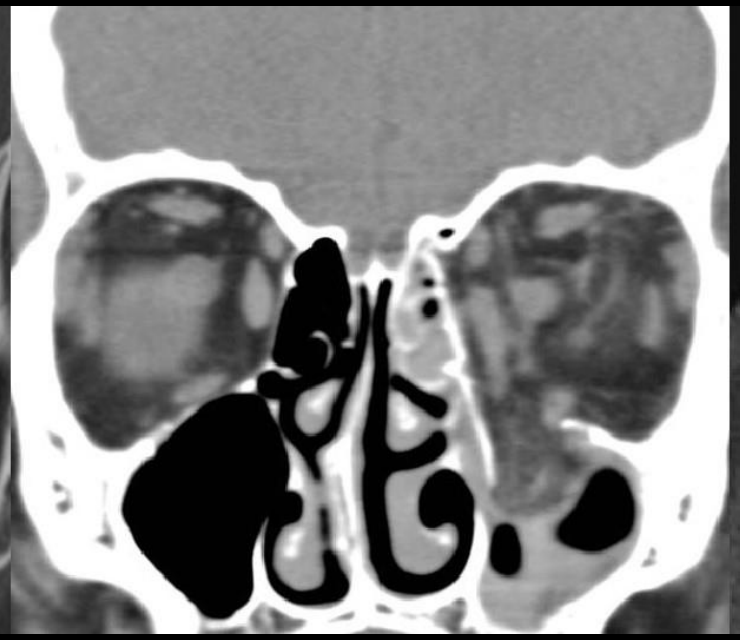






Orbit fractures

Medial blow-out fractures are the second most common type, occurring through the lamina papyracea. Orbital fat and the medial rectus muscle may prolapse into the ethmoid air cells.



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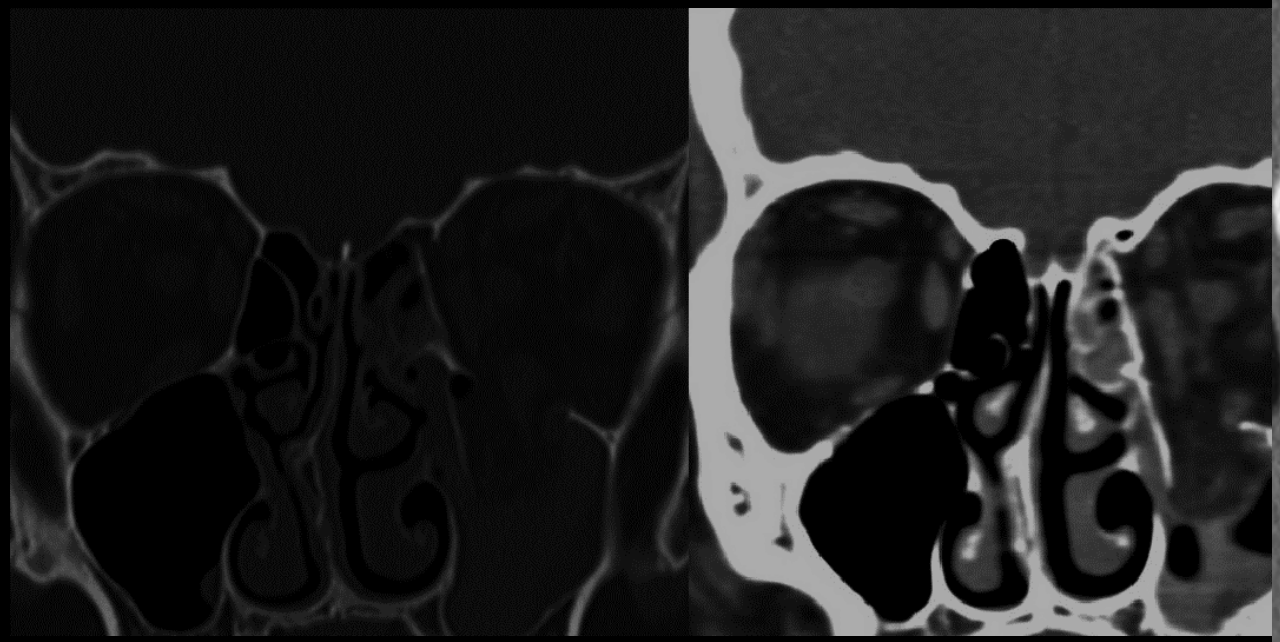

