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TRAUMA & EMERGENCY RADIOLOGY

Face and neck injuries – what the resident needs to know on call

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Conflict of interests

- No conflict of interests related to the contents of this presentation



Three tips for residents

Be systematic in your approach (it's all about anatomy)

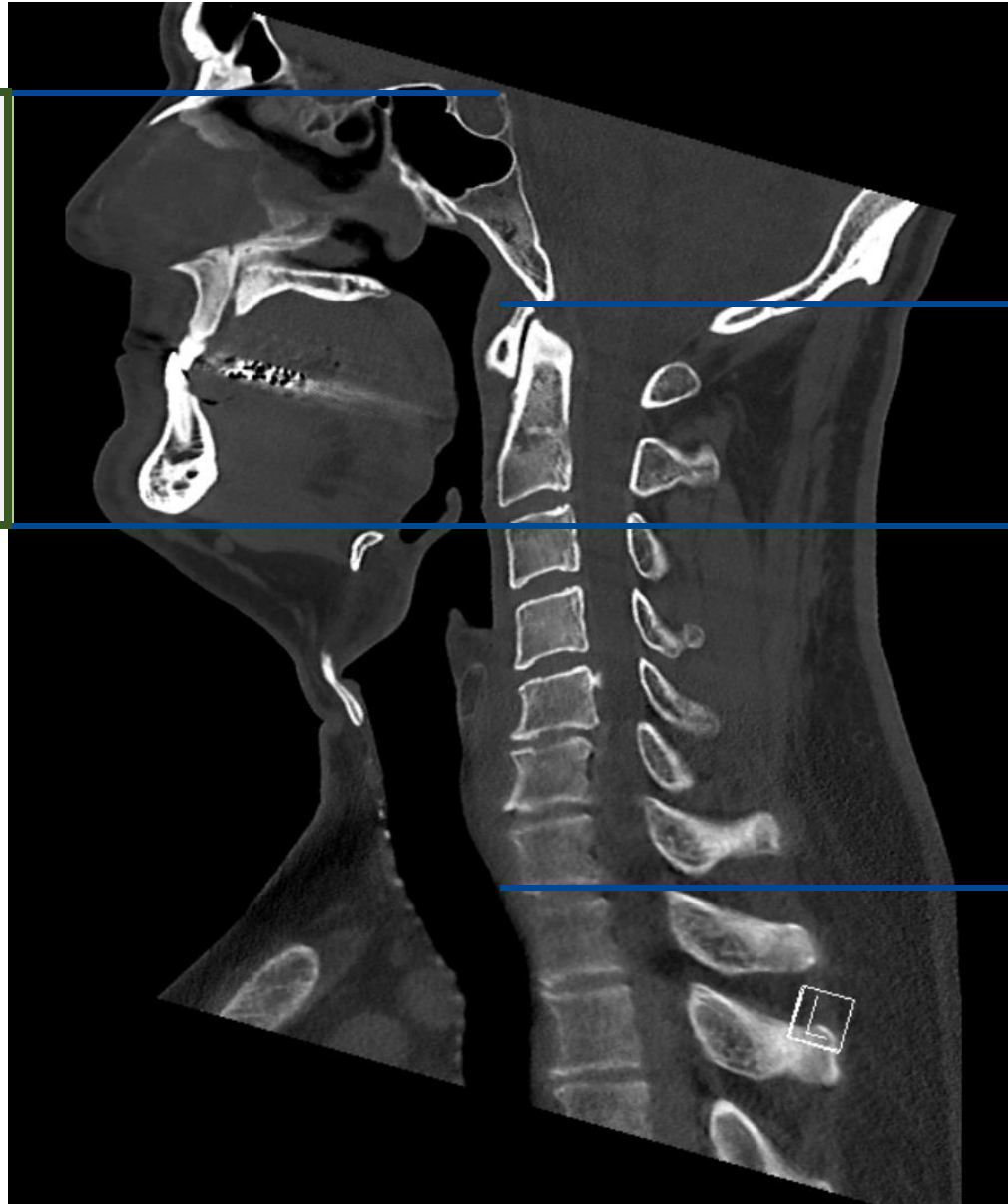
It's not only about the bones – look for associated findings and complications

Call a friend (surgeon)



Skull base

1 Face



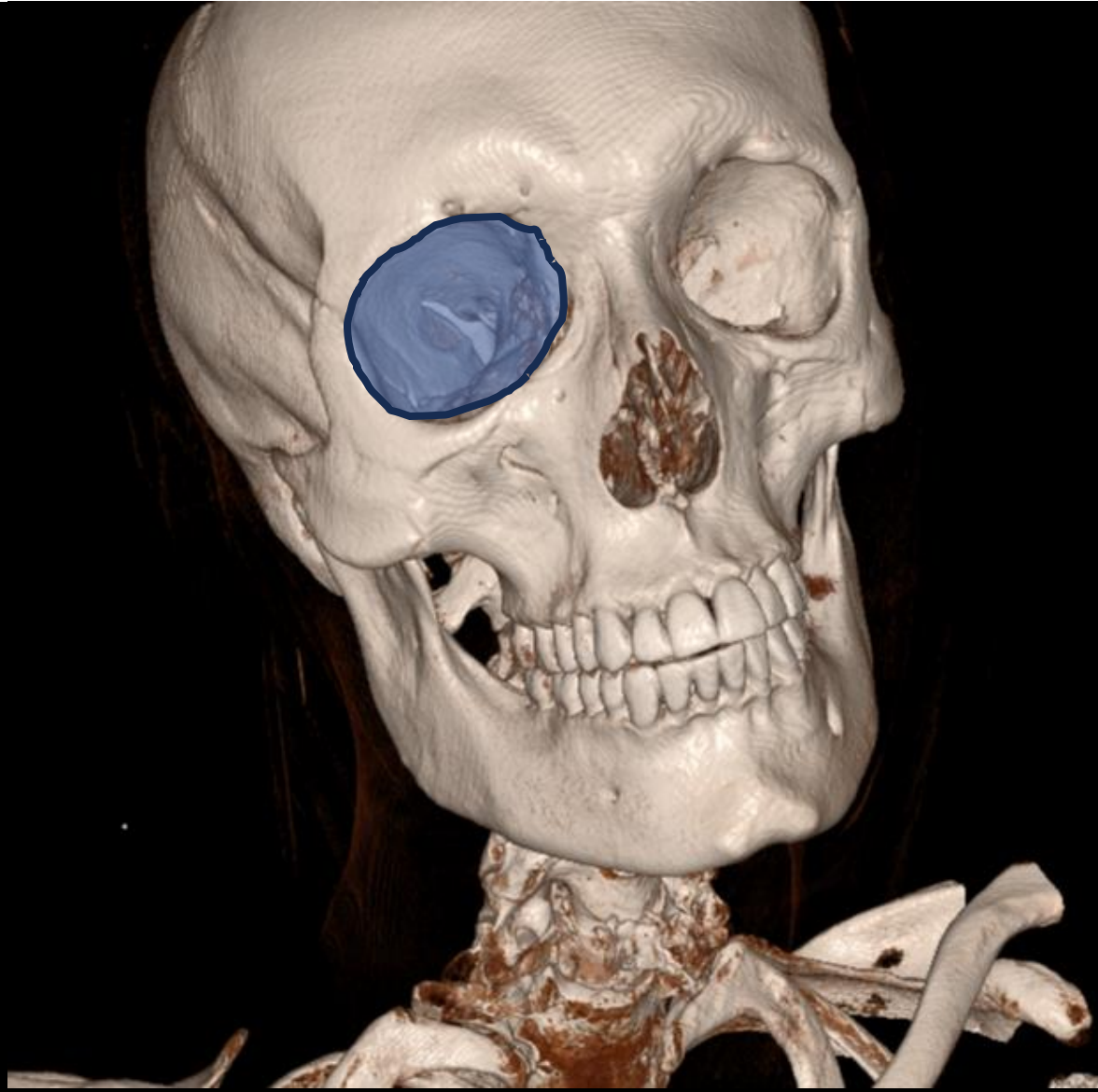
Skull base

Upper cervical spine
(C1 + C2)

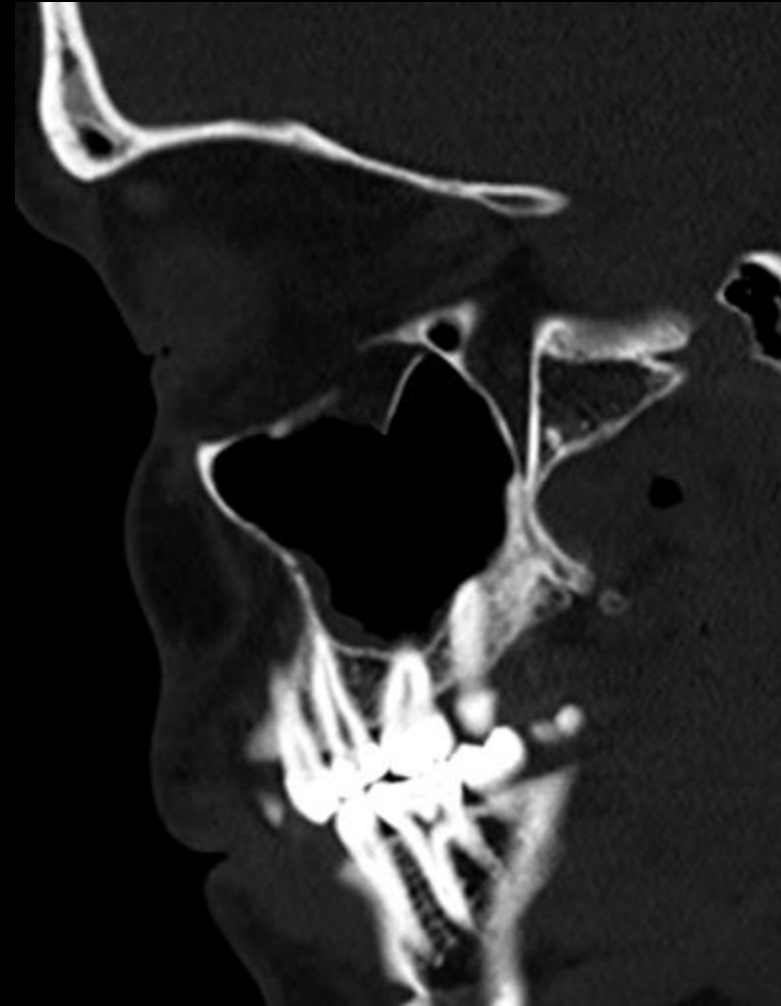
Subaxial
Cervical spine
(C3 - C7)



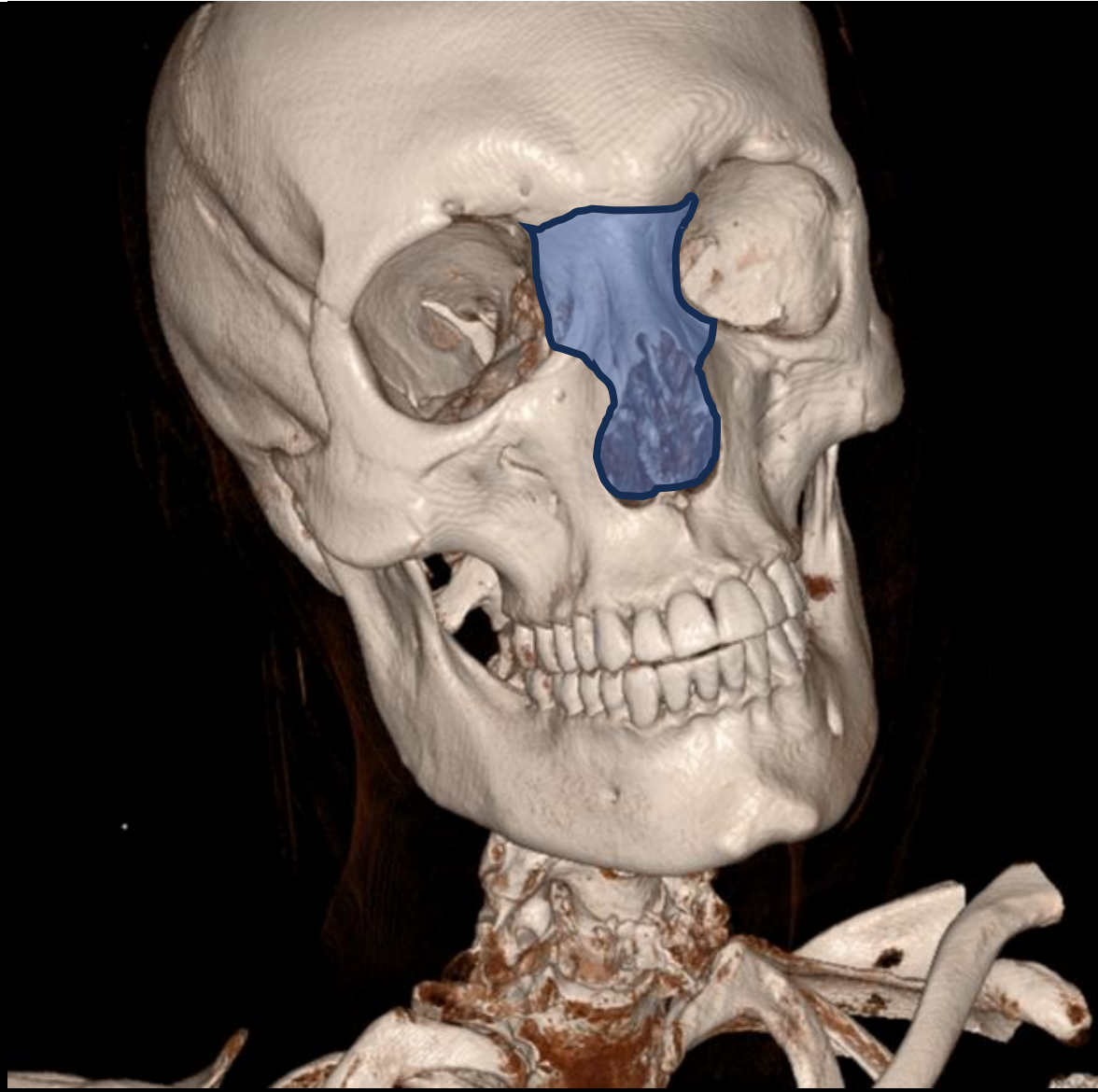
Orbit



Blow-out fracture orbital floor



Nose / naso-orbito-ethmoid (NOE)



