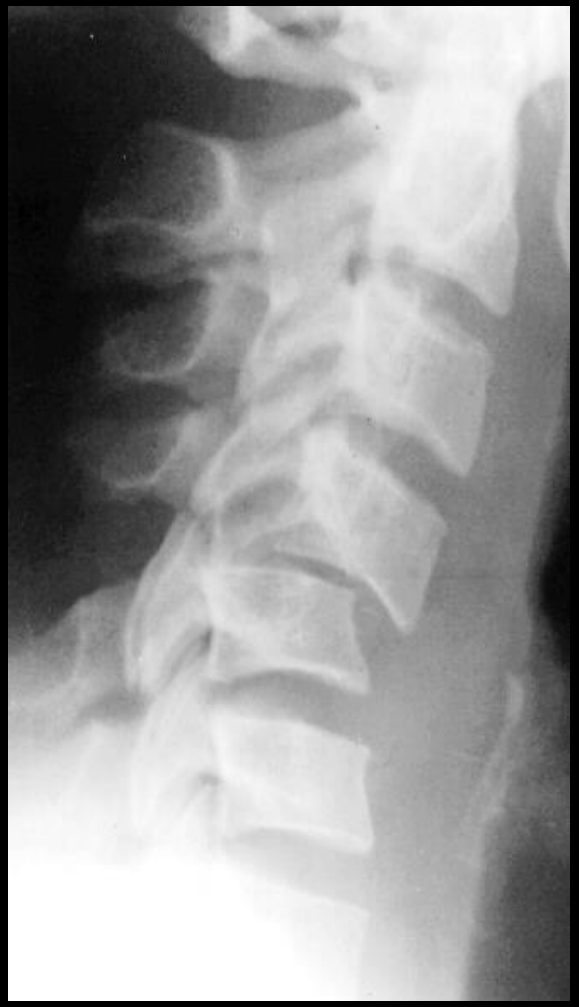

Spine Fractures: Identifying Unstable Injuries in Cervical Spine

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UCSF SPARC Spine Pathology Advanced Research Center

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Cervical Fracture Summary

USUALLY STABLE

- Type 1 and Type 3 Dens*
- Occipital condyle fractures*
- C1 ring fractures**
- Non displaced facet fractures
- Transverse process fractures
- Isolates spinous process fractures
- Isolated osteophyte fractures

SOMETIMES UNSTABLE

- Type 2 Dens
- Type II Hangman's
- Atypical Hangman's
- Floating lateral mass fractures
- Burst fractures

ALWAYS UNSTABLE

- AOD
- Facet dislocations
- Flexion teardrop
- Type III Hangman's
- Flexion distraction
- Displaced facet fractures

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Defining Instability

- “the loss of the ability of the spine under physiologic loads to maintain its patterns of displacement so there is no initial or additional neurologic deficit, no major deformity, and no incapacitating pain”

-White and Panjabi

Topics

- Initial Evaluation
- Cervical Clearance
- Radiographic Assessment
- Case Example

Initial Evaluation

- ATLS guidelines of the American College of Surgeons
- "all trauma patients should be presumed to have an unstable cervical spine injury … until all aspects of the cervical spine have been adequately studied and an injury excluded."