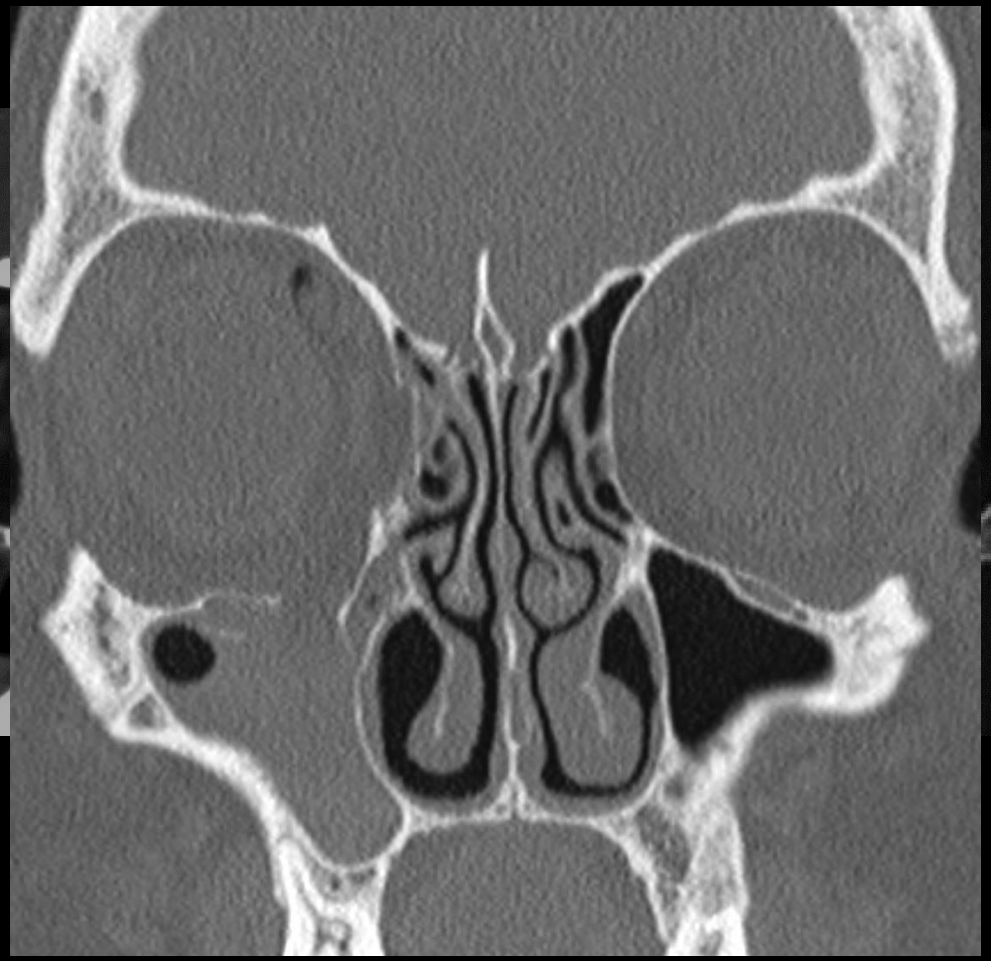

Orbit fractures

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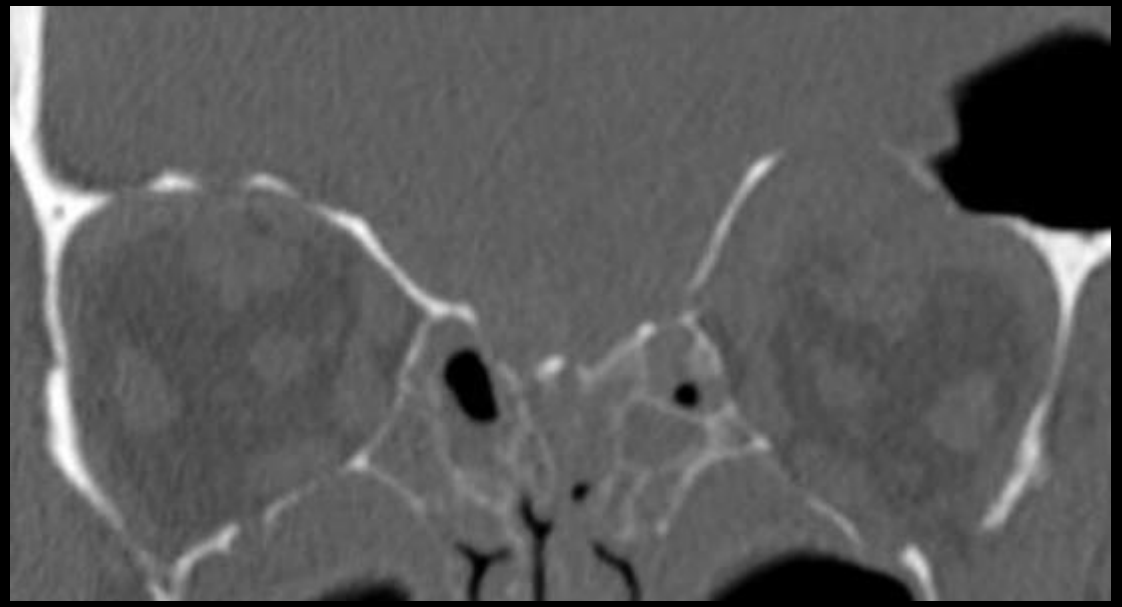
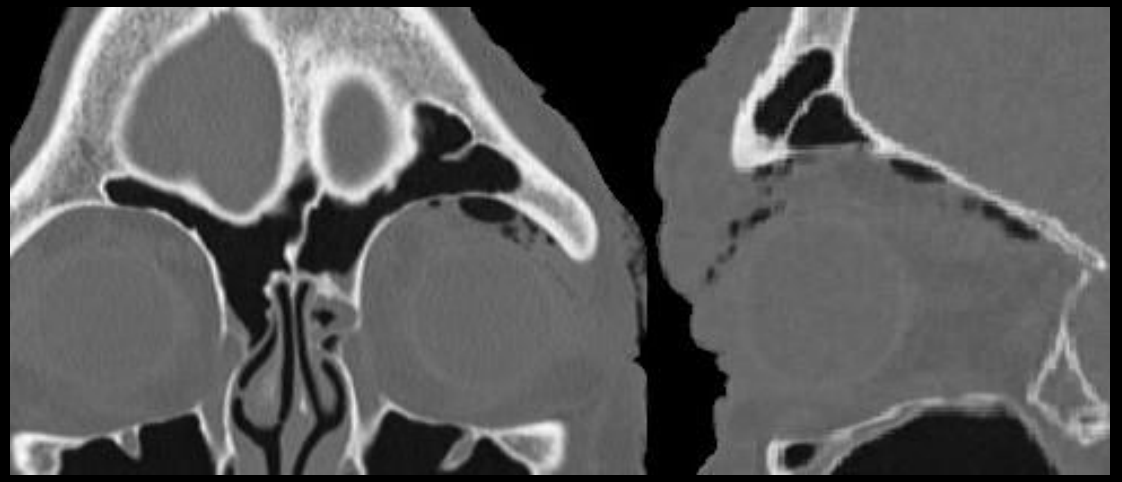
Fractures may only involve the sinus, the anterior cranial fossa (less common), or both sinus and anterior cranial fossa. In the latter, CSF leaks and meningitis may occur.