Nose fracture



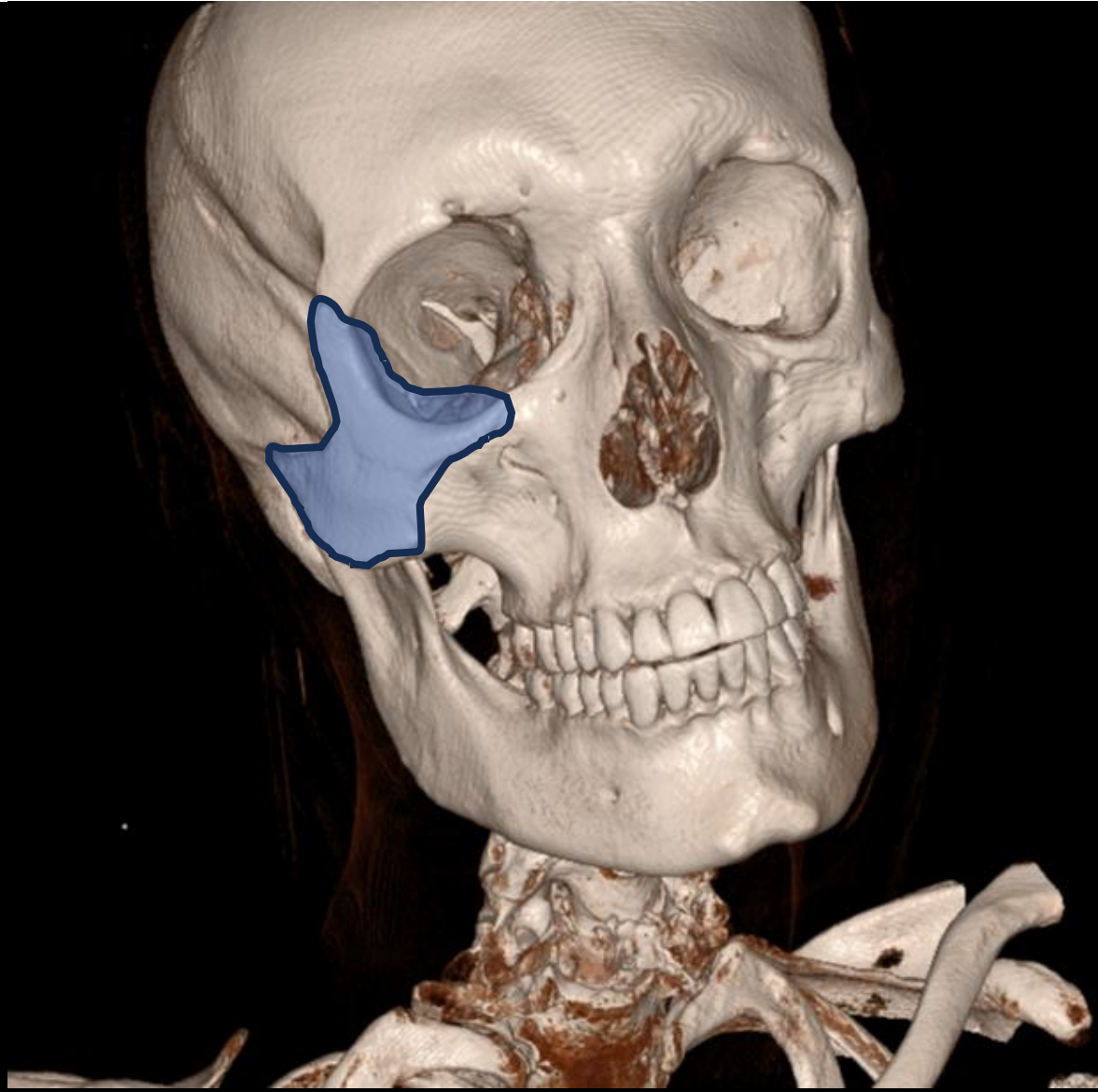
Manson classification



NOE

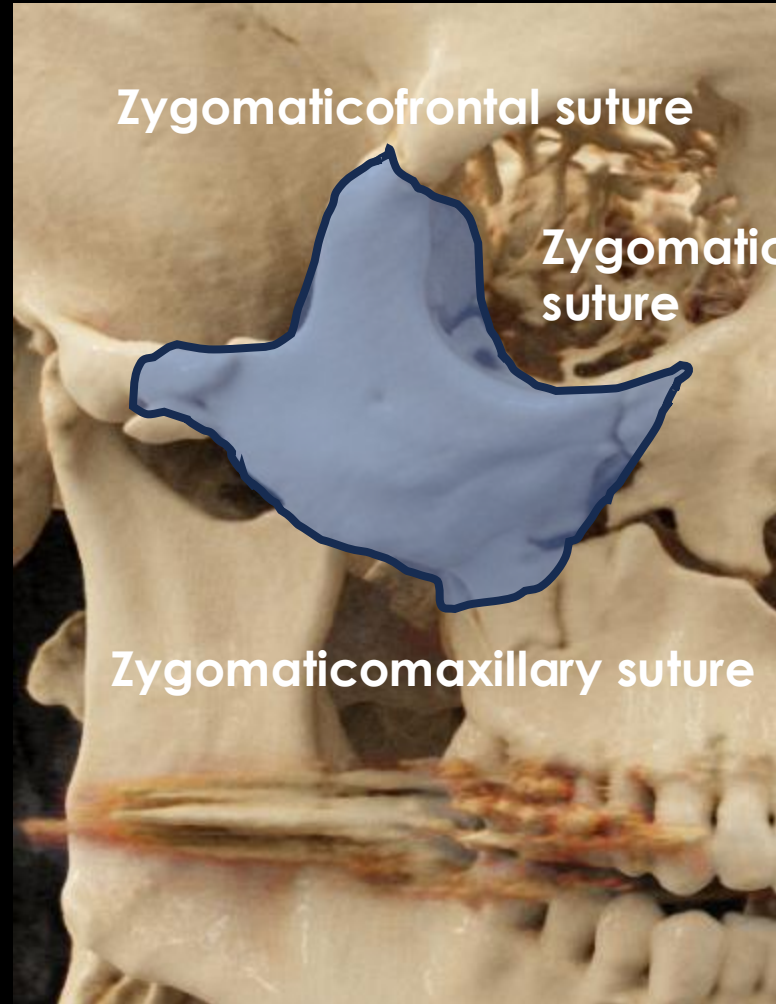


Zygoma



Zygomaticomaxillary complex

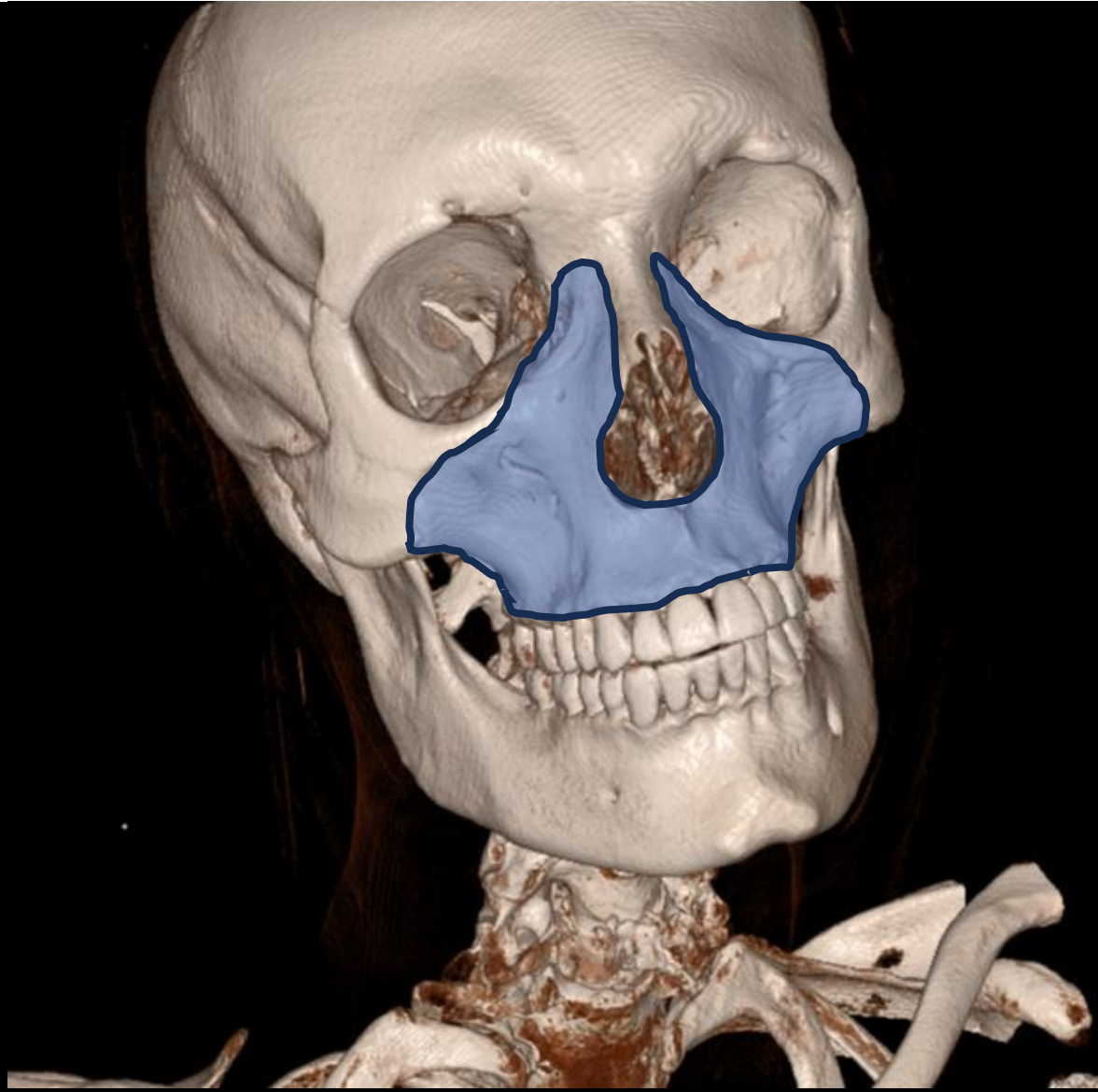
Zygomaticotemporal suture



ZMC fracture



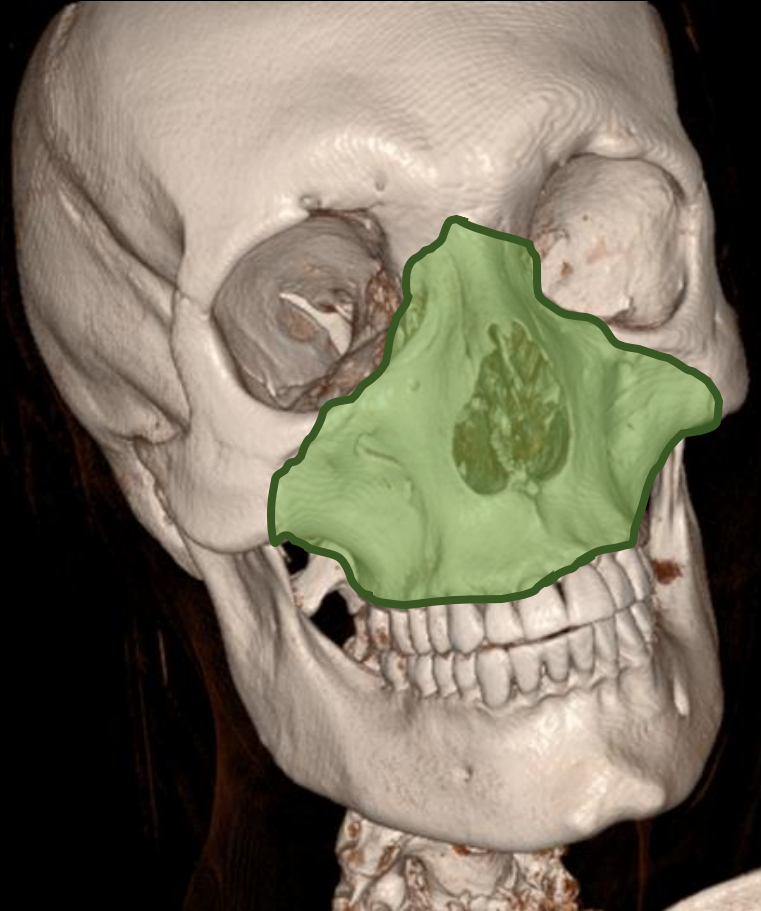
Maxilla



Le Fort



‘Floating palate’



‘Floating maxilla’

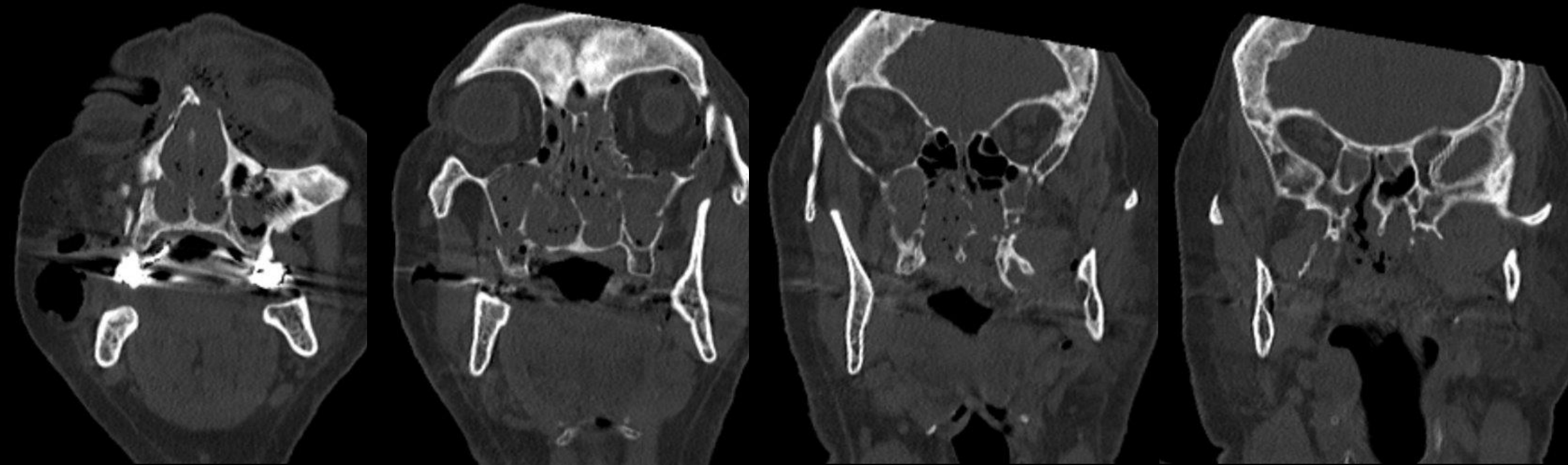


‘Craniofacial dissociation’