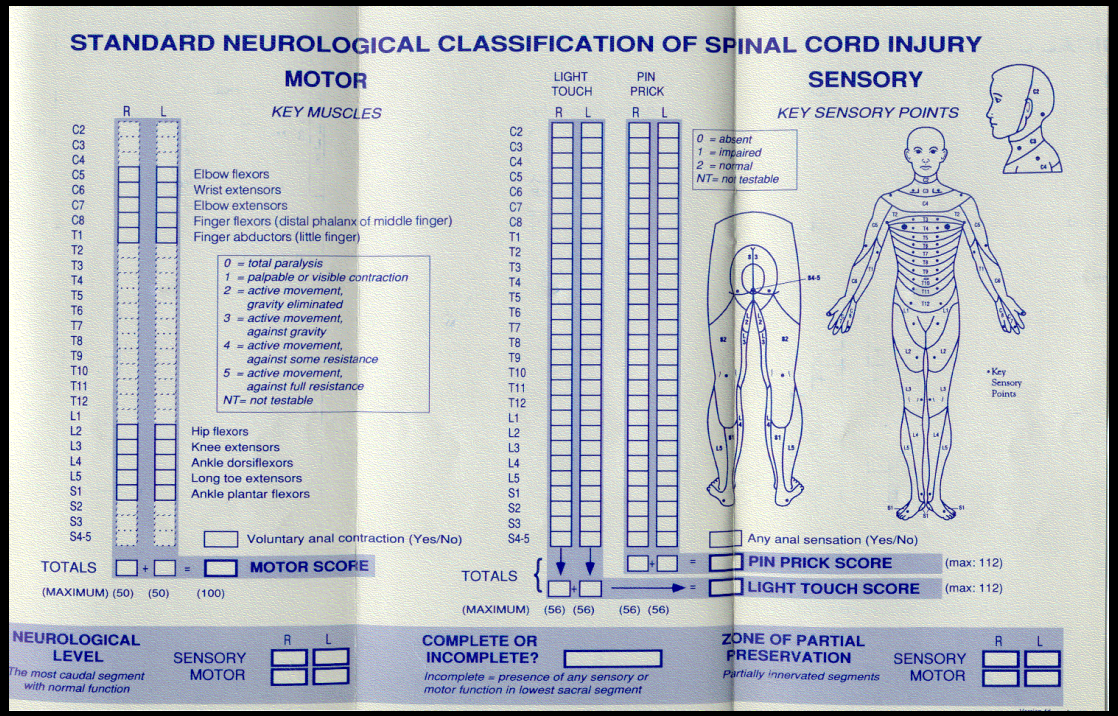
H & P

- History
  - Mechanism
  - Anticoagulation
  - Numbness/weakness
- Physical Examination
  - Midline tenderness -stepoffs
  - Motor and Sensory Examination
  - Rectal Examination

45 y/o male

- History
  - Fell from skateboard
  - No other injuries
  - Denies Pain/weakness
  - GCS 15
  - Normal state of mind
  - Placed in collar
- Physical Examination
  - No midline TTP
  - Neurointact
  - Normal rectal tone

Physical Exam



STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR — KEY MUSCLES

C2 C3 C4 C5 C6 C7 C8 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1 L2 L3 L4 L5 S1 S2 S3 S4-5

C5 Elbow flexors
C6 Wrist extensors
C7 Elbow extensors
C8 Finger flexors (distal phalanx of middle finger)
T1 Finger abductors (little finger)

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
NT= not testable

L2 Hip flexors
L3 Knee extensors
L4 Ankle dorsiflexors
L5 Long toe extensors
S1 Ankle plantar flexors

Voluntary anal contraction (Yes/No)

TOTALS + = MOTOR SCORE
(MAXIMUM) (50) (50) (100)

SENSORY — KEY SENSORY POINTS

LIGHT TOUCH / PIN PRICK

0 = absent
1 = impaired
2 = normal
NT= not testable

Any anal sensation (Yes/No)

TOTALS + = PIN PRICK SCORE (max: 112)
+ = LIGHT TOUCH SCORE (max: 112)
(MAXIMUM) (56) (56) (56) (56)

NEUROLOGICAL LEVEL — The most caudal segment with normal function — SENSORY R L / MOTOR R L

COMPLETE OR INCOMPLETE? — Incomplete = presence of any sensory or motor function in lowest sacral segment

ZONE OF PARTIAL PRESERVATION — Partially innervated segments — SENSORY R L / MOTOR R L

ASIA IMPAIRMENT SCALE

- ☐ **A = Complete:** No motor or sensory function is preserved in the sacral segments S4-S5.
- ☐ **B = Incomplete:** Sensory but not motor function is preserved below the neurological level and extends through the sacral segments S4-S5.
- ☐ **C = Incomplete:** Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle grade less than 3.
- ☐ **D = Incomplete:** Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle grade greater than or equal to 3.
- ☐ **E = Normal:** Motor and sensory function is normal.

CLINICAL SYNDROMES

- ☐ Central Cord
- ☐ Brown-Sequard
- ☐ Anterior Cord
- ☐ Conus Medullaris
- ☐ Cauda Equina

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Imaging?

NEXUS Criteria: who doesn't need imaging?

- Normal level of alertness (GCS 15)
- No evidence of intoxication
- Absence of tenderness in the posterior midline
- Absence of a neurological deficit
- No distracting pain elsewhere

Hoffman JR et al, N Engl J med, 2000

Clear Spine?