Very easily missed on axial images





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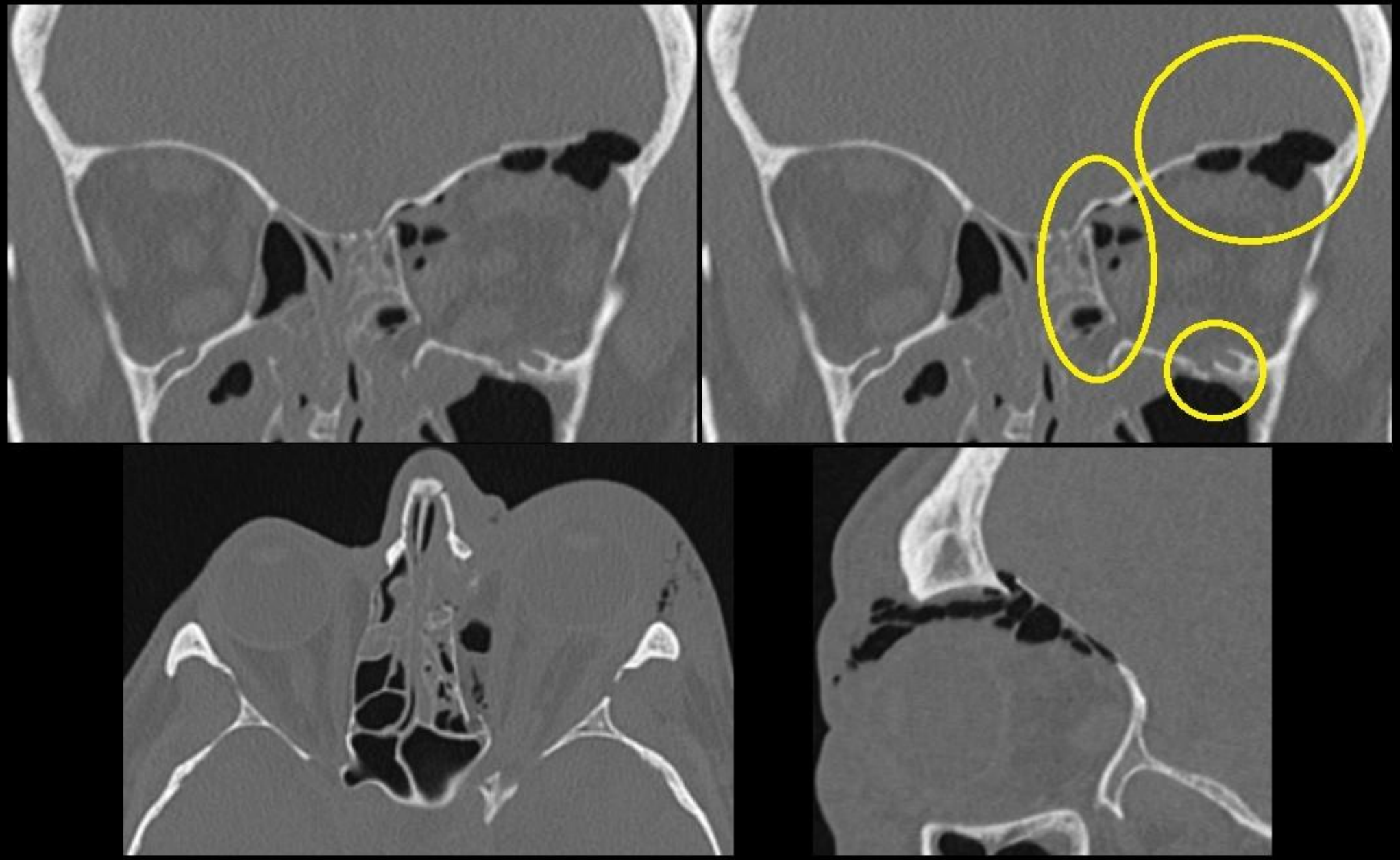

Orbit fractures

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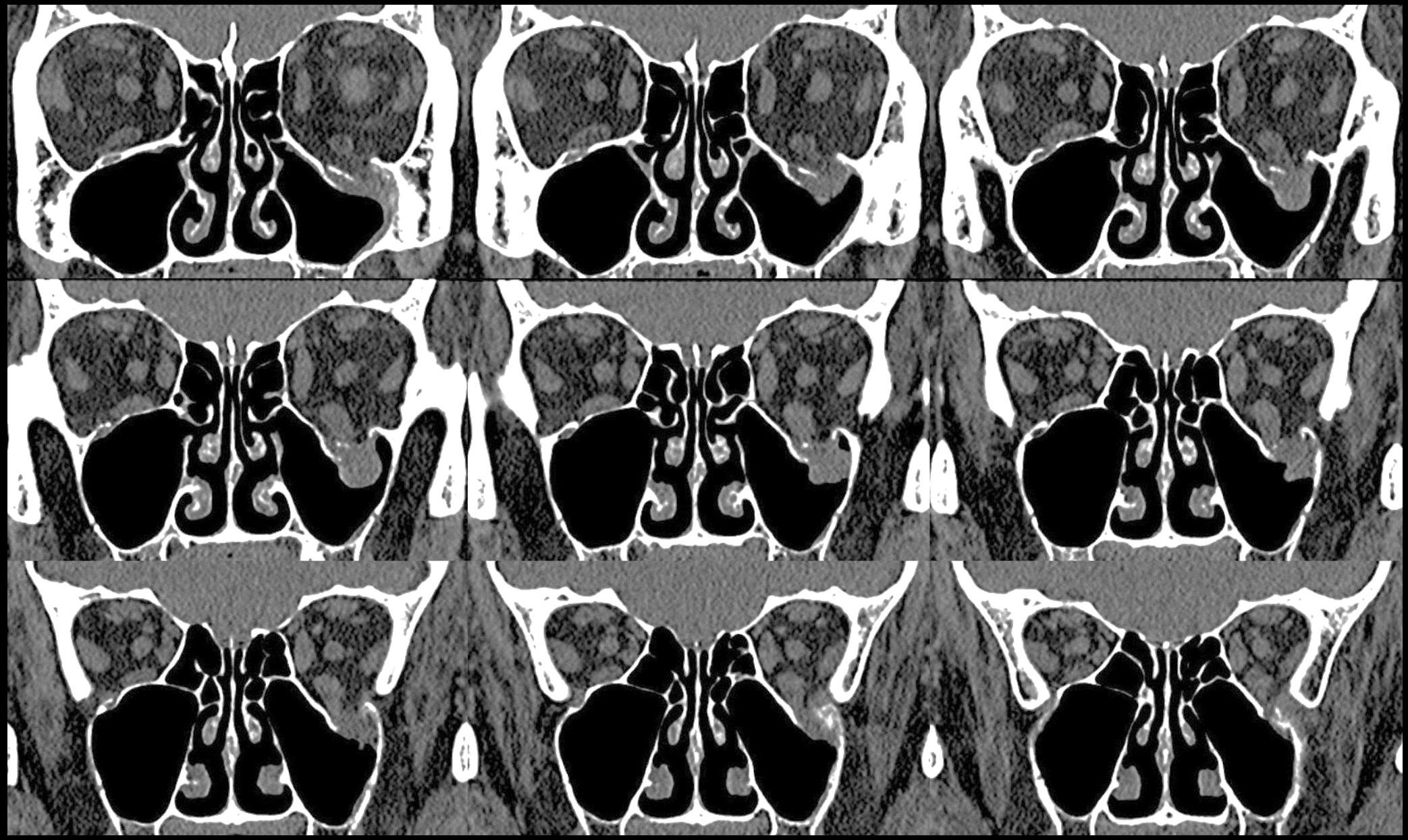
- extraocular muscle entrapment - suspected if there is a change in the shape &/or angle of the muscle