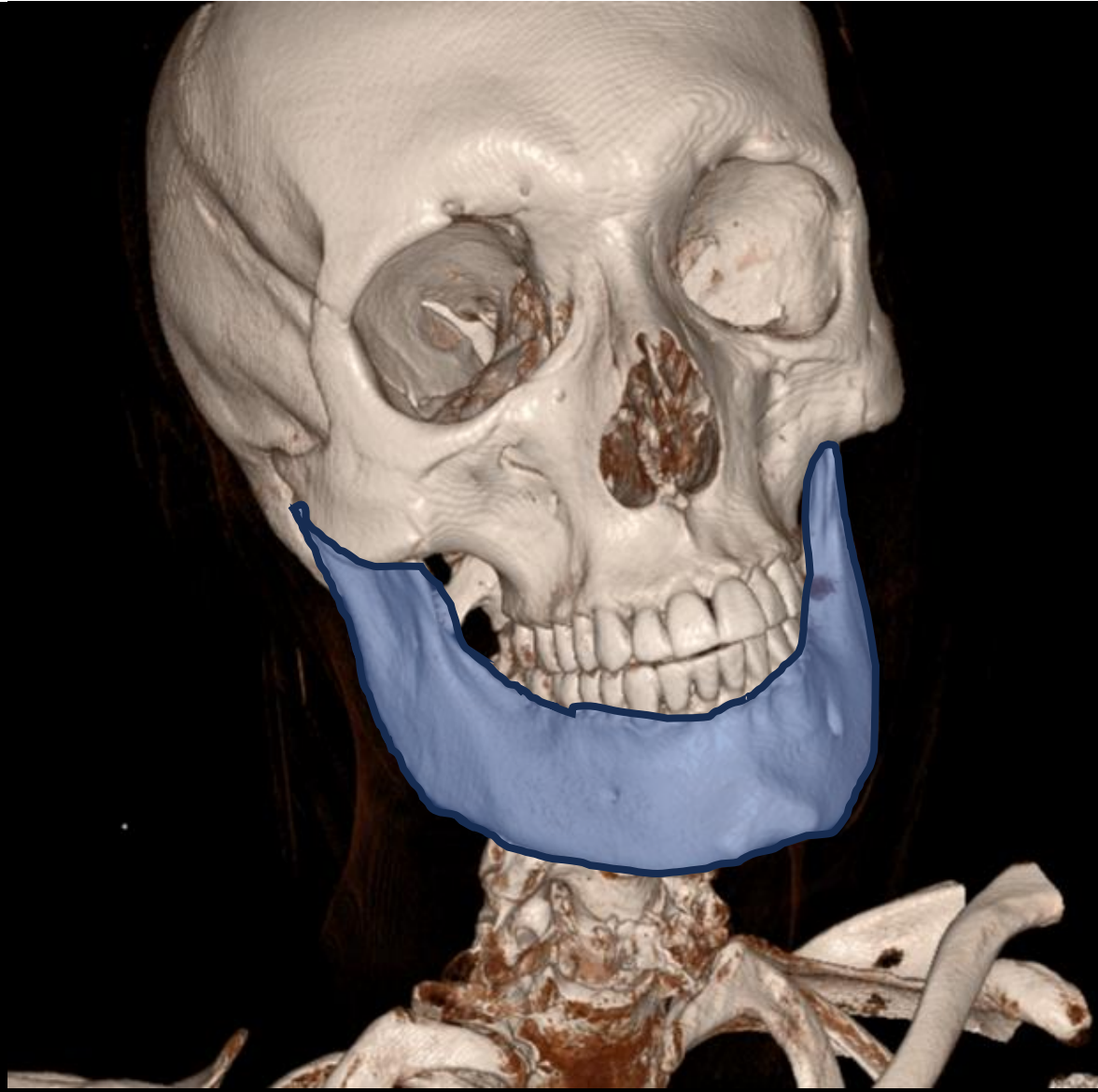
Le Fort II + mandible



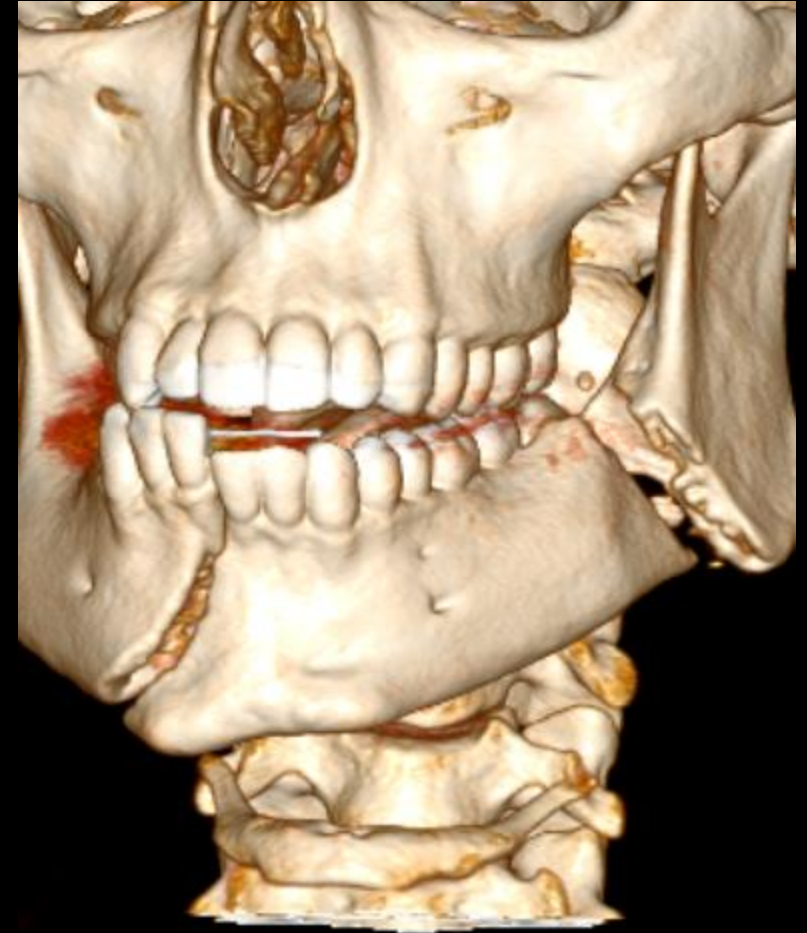
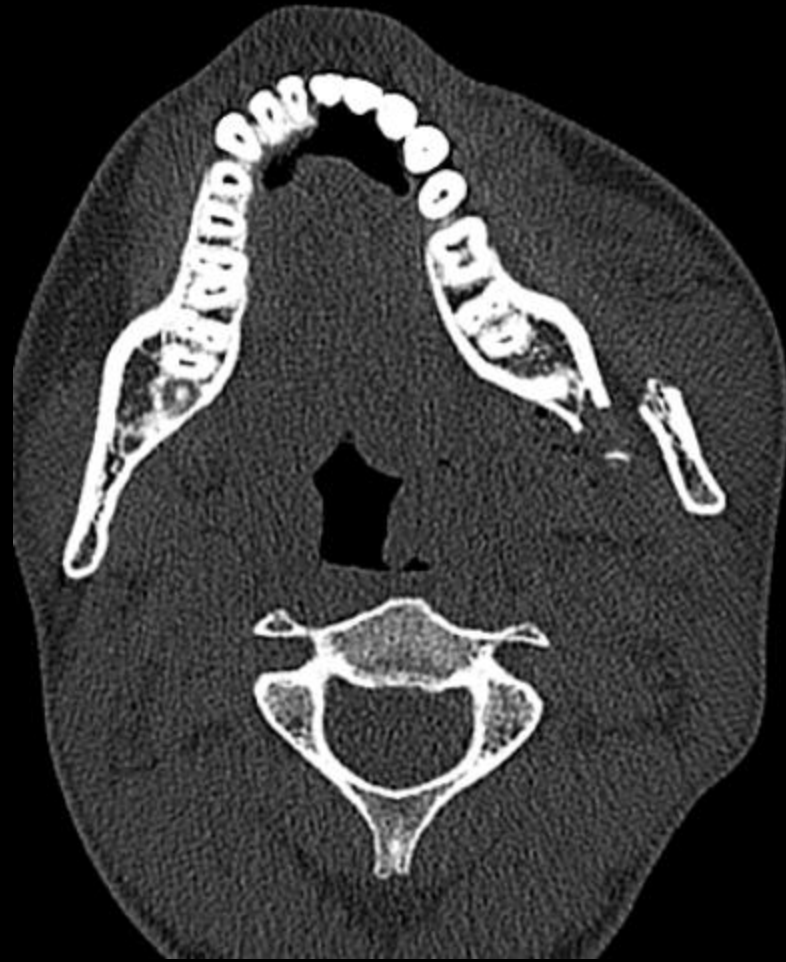
Le Fort I + II + III + NOE



Mandible

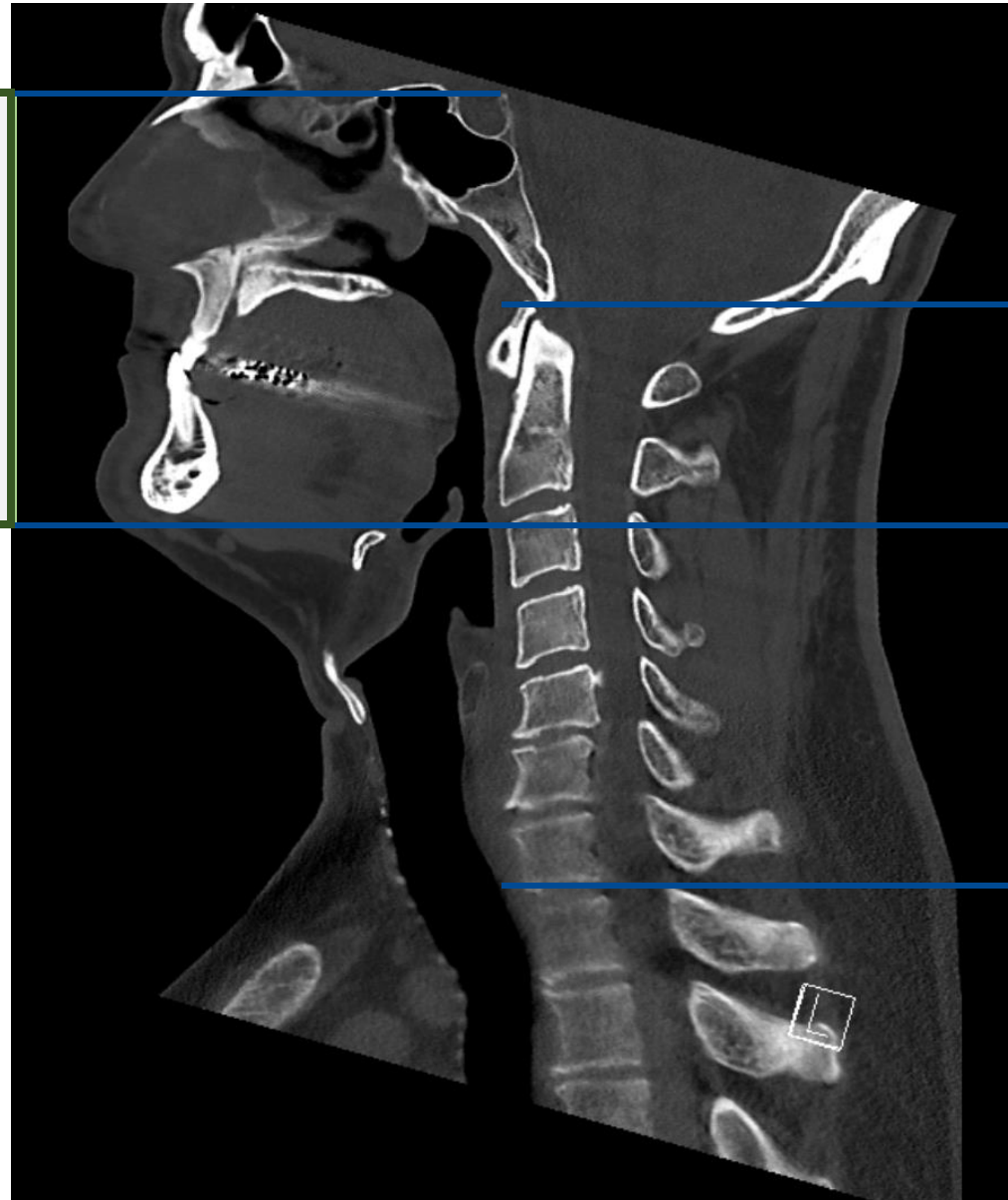


Mandibular fracture



Skull base

1 Face



Skull base

**Upper cervical spine
(C1 + C2)**

2

**Subaxial
Cervical spine
(C3 - C7)**

3



Cervical spine – How and when?

“Canadian C-spine Rule”

High-risk factors present?

Age ≥ 65 years, extremity paresthesias, or dangerous mechanism

Fall from ≥ 3 ft (0.9 m) / 5 stairs, axial load injury, high speed MVC/rollover/ejection, bicycle collision, motorized recreational vehicle

Yes



Low risk factors present

Sitting position in the ED, ambulatory at any time, delayed (not immediate onset) neck pain, no midline tenderness. Simple rearend motor vehicle collision (MVC) (not simple if pushed into traffic, hit by bus/large truck, rollover, hit by high-speed vehicle)

No



Able to actively rotate neck 45° left and right

No



Imaging strategy

> ~~X-ray cervical spine~~

> **CT cervical spine**

- **Bony structures**
- **Reveals «all» fractures (98-100%)**

> **MR cervical spine**

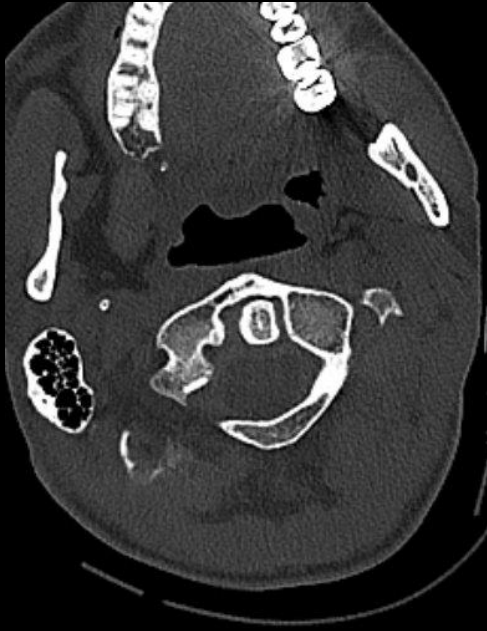
- **Soft tissue**
- **Ligaments**
- **Disks**
- **Cord – epidural / intramedullary**

CT Cervical spine

Ax 0.625 mm (soft)



Ax 0.625 mm (bone)



Ax 2 mm



Sag 2 mm



Cor 2 mm

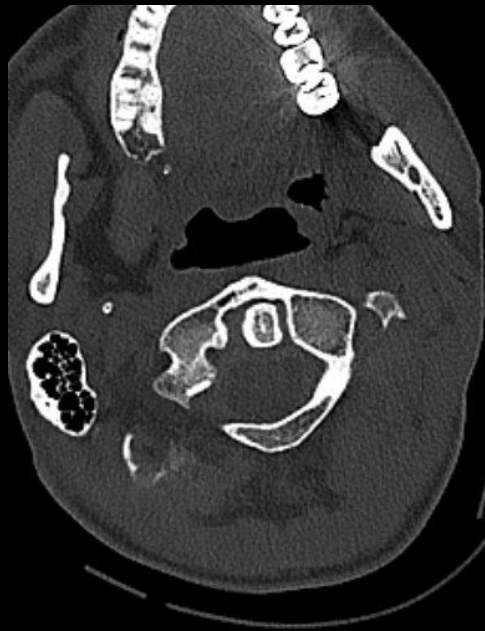


CT Cervical spine

Ax 0.625 mm (soft)



Ax 0.625 mm (bone)



Ax 2 mm



Sag 2 mm



Cor 2 mm



CTA?

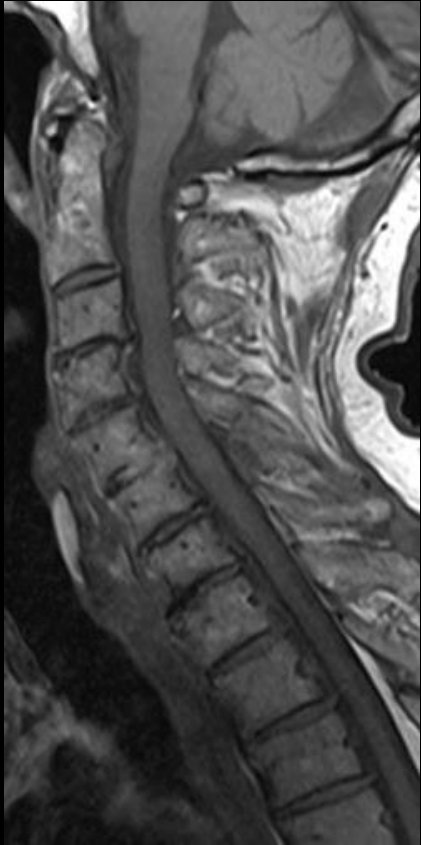
Table 2: Risk Factors for Blunt Cerebrovascular injury

Le Fort II or III facial fractures
Skull base fracture extending to petrous internal carotid artery canal
Fractures of C1–C3
Fracture line reaching a transverse foramen
Facet subluxation or dislocation
Scalp degloving injury
Severe mandibular fractures
Closed head injury
Major chest trauma

MR Cervical spine

Standard:

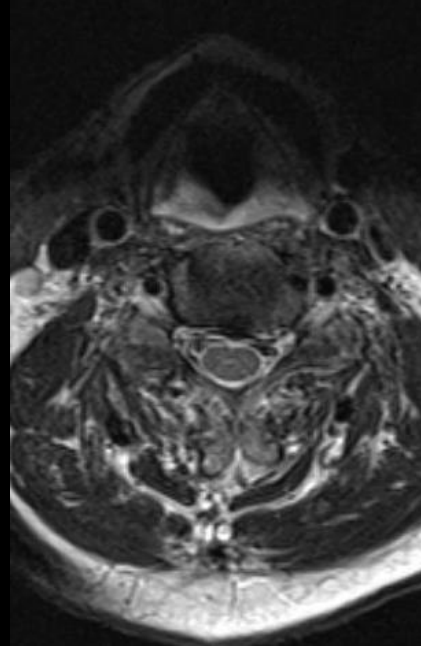
Sag T1



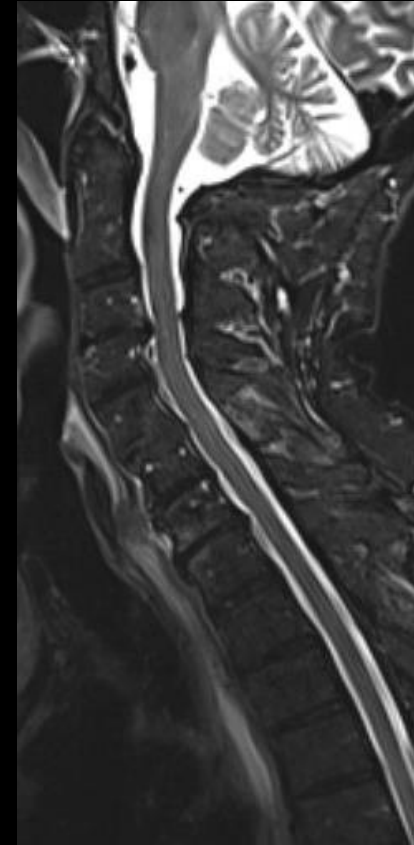
Sag T2



Ax T2



Sag STIR



Sag T2 SPACE



Children vs. adults



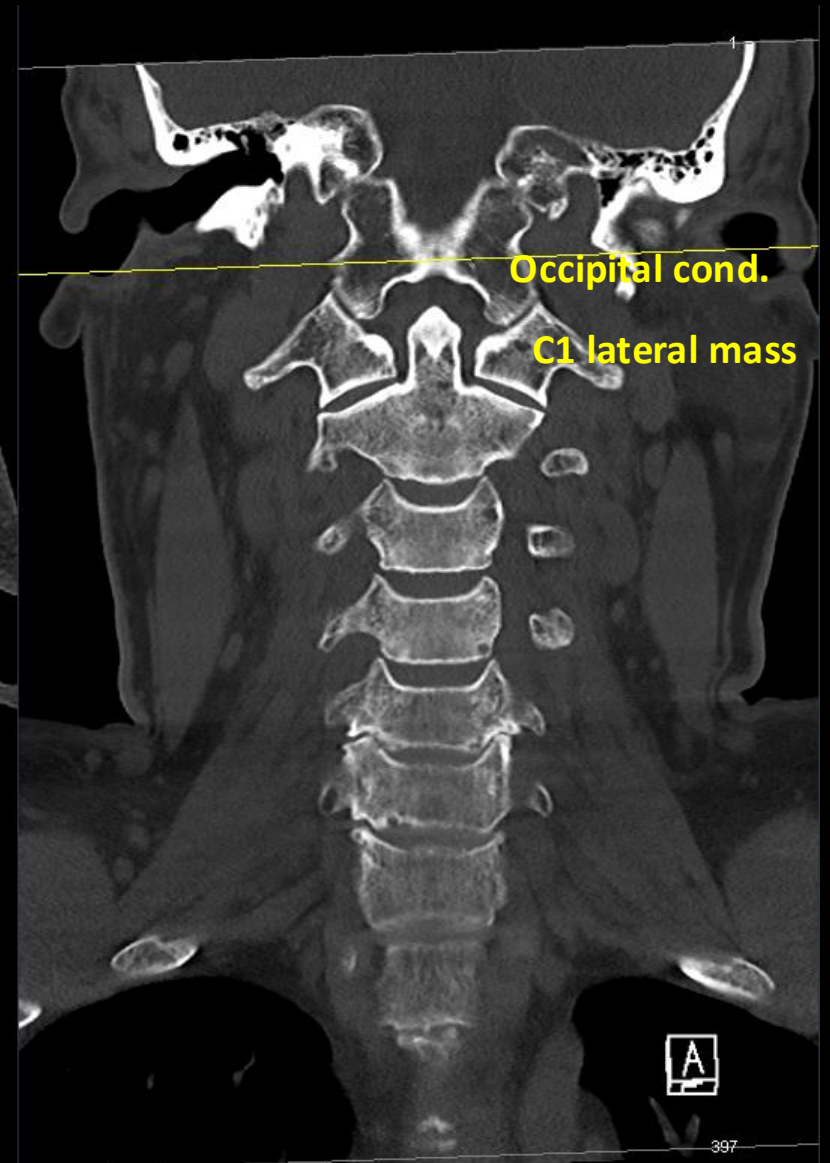
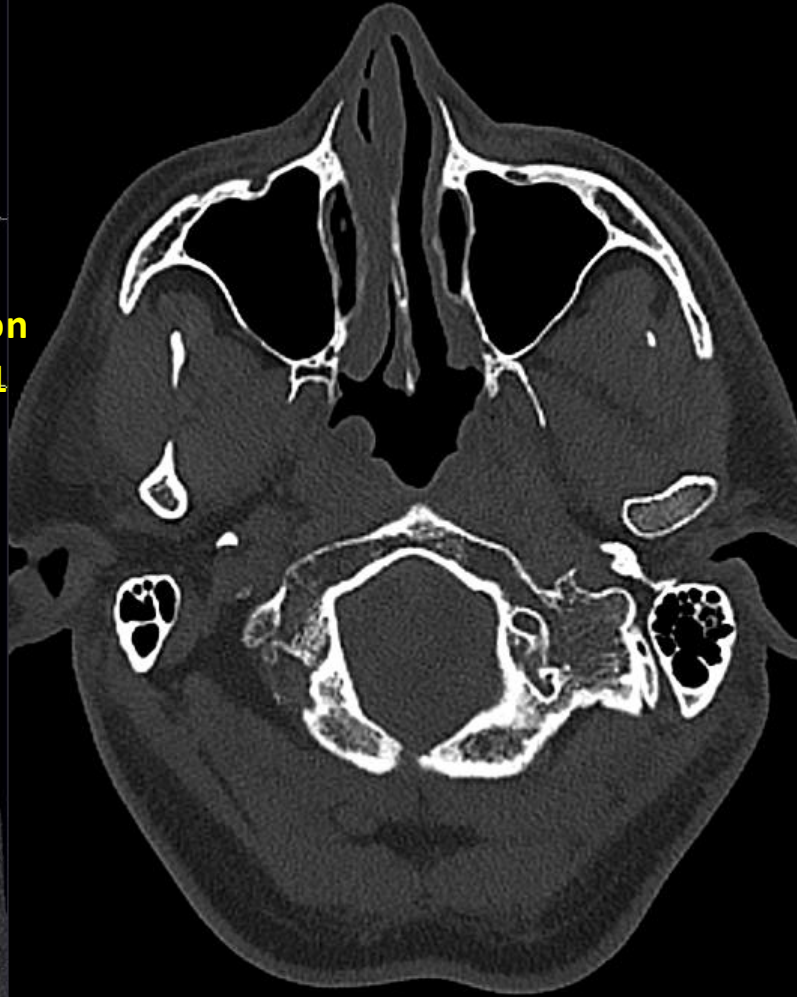
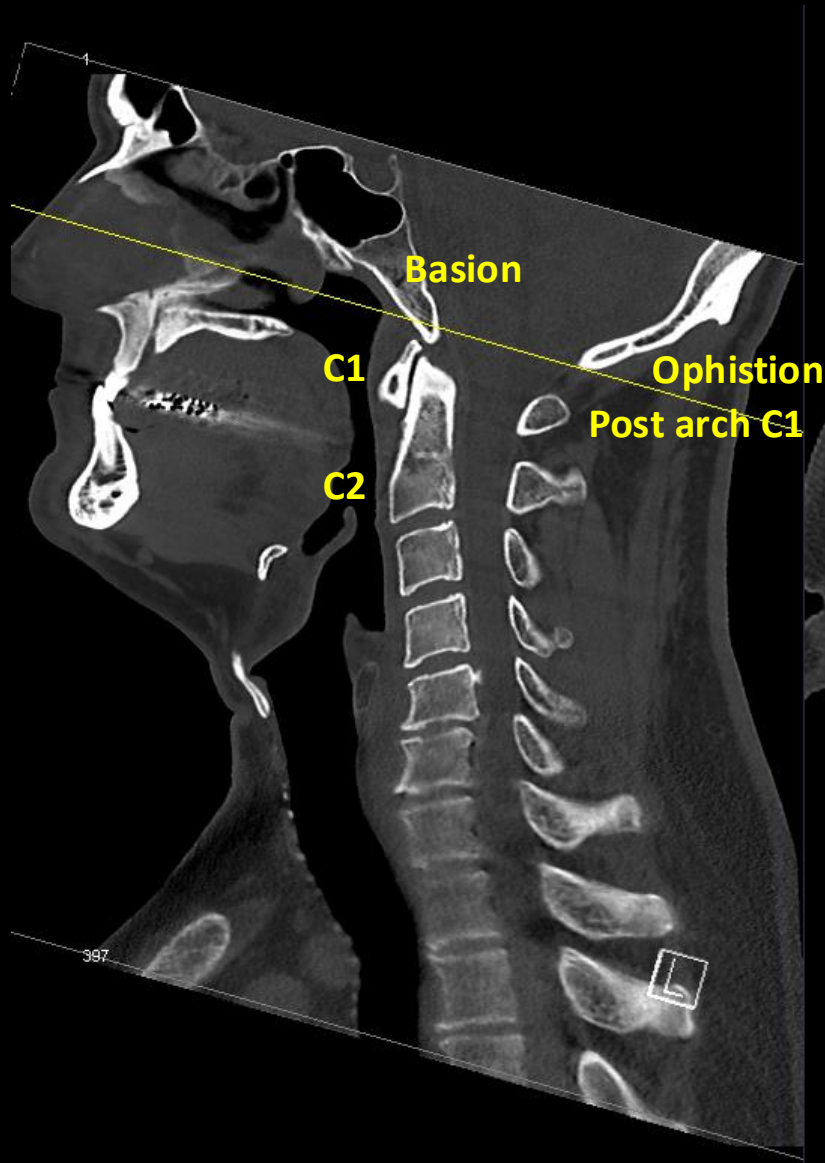
Differences between pediatric and adult spinal cord injuries

Injury Feature	Children	Adults
Spinal level	Craniocervical junction to C3*	C5-T1
Fulcrum level	C2-C3	C5-C6
Injury type	More likely ligamentous or soft tissue	More likely osseous
Longitudinal distractibility	Resilient to longitudinal distraction	Less distractible
	Susceptible to SCIWORA	SCIWORA is rare
Trauma-associated infarct	Delayed spinal cord infarction†	Delayed spinal cord infarction is rare

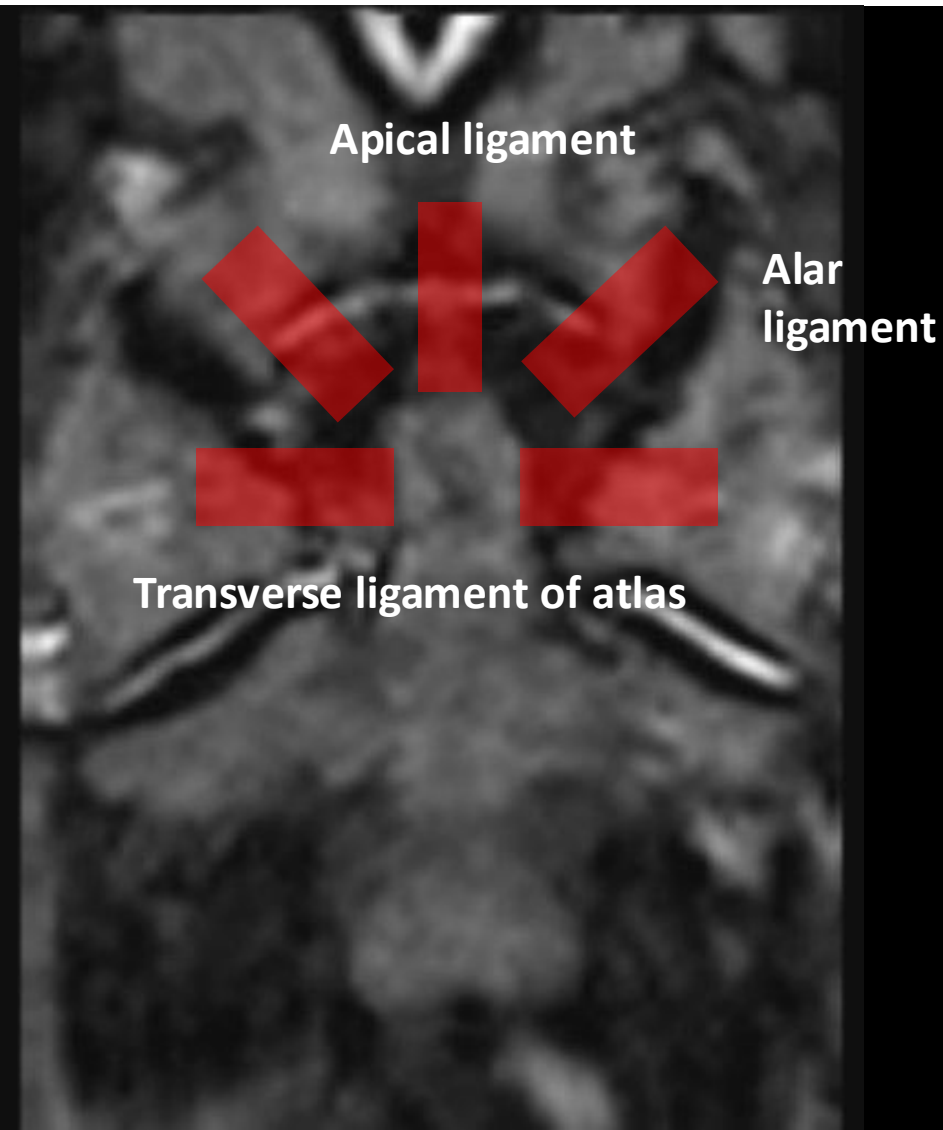
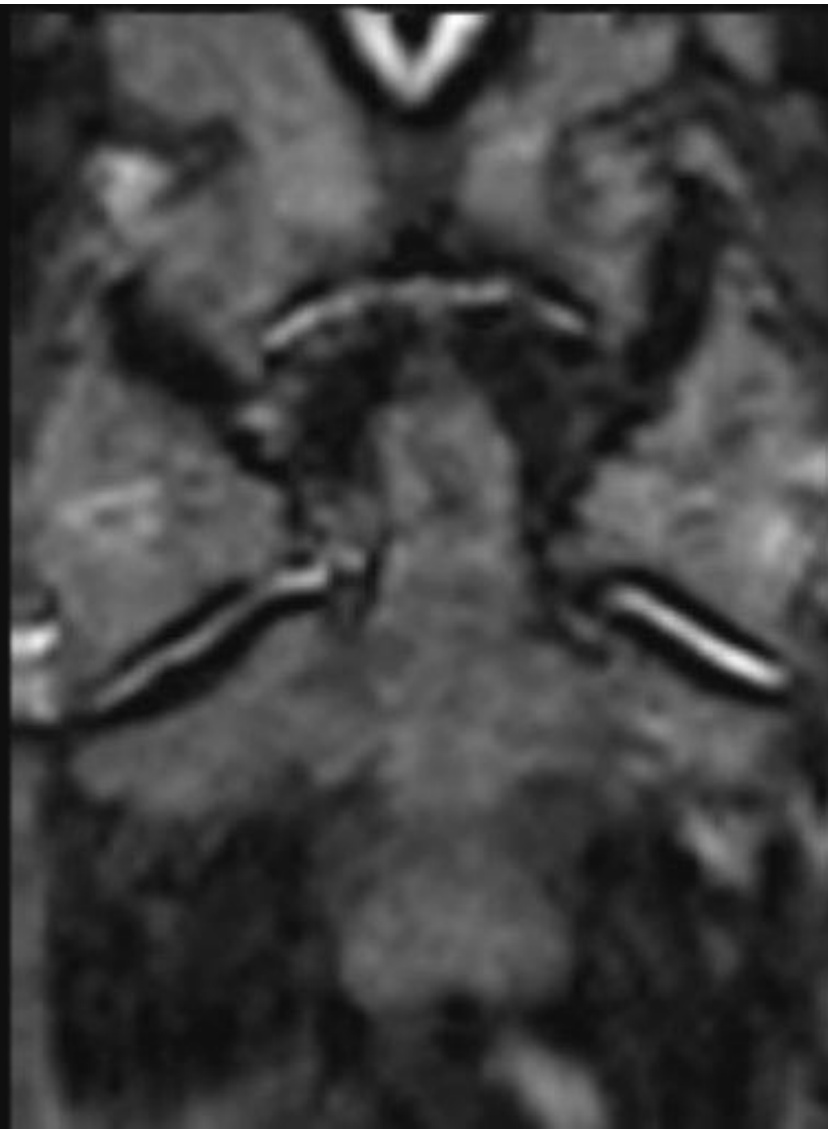
SCIWOAR = spinal cord injury without radiographic abnormality



Craniocervical junction



Ligaments



Craniocervical junction

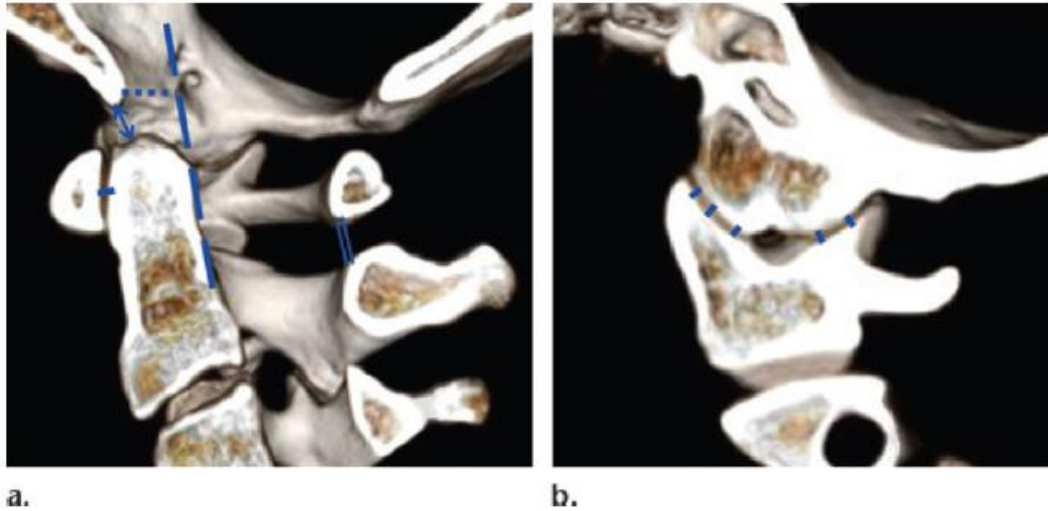


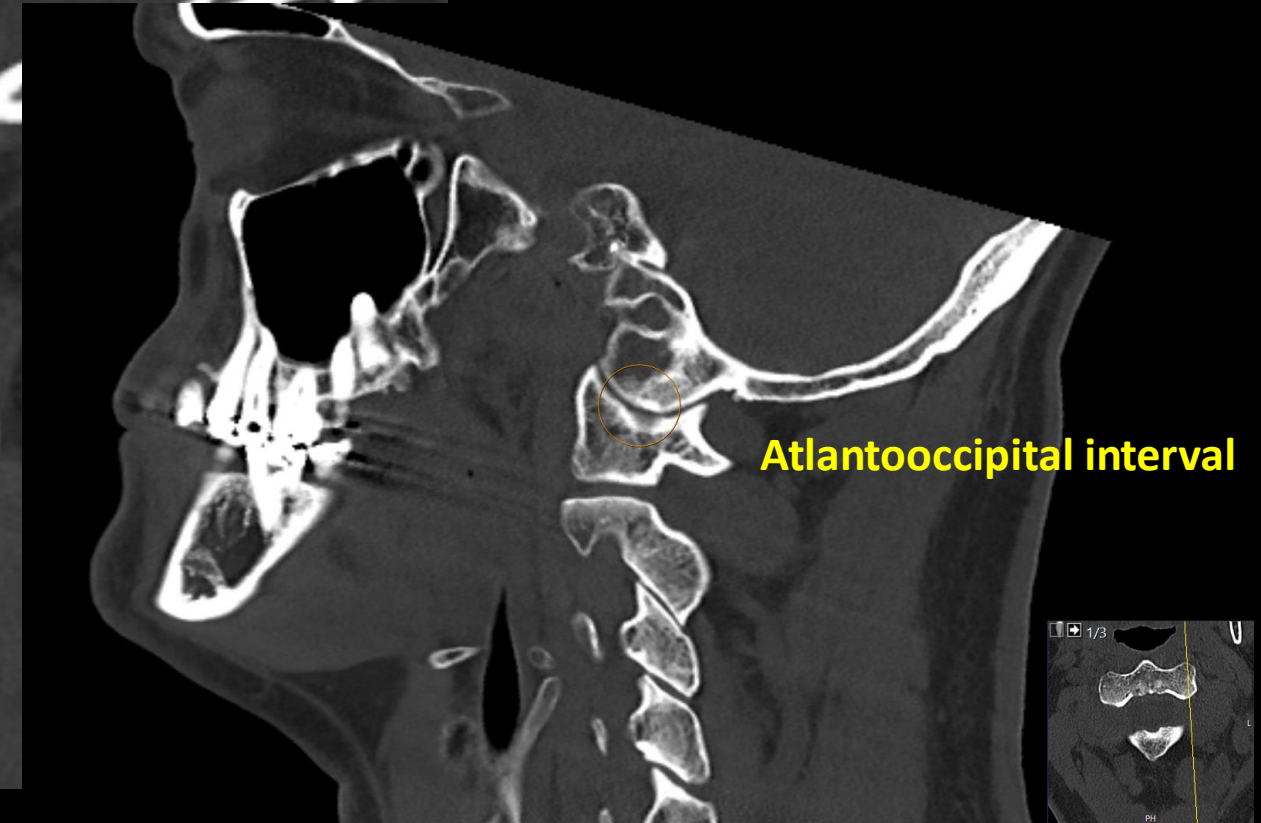
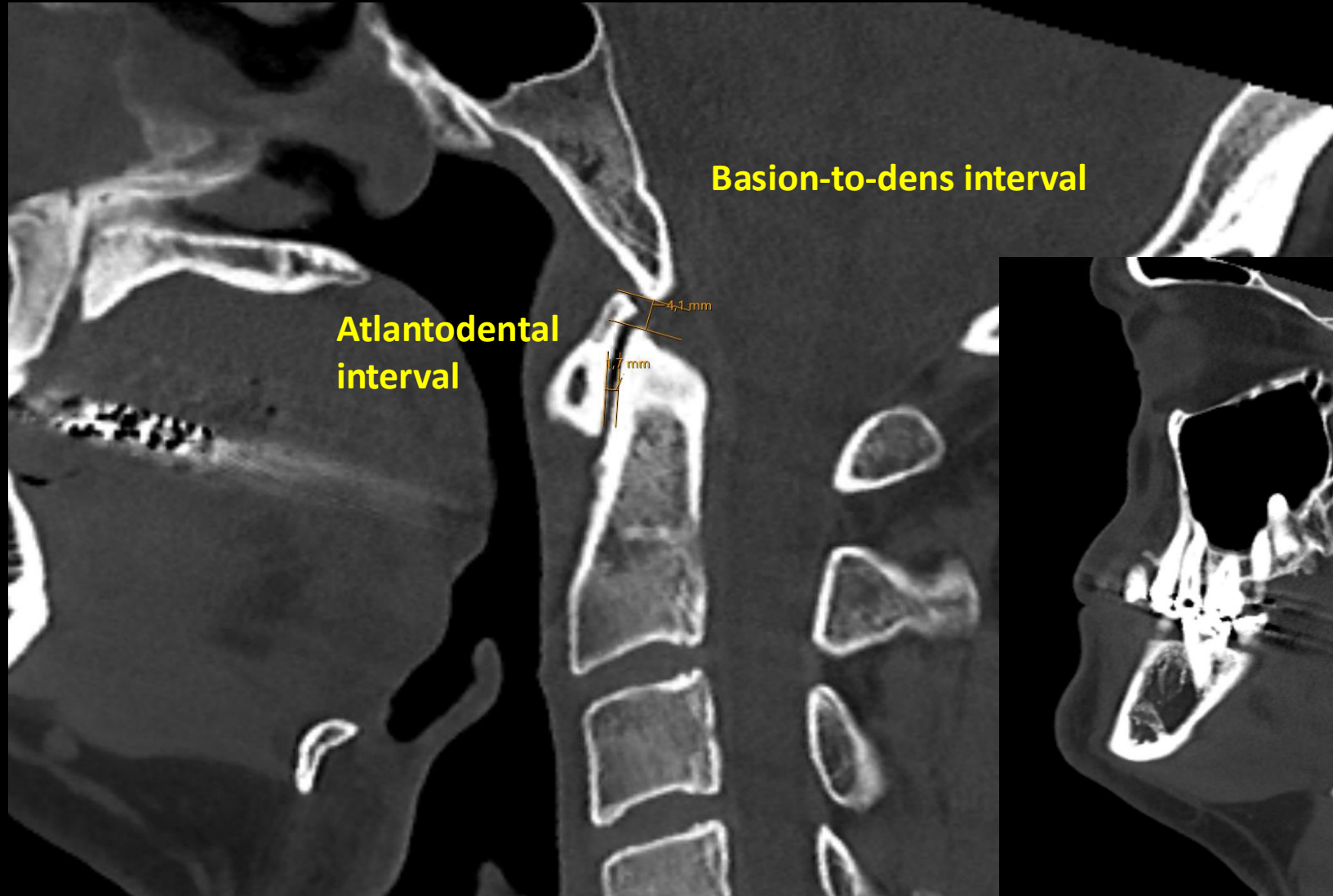
Figure 1. Normal intervals of the craniocervical junction. (a) Midsagittal half-space volume-rendered CT image shows the atlantodental interval (solid line), the basion-dens interval (double-headed arrow), the posterior axial line (dashed line), the basion-to-posterior axial line interval (dotted line), and the C1-C2 spinolaminar distance (parallel lines). (b) Volume-rendered CT image shows the normal relationship of an occipital condyle and the lateral mass of C1, with close apposition, and the nearly equidistant intervals (solid lines) along all points in the midsagittal plane of the joint.

Table 4: Normal Measurements in the Craniocervical Junction

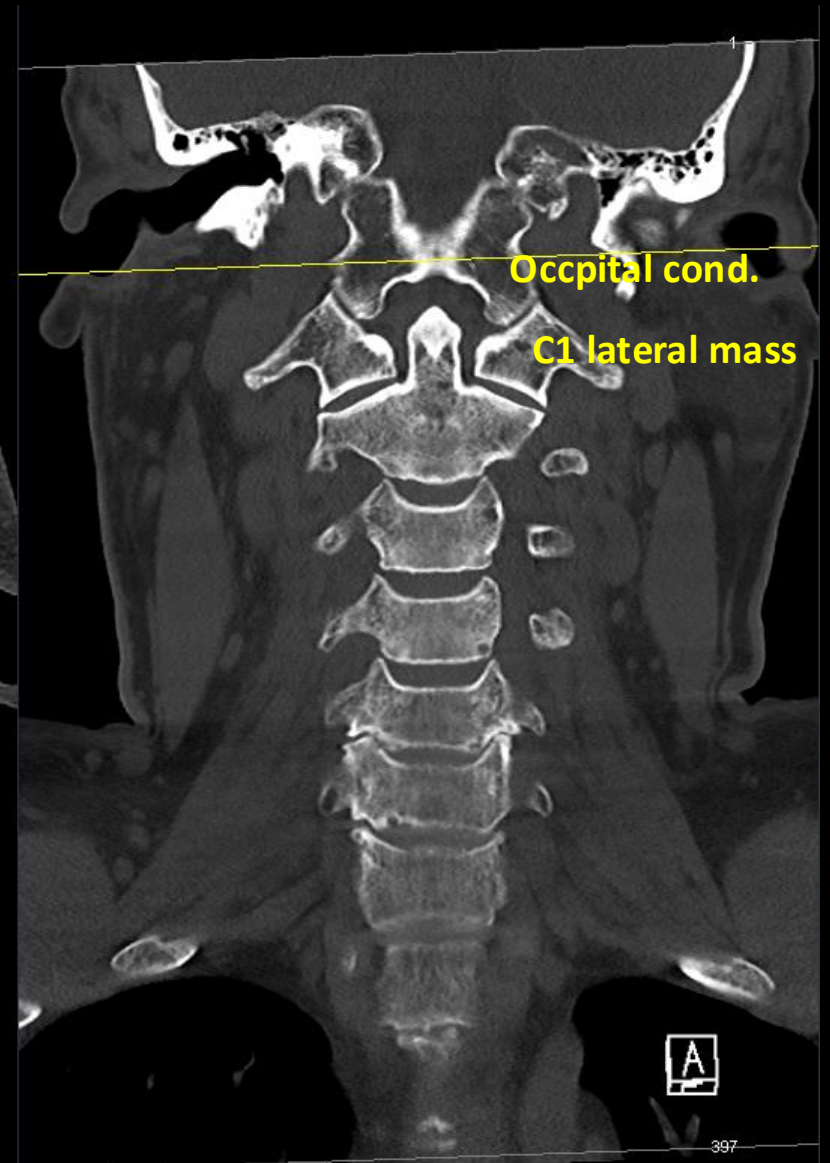
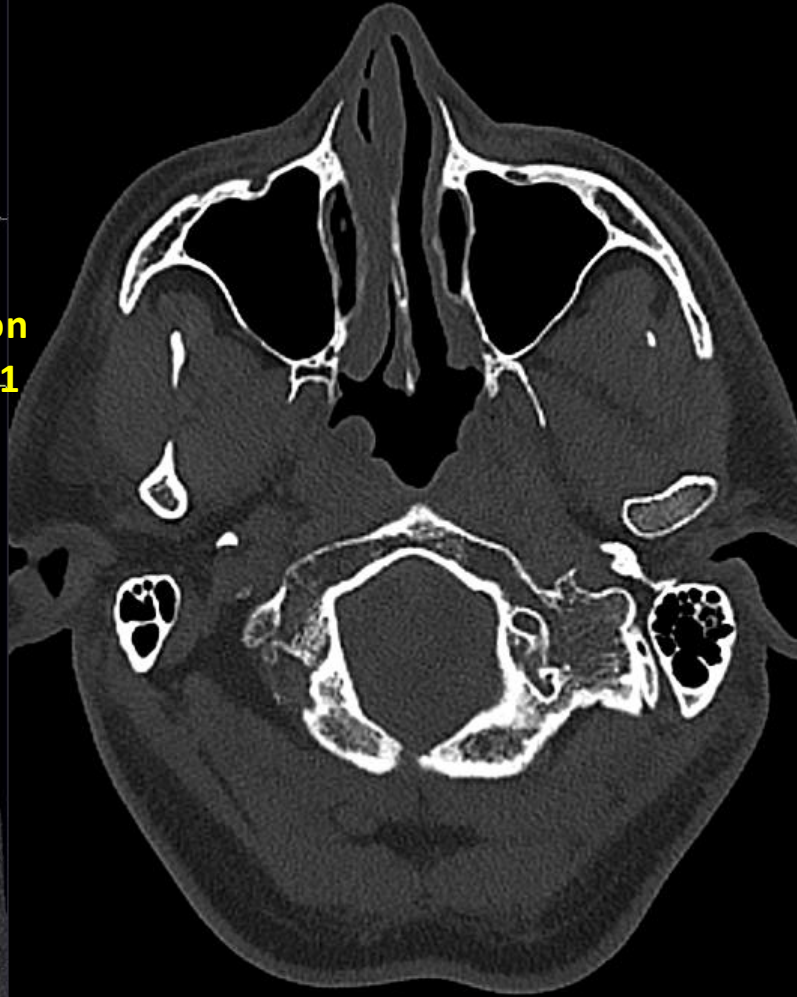
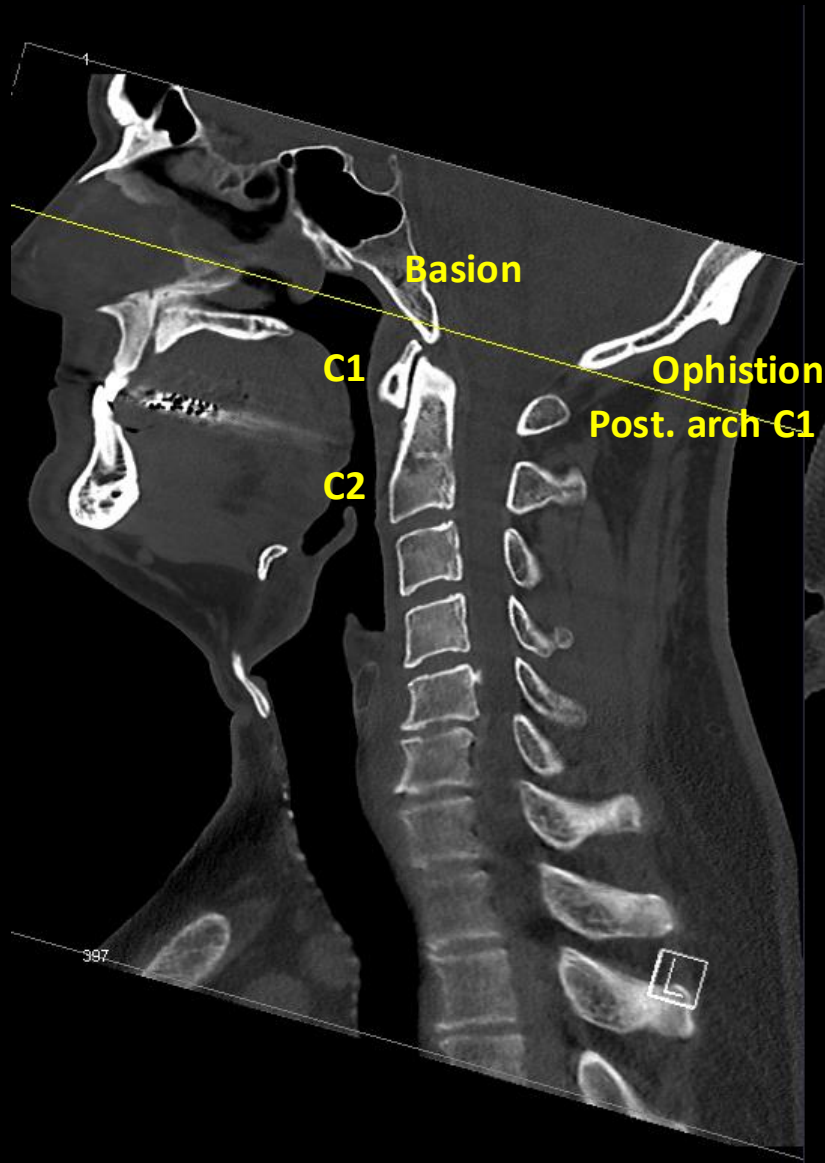
Interval	Ligaments Injured	Radiography Cutoff/Reference	Multidetector CT Cutoff/Reference
Basion-to-dens interval	Alar ligaments, tectorial membrane	12 mm/Harris et al (44)	8.5–9.5 mm/Rojas et al (37), Chang et al (35)
Basion–axial line interval	Alar ligaments, tectorial membrane	>12 mm anterior or 4 mm posterior to the posterior axillary line/Harris et al (44)	Difficult to reproduce/Rojas et al (37)
Atlantodental interval	Transverse ligament, atlanto-occipital and C1-C2 capsules, tectorial membrane, alar ligaments	3 mm (men), 2.5 mm (women)/Hinck and Hopkins (45)	2 mm/Rojas et al (37)
Atlanto-occipital interval	Atlanto-occipital joint capsules, alar ligaments, tectorial membrane	No data in adults	4.0 mm (summed)/Chang et al (35); 2.5 mm (single atlanto-occipital interval)/Rojas et al (37)
Atlantoaxial interval	C1-C2 joint capsules, alar ligaments, tectorial membrane	No data in adults	Midsagittal, 2.6–4.0 mm/Gonzalez et al (46), Chaput et al (41); lateral margins, 1.2 mm/Radcliff et al (47); posterior and anterior margins, 1 mm/Gonzalez et al (46)
Powers ratio	Transverse ligament, atlanto-occipital joint capsules, tectorial membrane, alar ligament	Anteriorly displaced atlanto-occipital distraction indicated by Powers ratio >1/Powers et al (42)	Anteriorly displaced atlanto-occipital distraction indicated by Powers ratio >1/Dziurzynski et al (43)