Orbit fractures



Maxillary sinus fractures … NOT!

The posterior superior alveolar canal

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The alveolar canals are apertures in the centre of the infratemporal surface of the maxilla, these transmit the posterior superior alveolar vessels and nerves.

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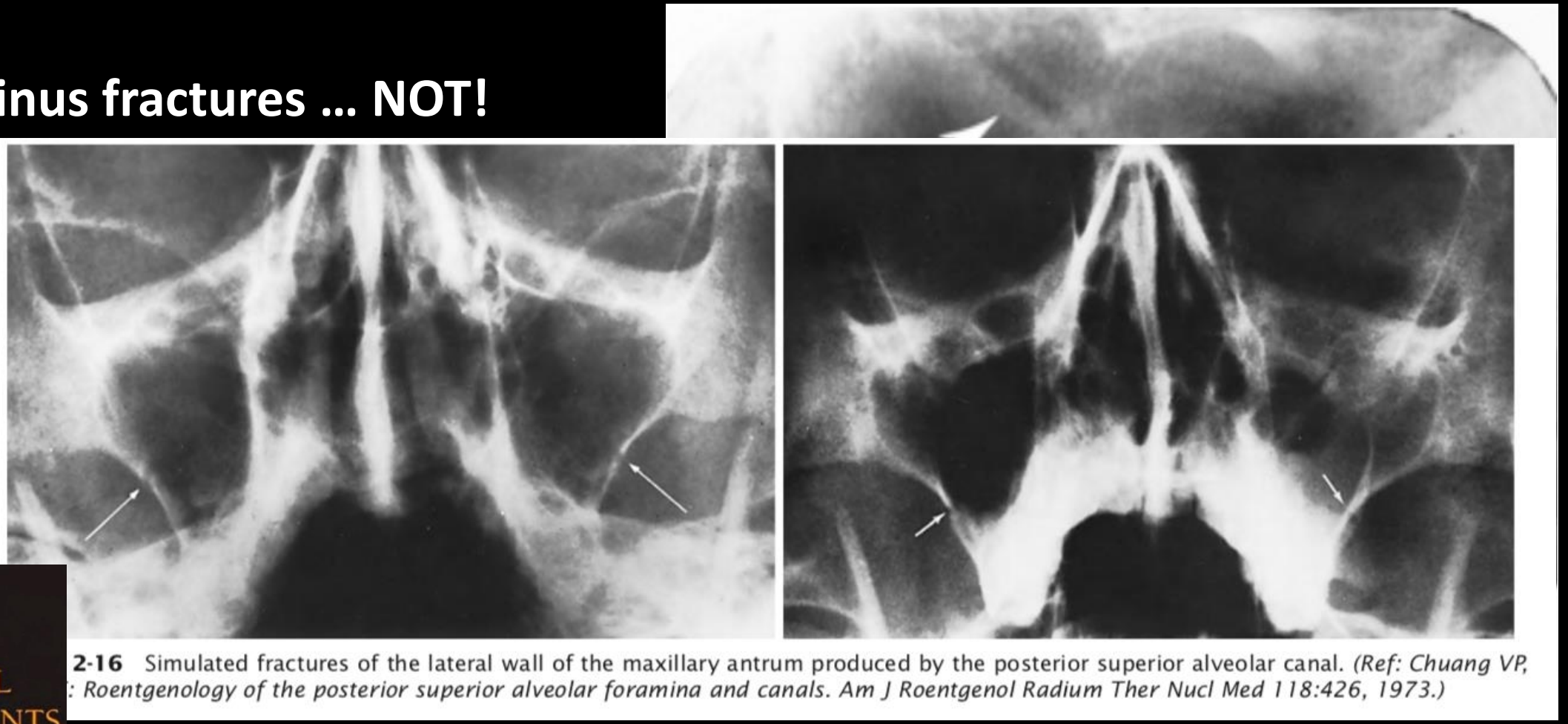
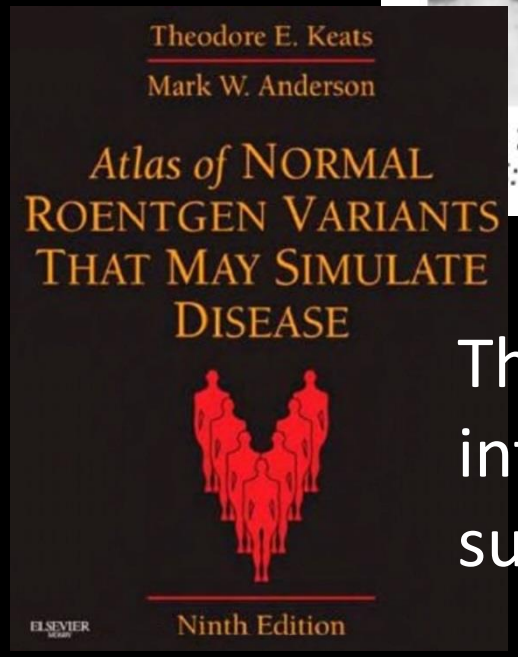


2-16 Simulated fractures of the lateral wall of the maxillary antrum produced by the posterior superior alveolar canal. *(Ref: Chuang VP, : Roentgenology of the posterior superior alveolar foramina and canals. Am J Roentgenol Radium Ther Nucl Med 118:426, 1973.)*