Craniocervical junction

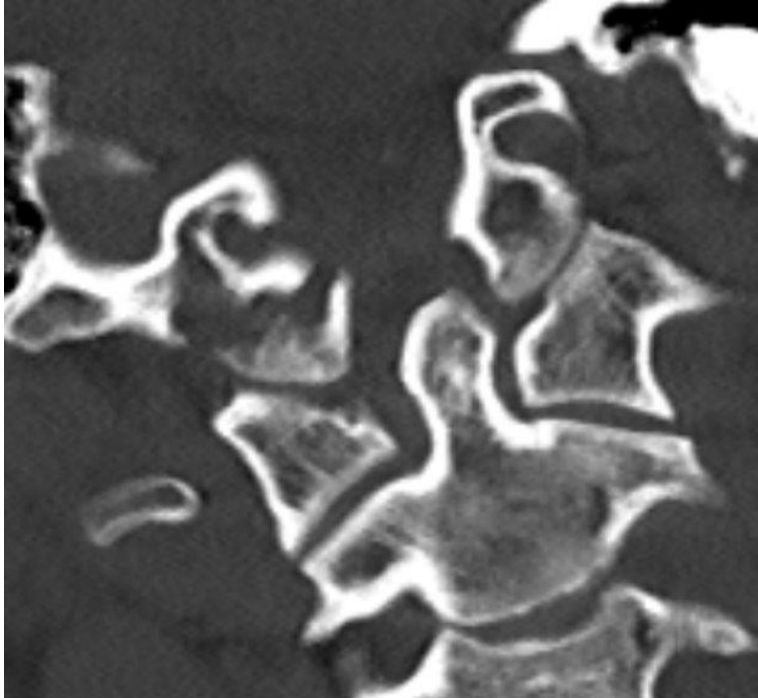


C0 – Occipital condyle



Occipital condyle fractures

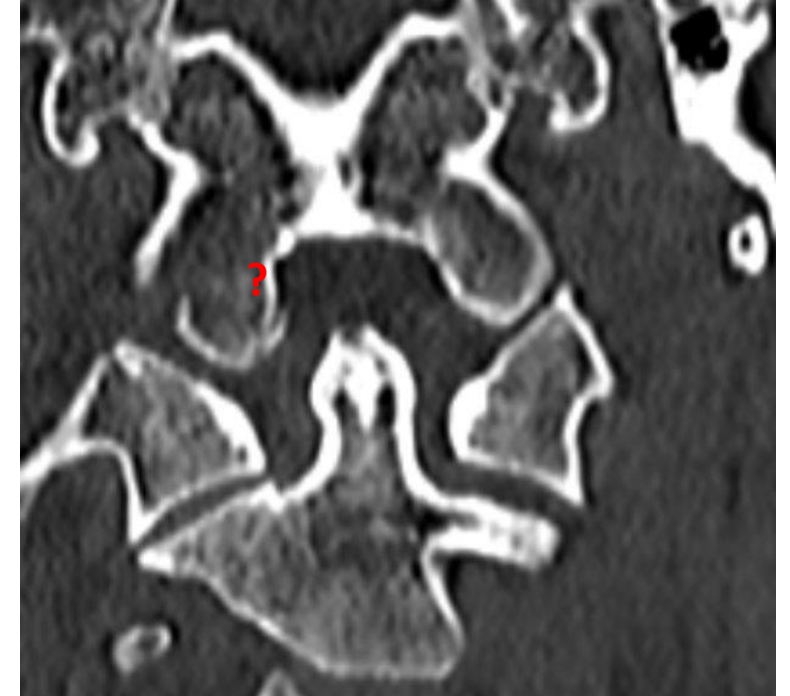
Classification (Anderson and Montesano ¹)



Type I: axial loading with minimal or no fracture displacement - **Stable**



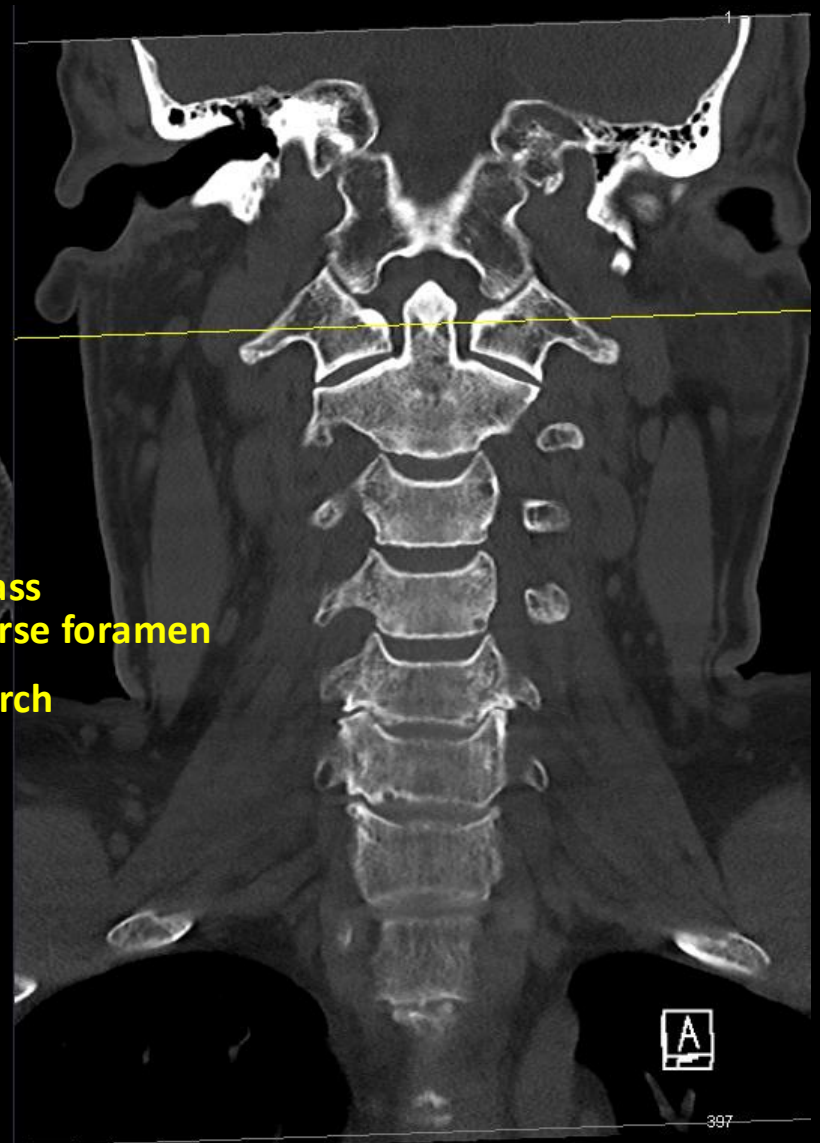
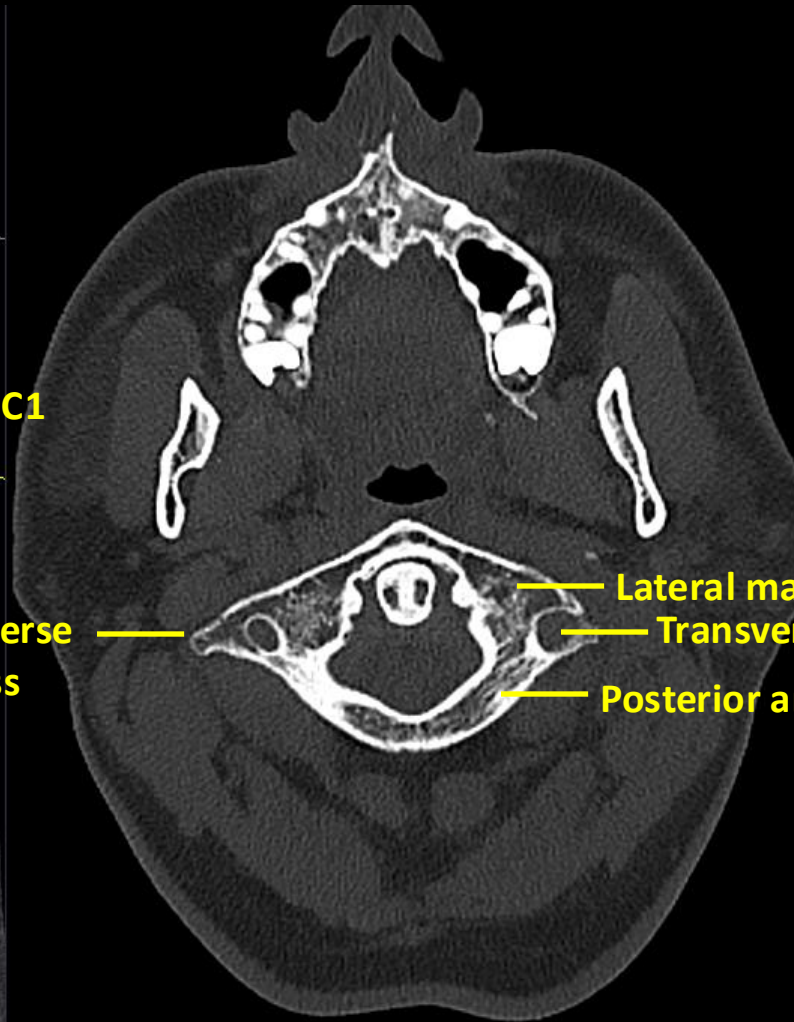
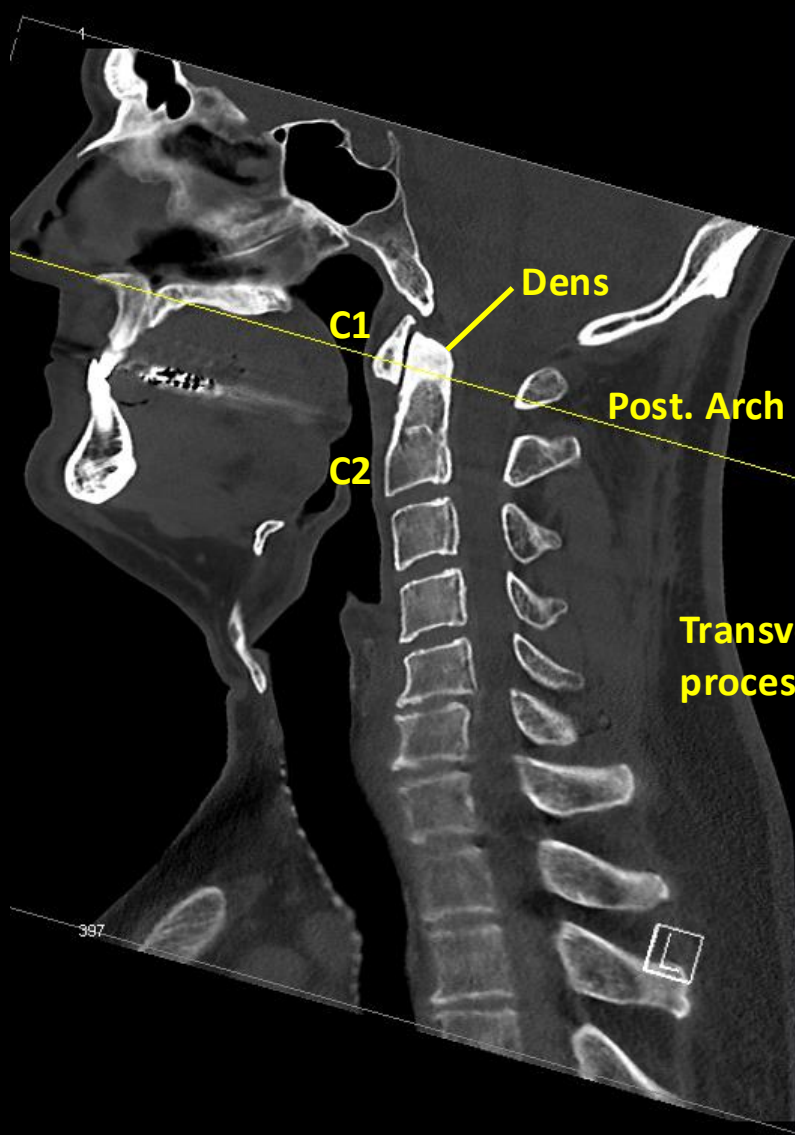
Type II: skull base fracture extending through the condyle — **Stable**



Type III: alar ligament avulsion fracture — **Unstable**

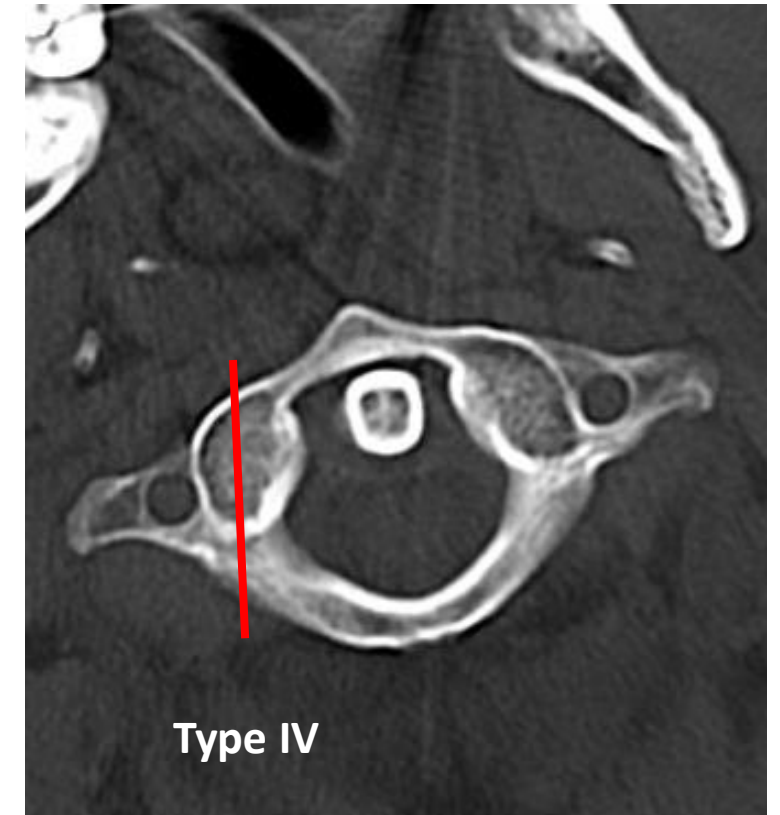
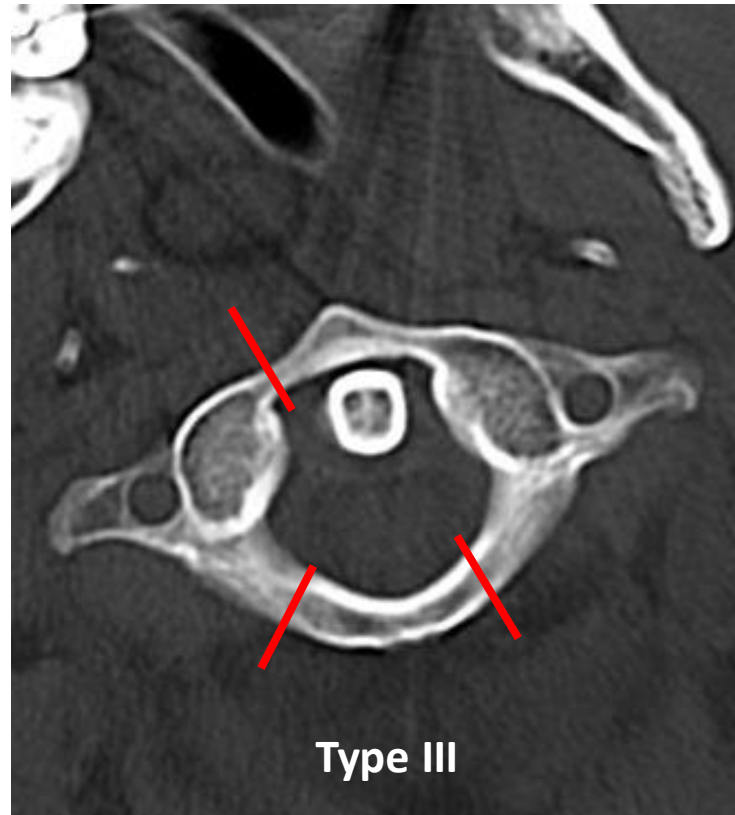
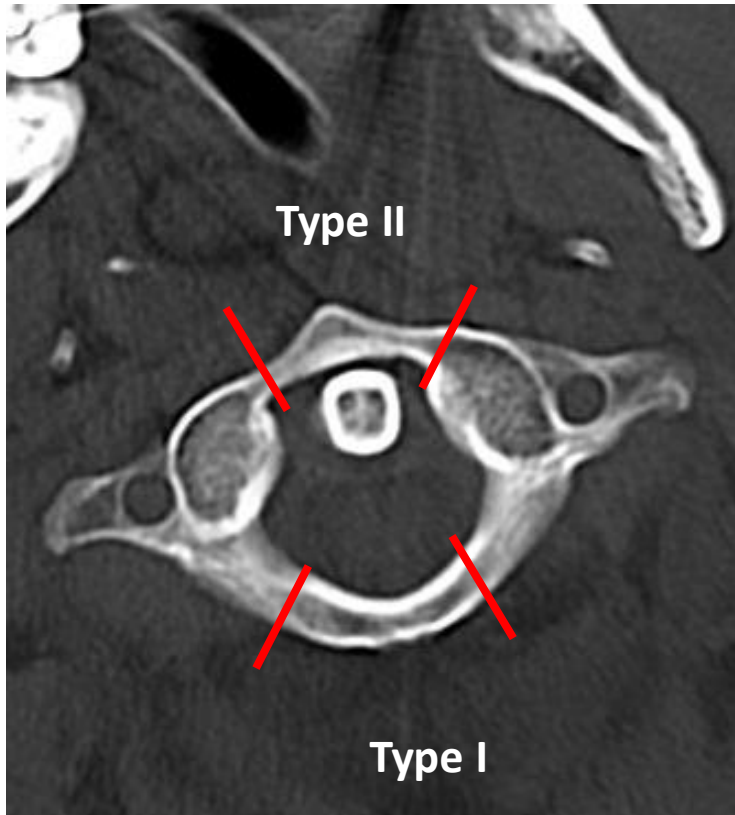


C1 - Atlas



Atlas fractures

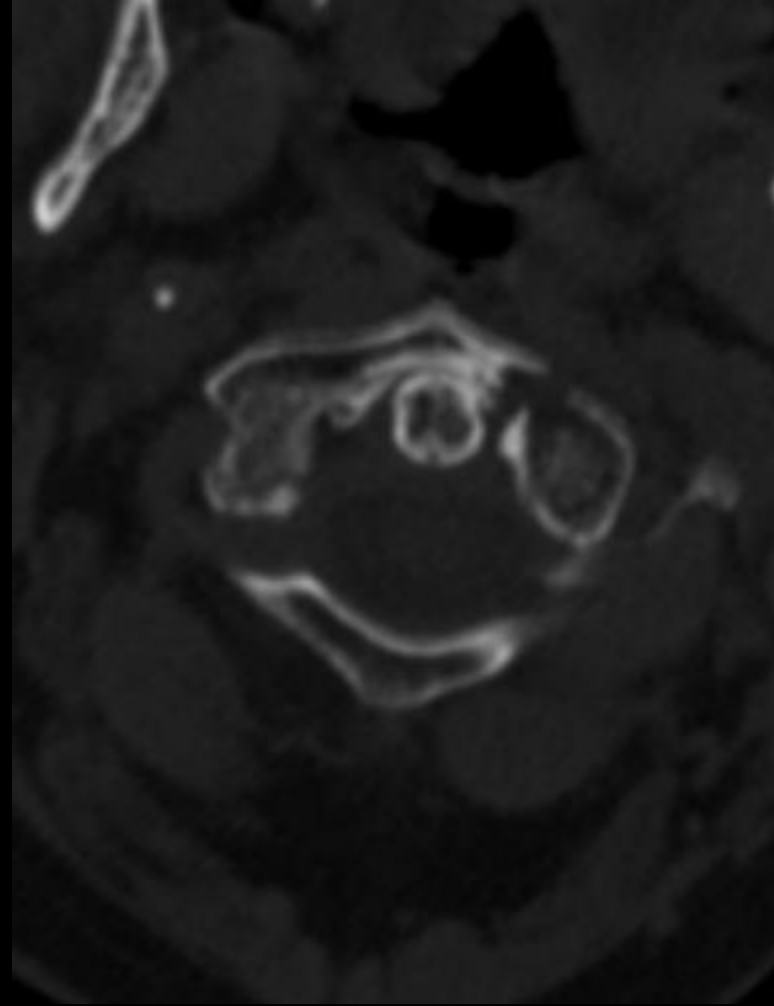
Classification (Jefferson, modified by Gehweiler¹)



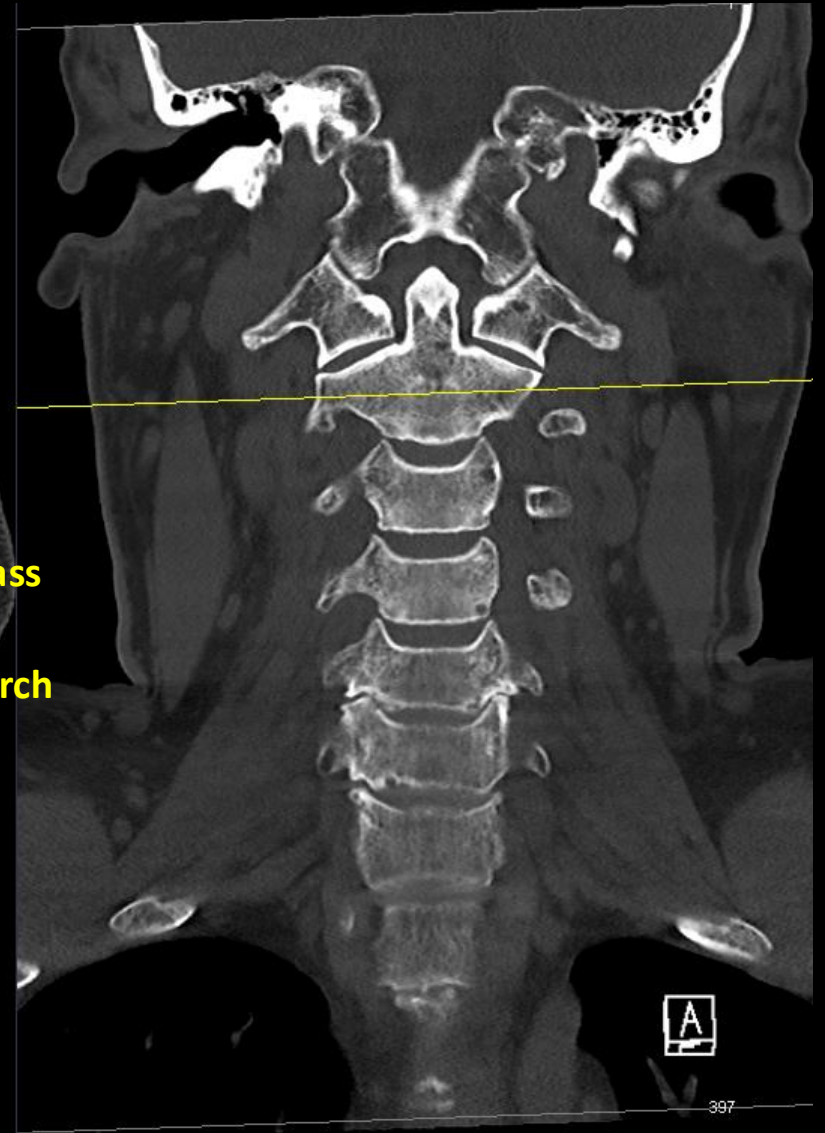
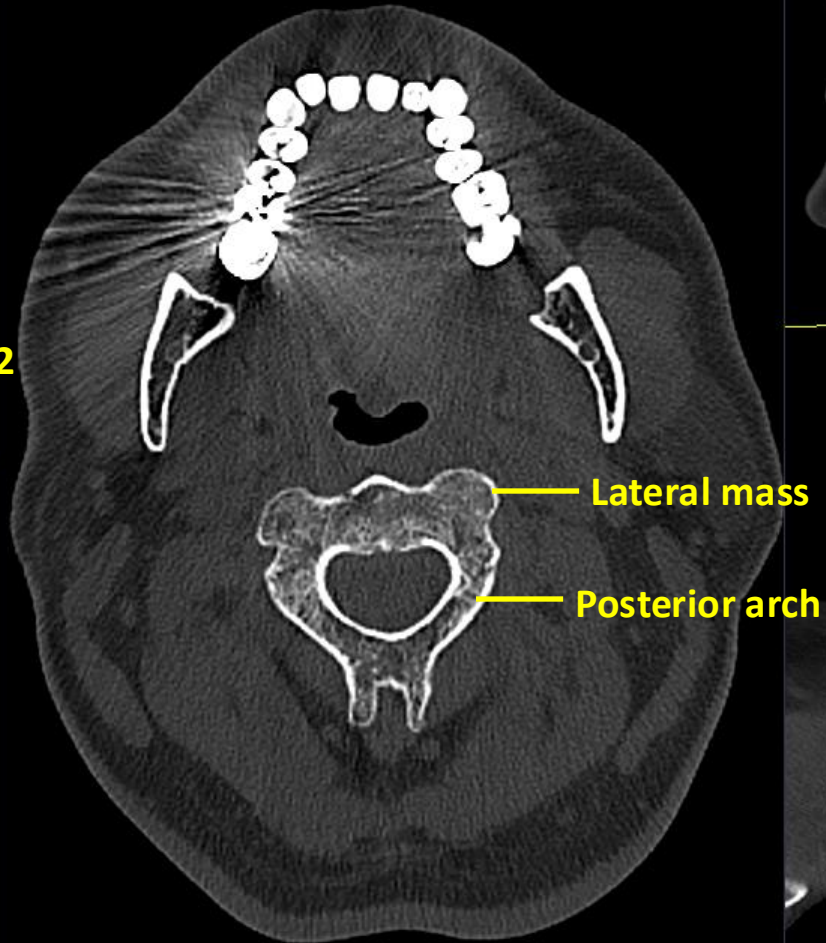
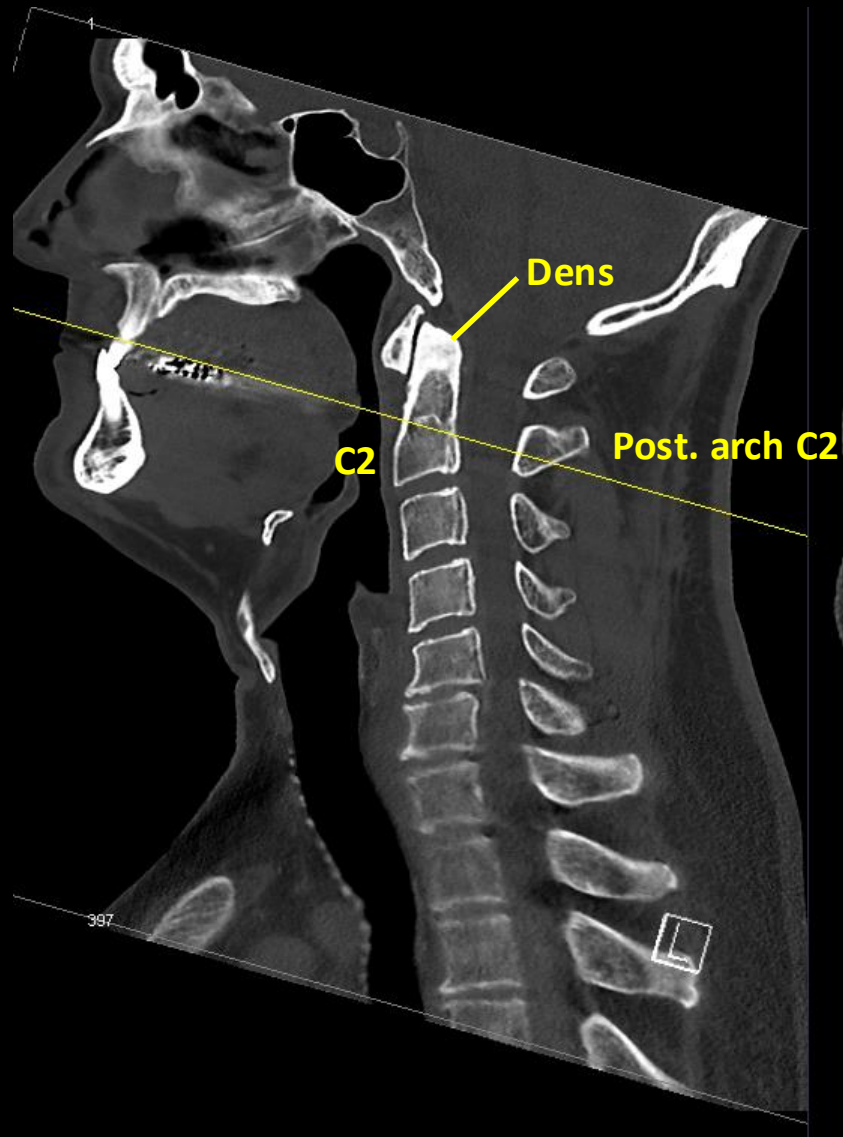
1 Gehweiler JA Jr, et al. (1976). "Fractures of the atlas vertebra." Skeletal Radiol 1(2):97–102



C1 fracture – Jefferson Burst



C2 - Axis



Odontoid fractures

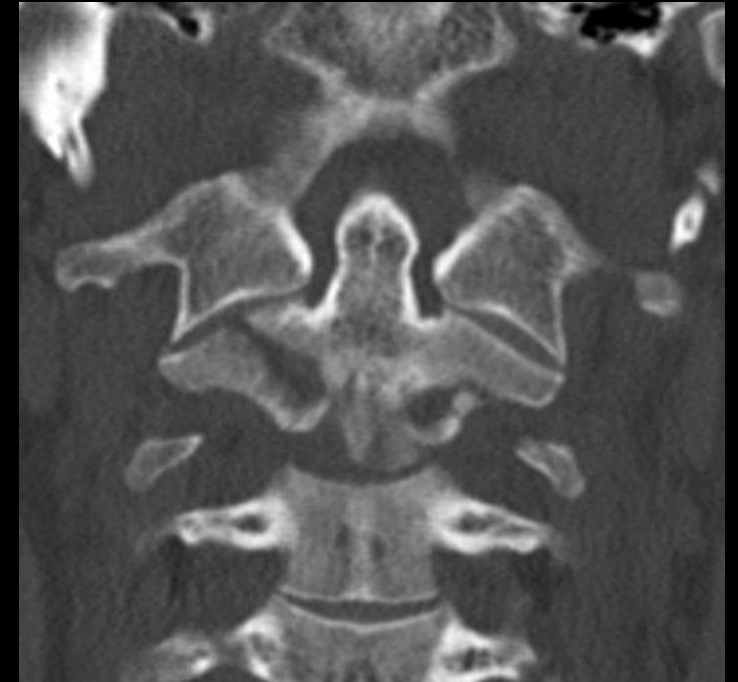
Classification (Anderson and D'Alonzo)