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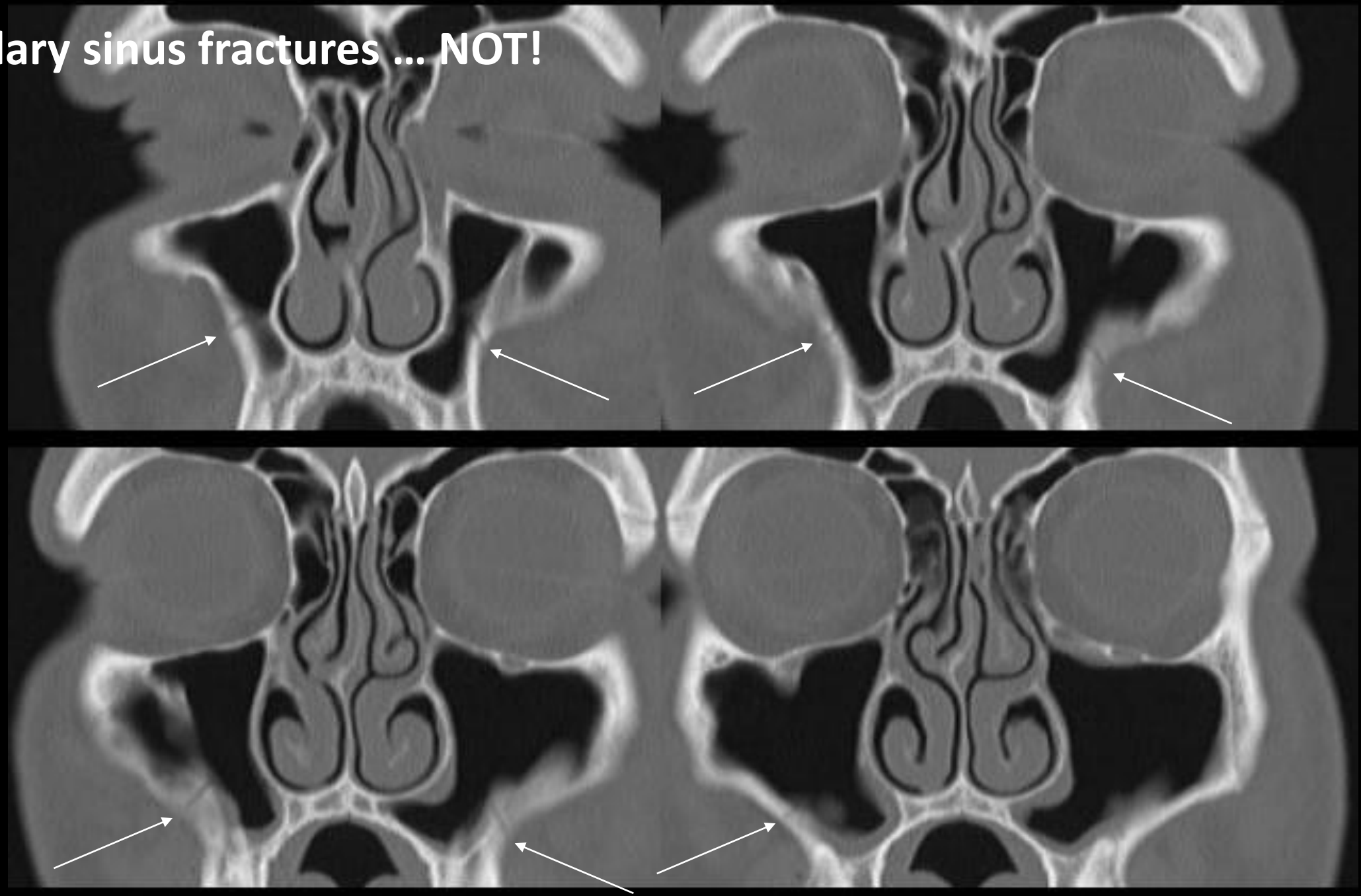
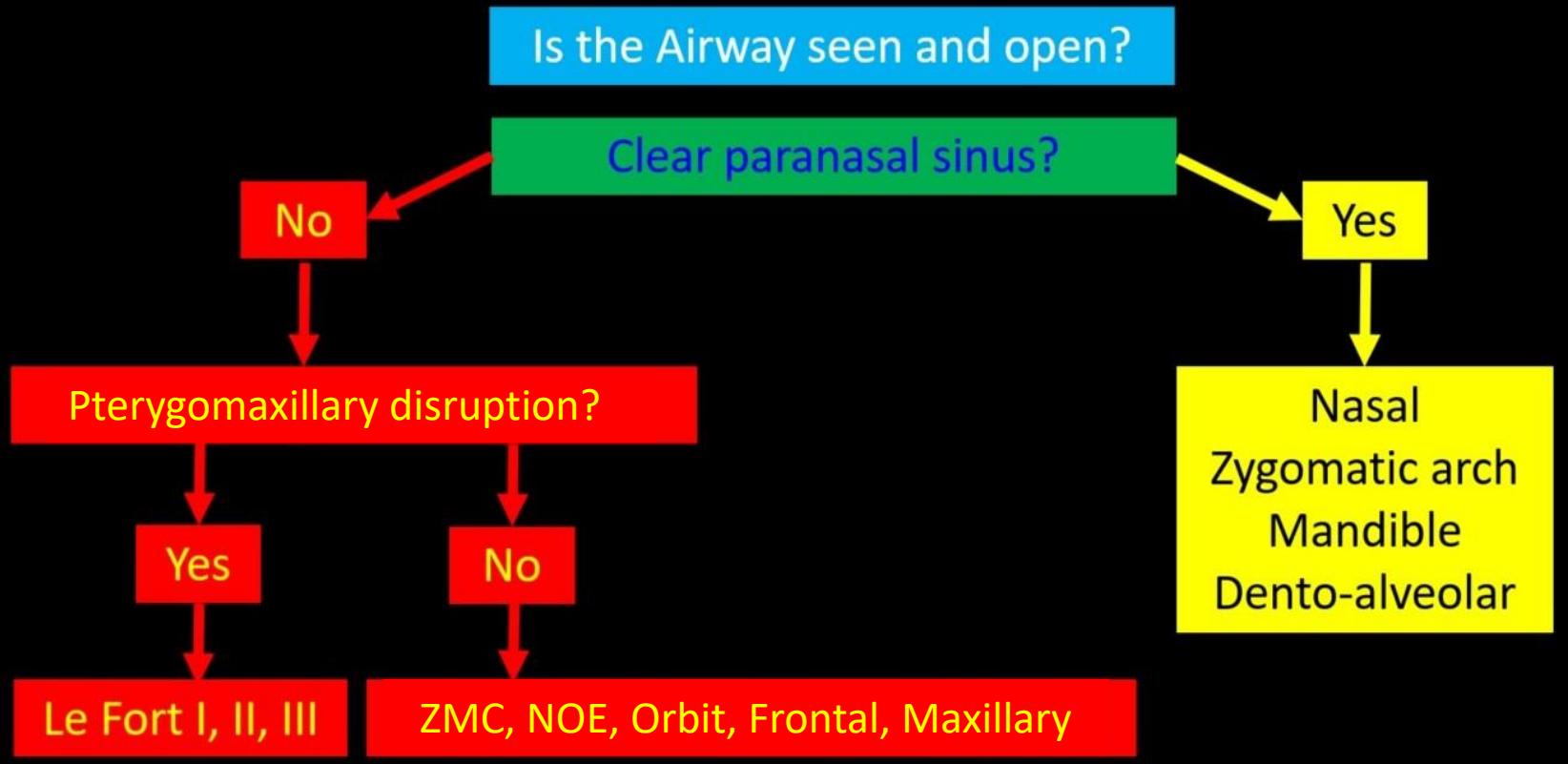
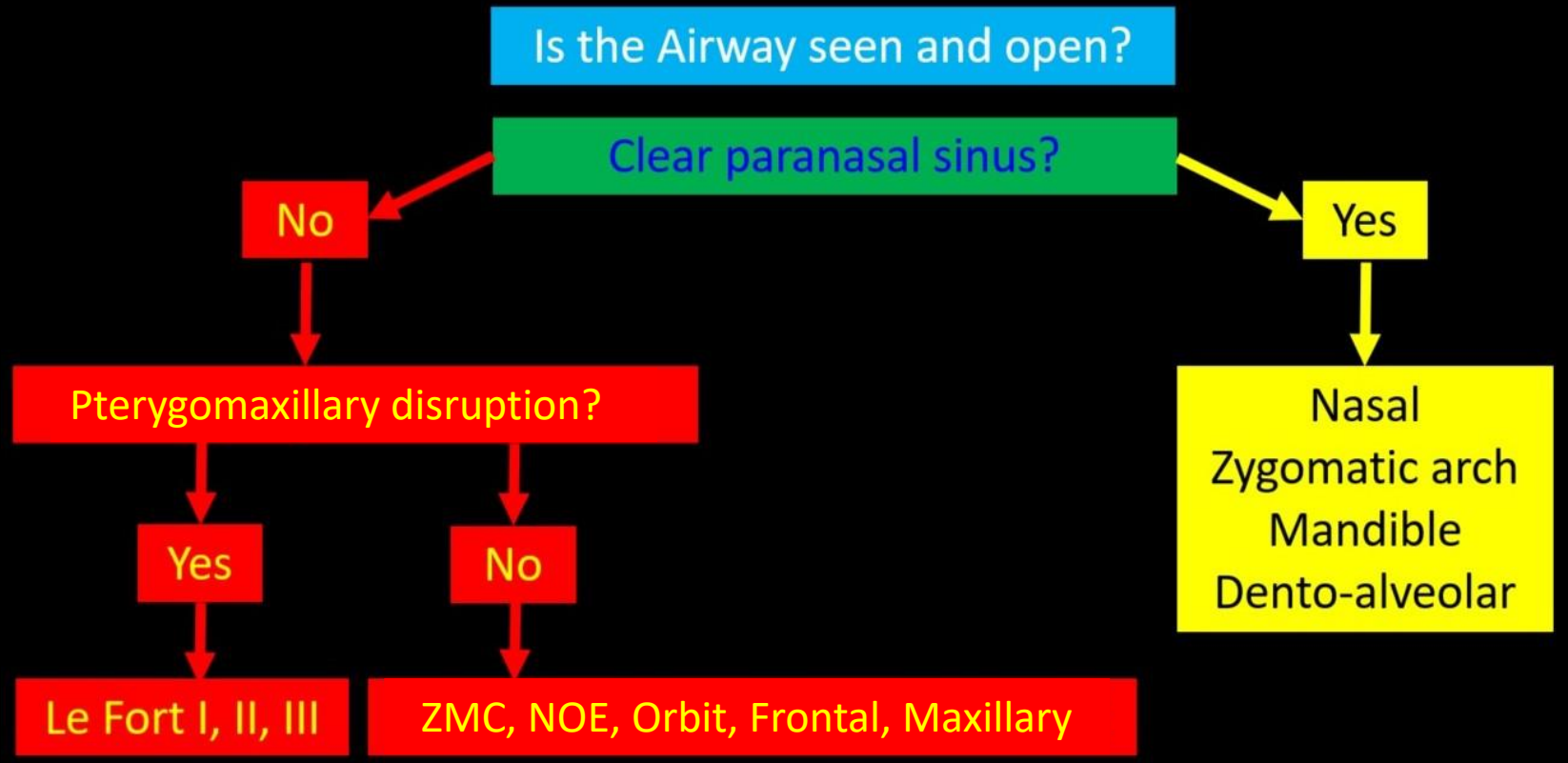