Type I: Fracture odontoid tip



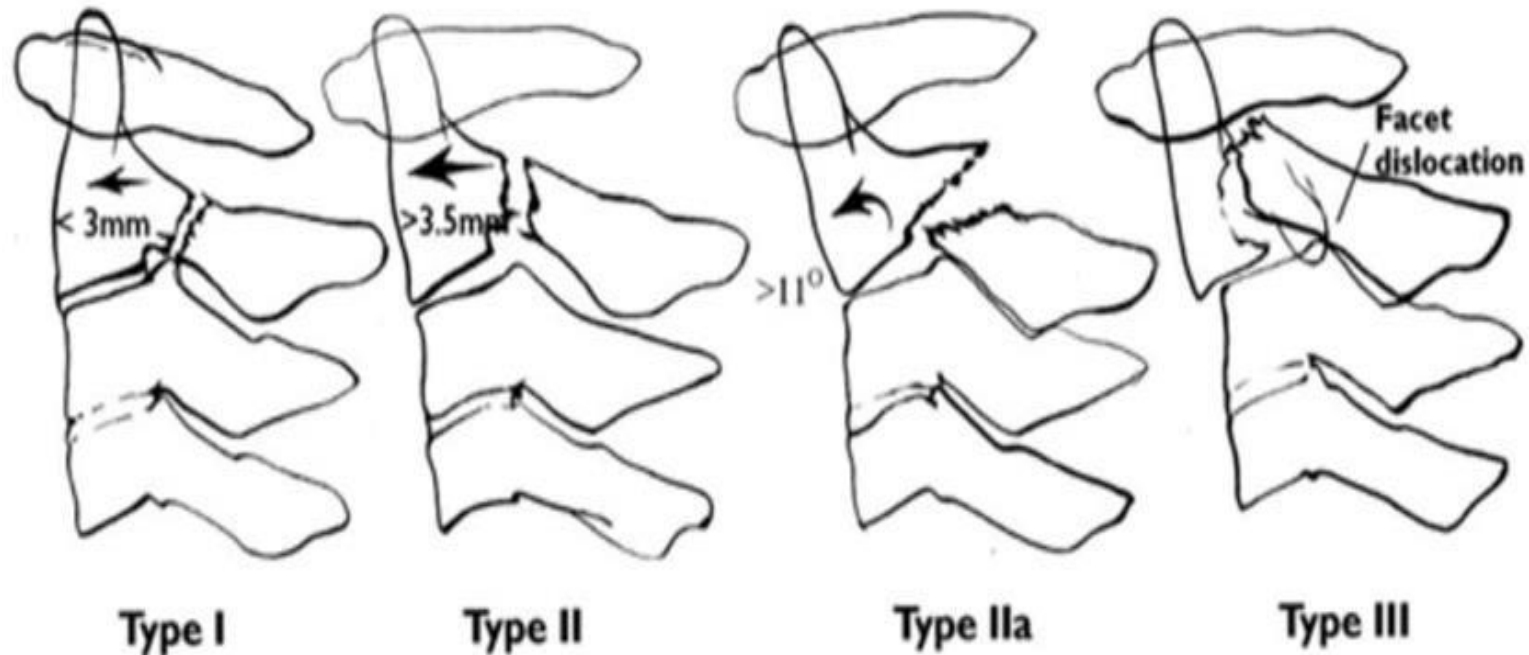
Type II: dens-body junction



Type III: body of axis

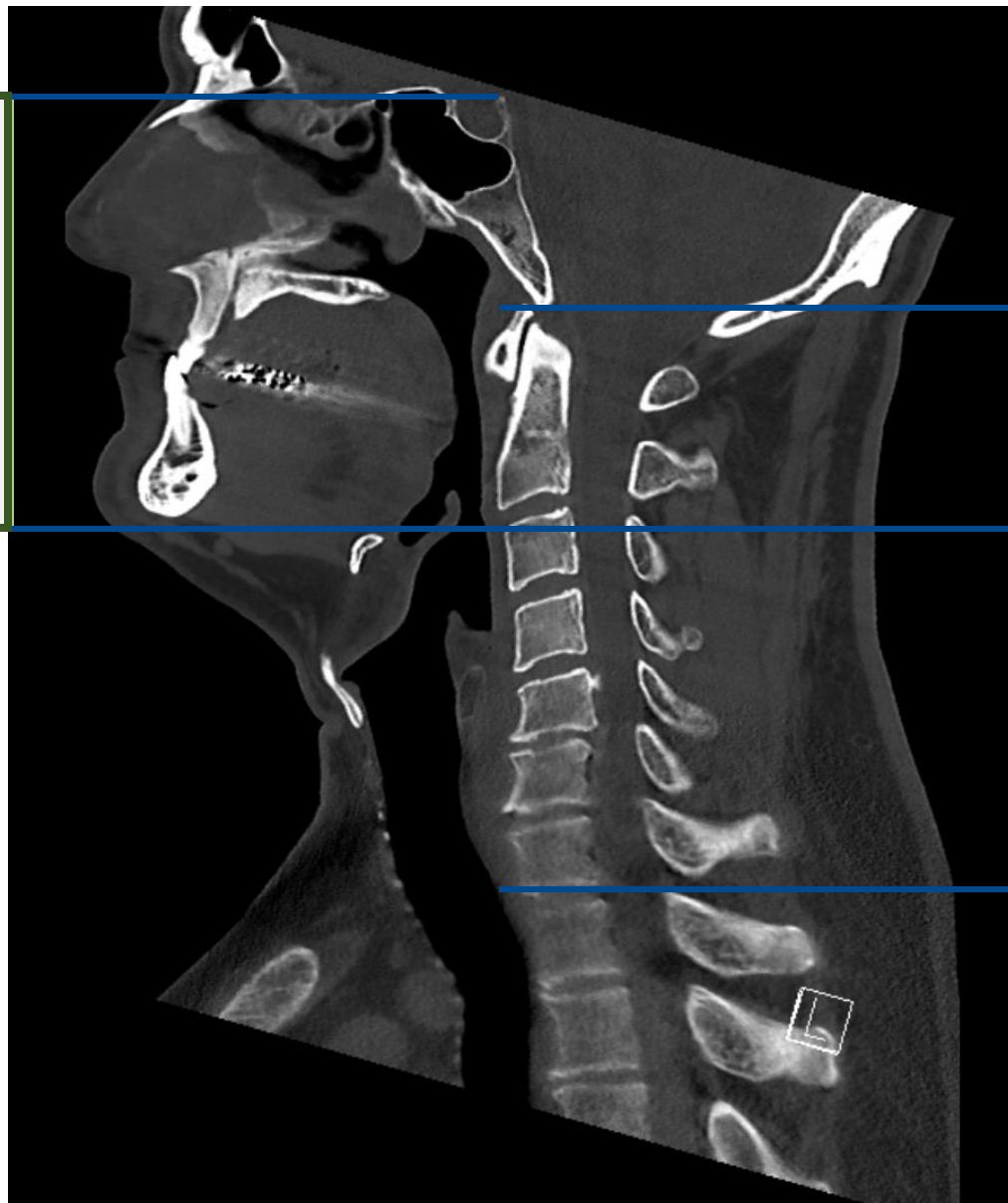
C2 – «Hangman»

Classification (Levine and Edwards)



Skull base

1 Face



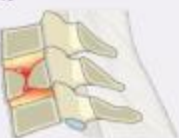
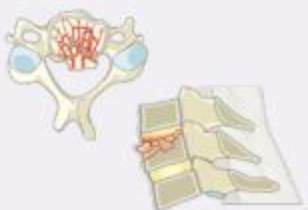
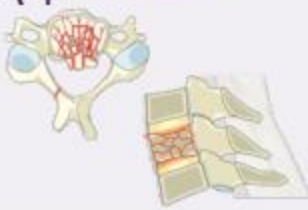
Skull base

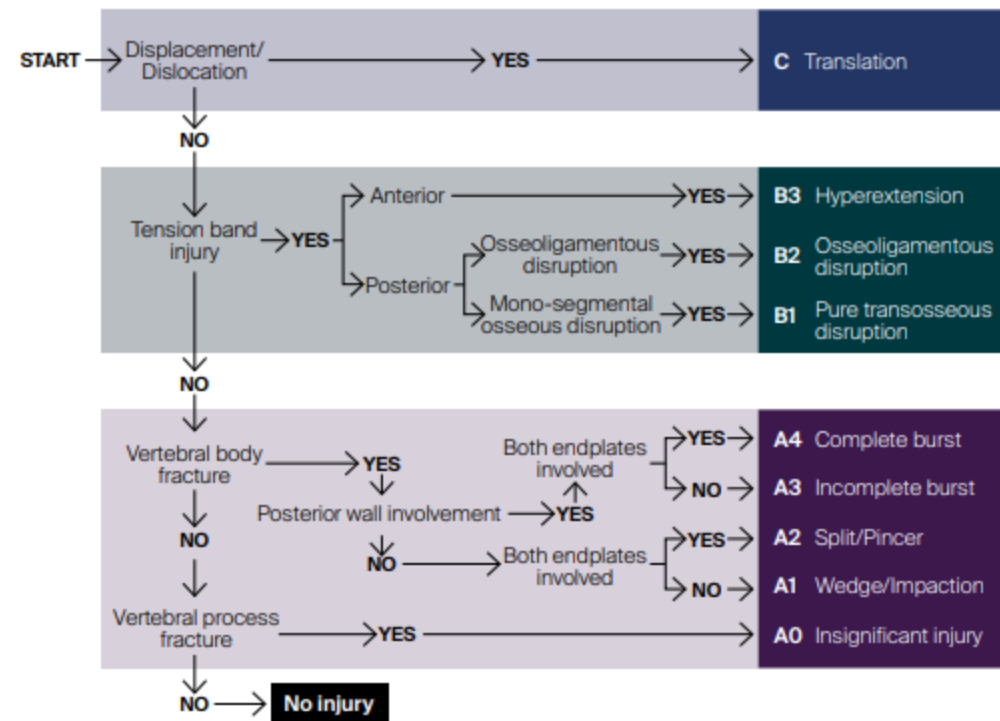
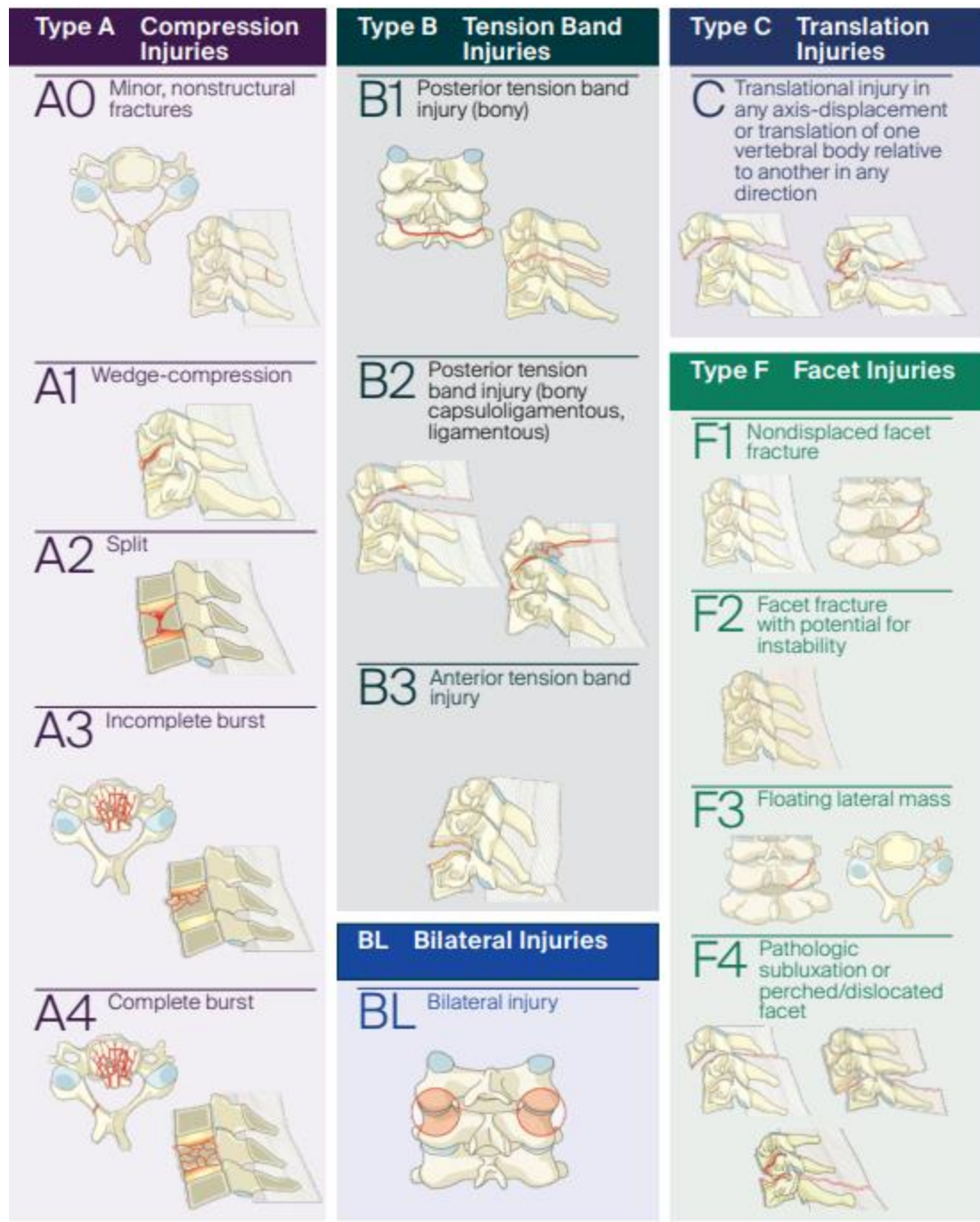
**Upper cervical spine
(C1 + C2)**

**Subaxial
Cervical spine
(C3 - C7)**



AO Spine Subaxial Injury Classification System

Type A Compression Injuries	Type B Tension Band Injuries	Type C Translation Injuries
A0 Minor, nonstructural fractures 	B1 Posterior tension band injury (bony) 	C Translational injury in any axis-displacement or translation of one vertebral body relative to another in any direction 
A1 Wedge-compression 	B2 Posterior tension band injury (bony capsuloligamentous, ligamentous) 	F1 Nondisplaced facet fracture 
A2 Split 	B3 Anterior tension band injury 	F2 Facet fracture with potential for instability 
A3 Incomplete burst 	BL Bilateral Injuries BL Bilateral injury 	F3 Floating lateral mass 
A4 Complete burst 		F4 Pathologic subluxation or perched/dislocated facet 



Neurology

Type	Neurological
N0	Neurology intact
N1	Transient neurologic deficit
N2	Radicular symptoms
N3	Incomplete spinal cord injury or any degree of cauda equina injury
N4	Complete spinal cord injury
NX	Cannot be examined
+	Continued spinal cord compression

Modifiers

Type	Description
M1	Posterior Capsuloligamentous Complex injury without complete disruption.
M2	Critical disc herniation.
M3	Stiffening/metabolic bone disease (ie DISH, AS, OPLL, OLF).
M4	Vertebral artery abnormality.



Subaxial Injury Classification (SLIC) and Severity Score

CT

1

Injury morphology

- 0 – No morphologic abnormality
- 1 – Compression
- 2 – Burst
- 3 – Distraction
- 4 – Rotation and/or translation

MR

2

Discoligamentous complex integrity

- 0 Intact
- 1 Indeterminate
- 2 Disruption

3

Neurological status

- 0 Intact
- 1 nerve root injury
- 2 Complete cord injury
- 3 Incomplete cord injury
- +1 Persistence cord compression

Score 0-3 – conservative

Score >4-5 – surgery



Ligaments

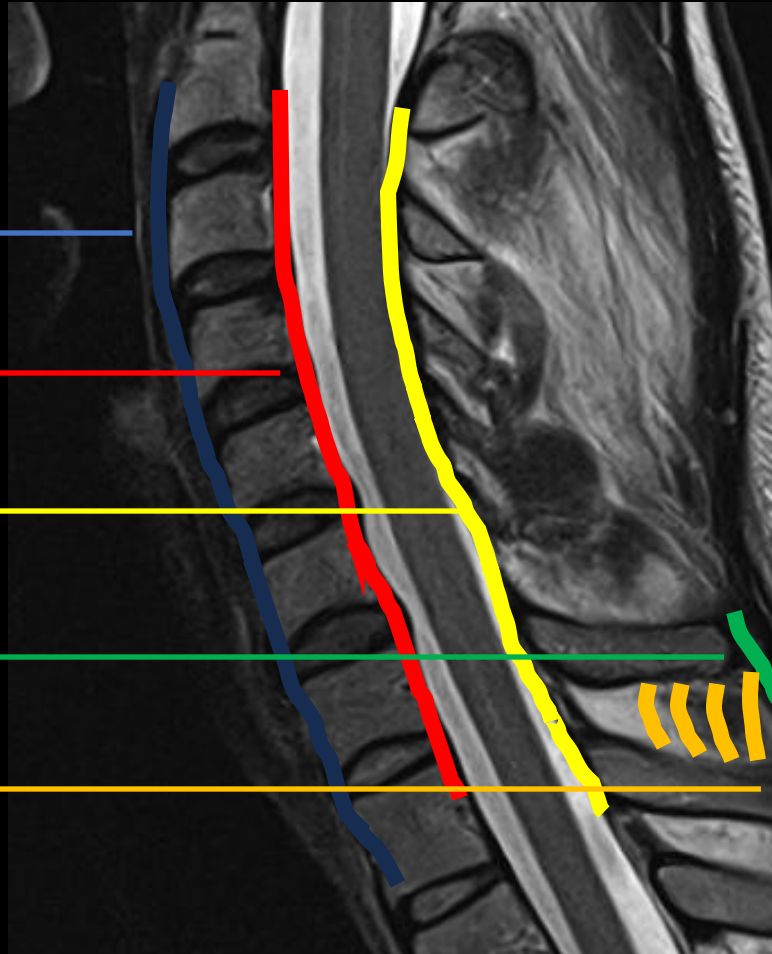
Lig. longitudinale anterior (ALL)

Llig. longitudinale posterior (PLL)

Lig. flavum

Lig. supraspinosus

Lig. intraspinosus



Three tips for residents

Be systematic in your approach (it's all about anatomy)

It's not only about the bones – look for associated findings and complications

Call a friend (surgeon)



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Thank you

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