Summary


Is the Airway seen and open?
Clear paranasal sinus?
No
Yes
Pterygomaxillary disruption?
Nasal
Zygomatic arch
Mandible
Dento-alveolar
Yes
No
Le Fort I, II, III
ZMC, NOE, Orbit, Frontal, Maxillary

Summary

ALWAYS check for intracranial & C-Spine injuries first.
2 critical facial findings – airway & vision



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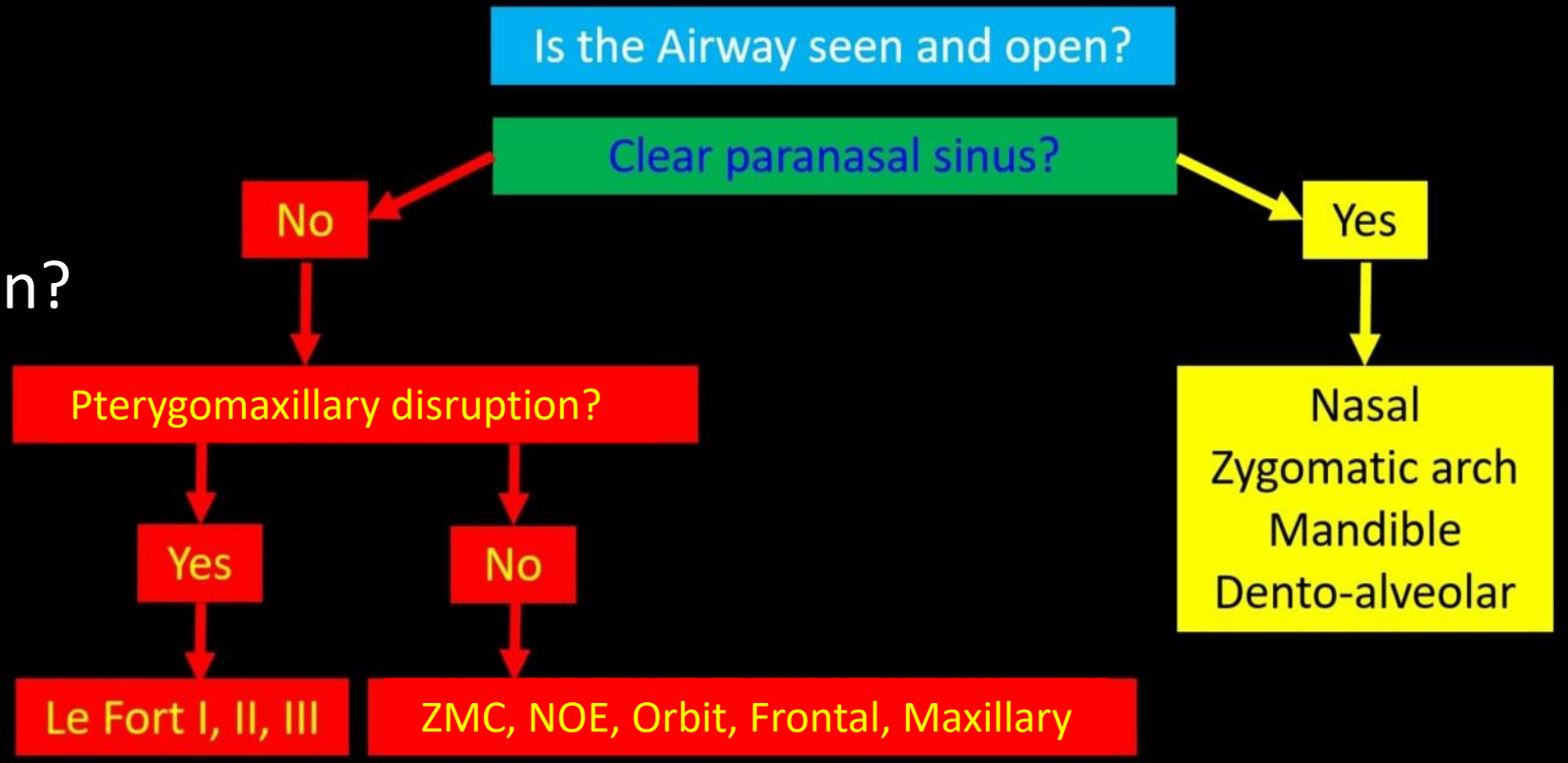

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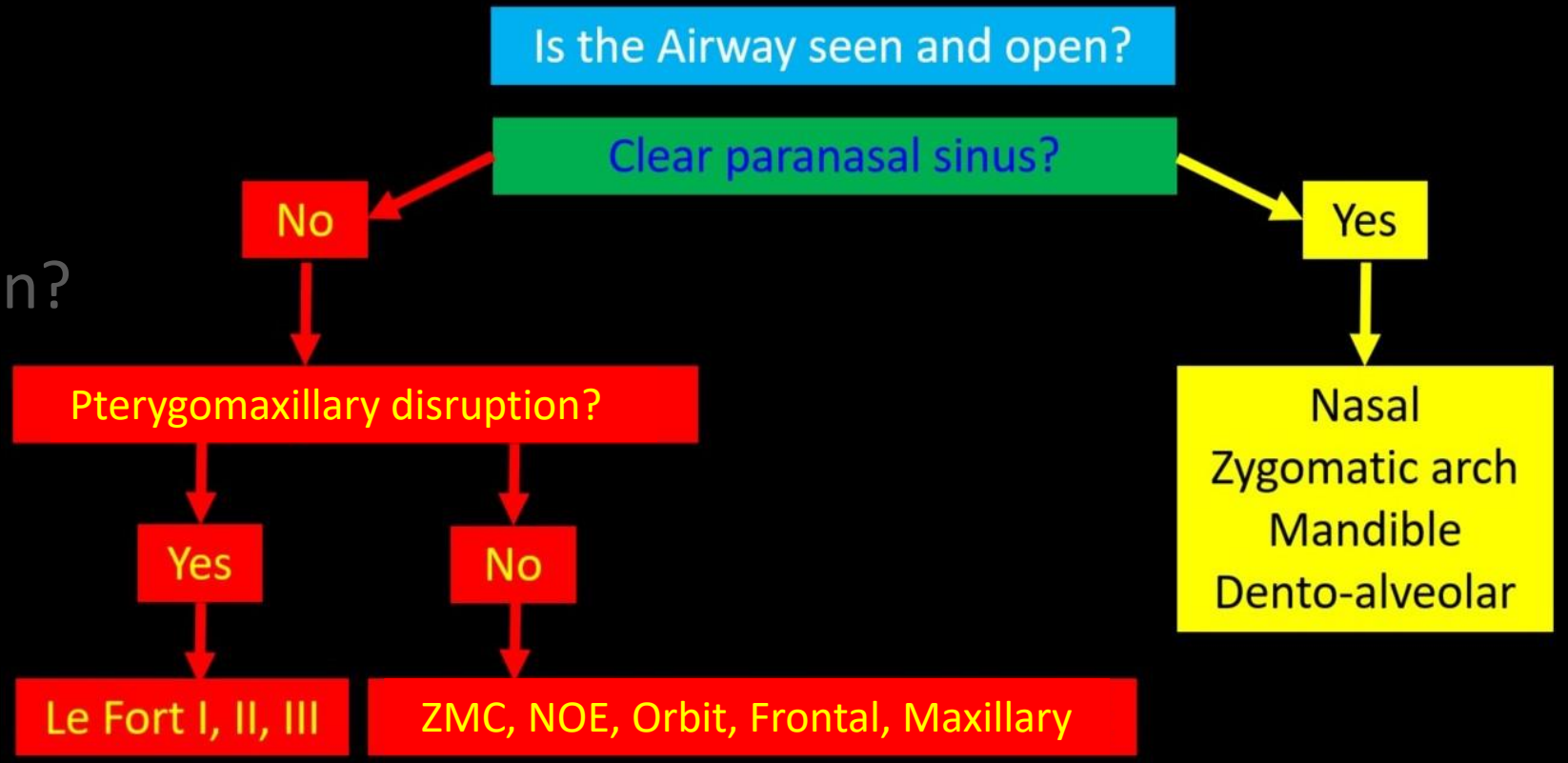
Try to fit all fractures into 1 or 2 patterns (but don't worry if you can't)



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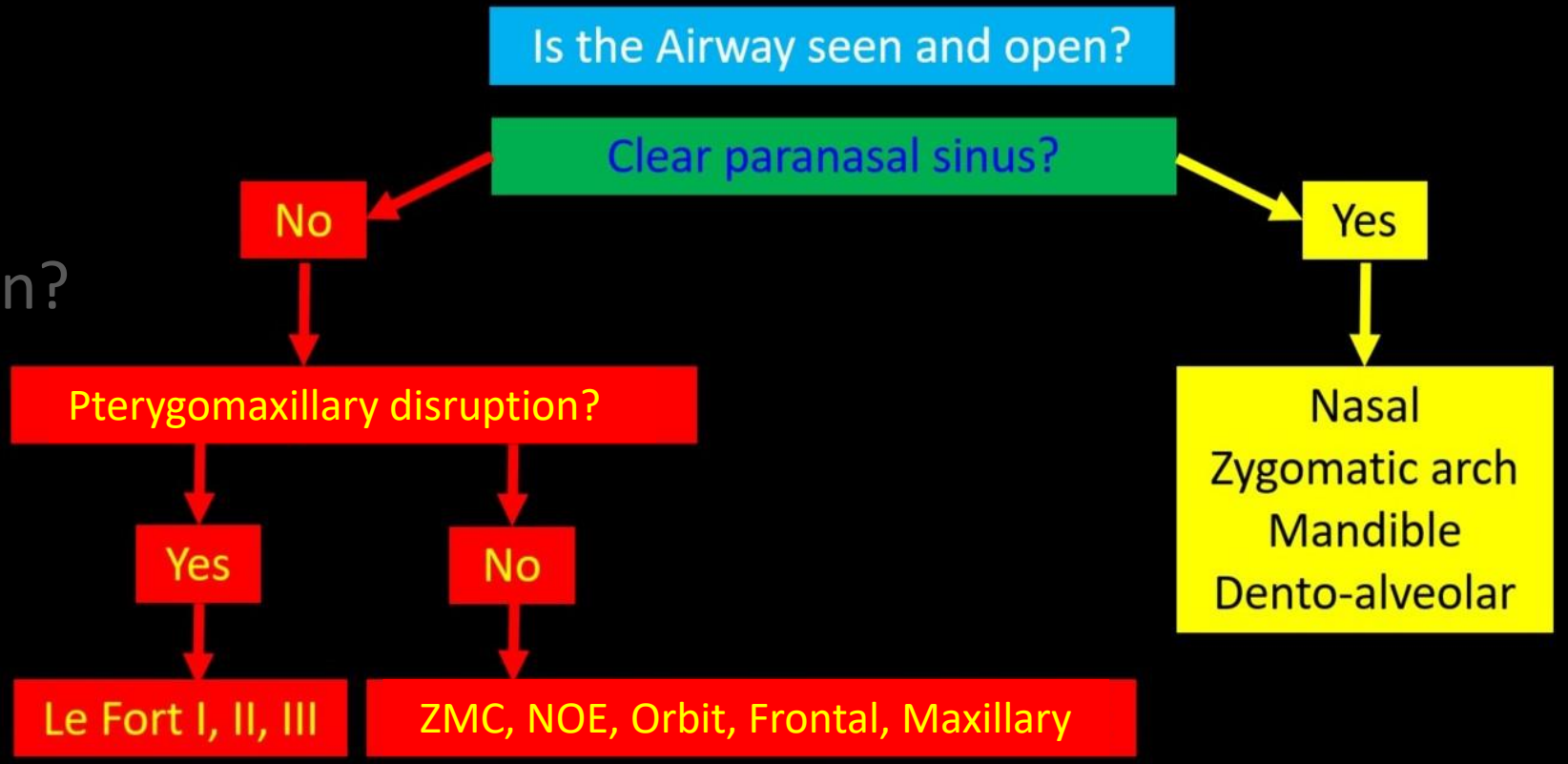

Look for potential soft-tissue complications.

The End?

Any Questions??

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Thank you for your attention.

Acknowledgements/References:

1) Hopper RA, Salemy S & Sze RW. Diagnosis of Midface fractures with CT: What the surgeon needs to know. Radiographics. May-June 2006.
2) https://radiopaedia.org/articles/facial-fractures; https://radiopaedia.org/articles/nasal-bone-fracture
3) https://radiopaedia.org/articles/le-fort-fracture-classification; https://radiopaedia.org/articles/zygomaticomaxillary-complex-fracture-1
4) https://radiopaedia.org/articles/naso-orbitoethmoid-noe-complex-fracture;
5) https://radiopaedia.org/articles/orbital-blow-out-fracture
6) Rathachai Kaewlai MD. Division of Emergency Radiology, Ramathibodi Hospital, Bangkok, Thailand. 25 Sep 2016 (available via: https://www.slideshare.net/TeleradiologySolutio/20160925-ser-drrathachai-kaewlai?qid=d60b52e2-a877-4014921c0ad7c3c605fb&v=&b=&from_search=19)