Cervical Clearance

Alert patient with normal cervical spine exam

- C-Spine can be cleared on clinical basis
- NEXUS + Active ROM

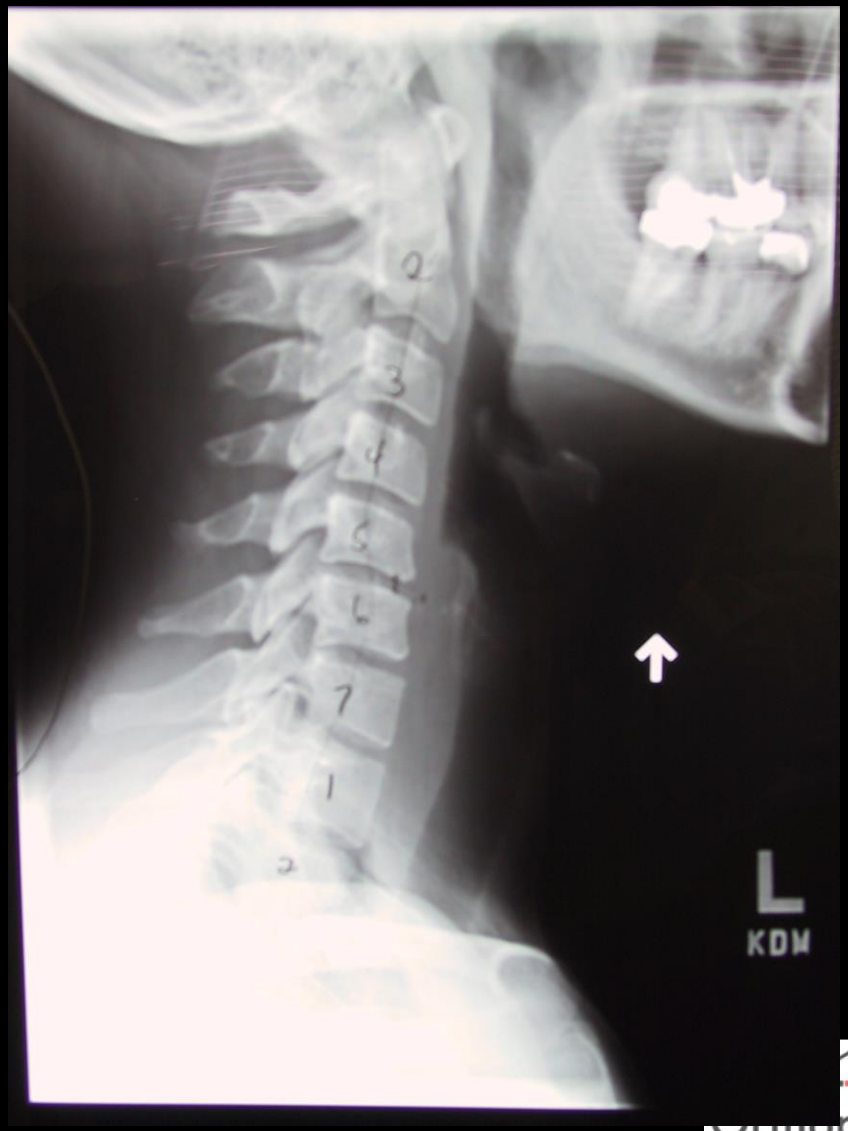
The Canadian C-Spine (cervical-spine) Rule (CCR) and the National Emergency X-Radiography Utilization Study (NEXUS) Low-Risk Criteria (NLC) are decision rules to guide the use of cervical-spine radiography in patients with trauma.

http://www.east.org/tpg/cspine2009.pdf

Imaging

- X-rays
- CT scan
- MRI

X-Ray



Landmarks and Lines

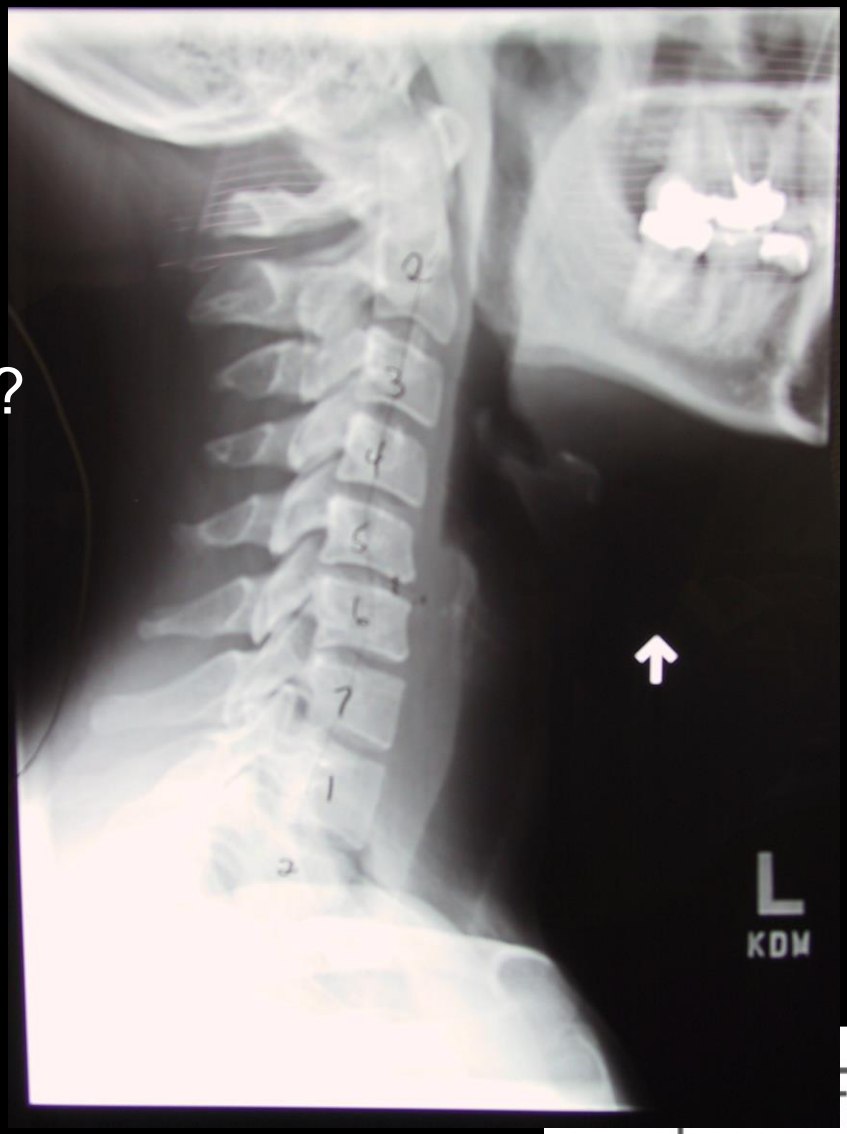
Lateral X-Ray:

Adequate Image?

- -Visualize O-C
- -Visualize T1
- - Swimmer's view?

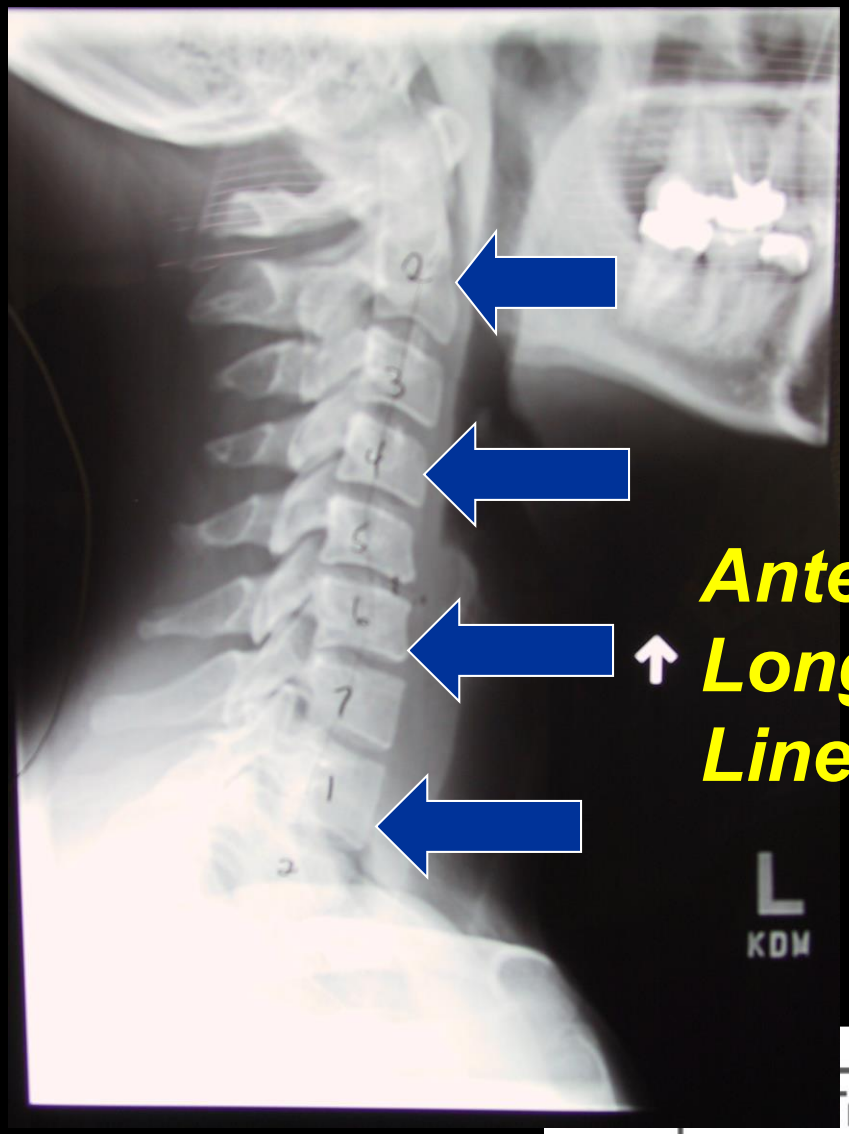
Assess:

- -Alignment
- -Disc Spaces
- -Soft Tissues



Landmarks and Lines

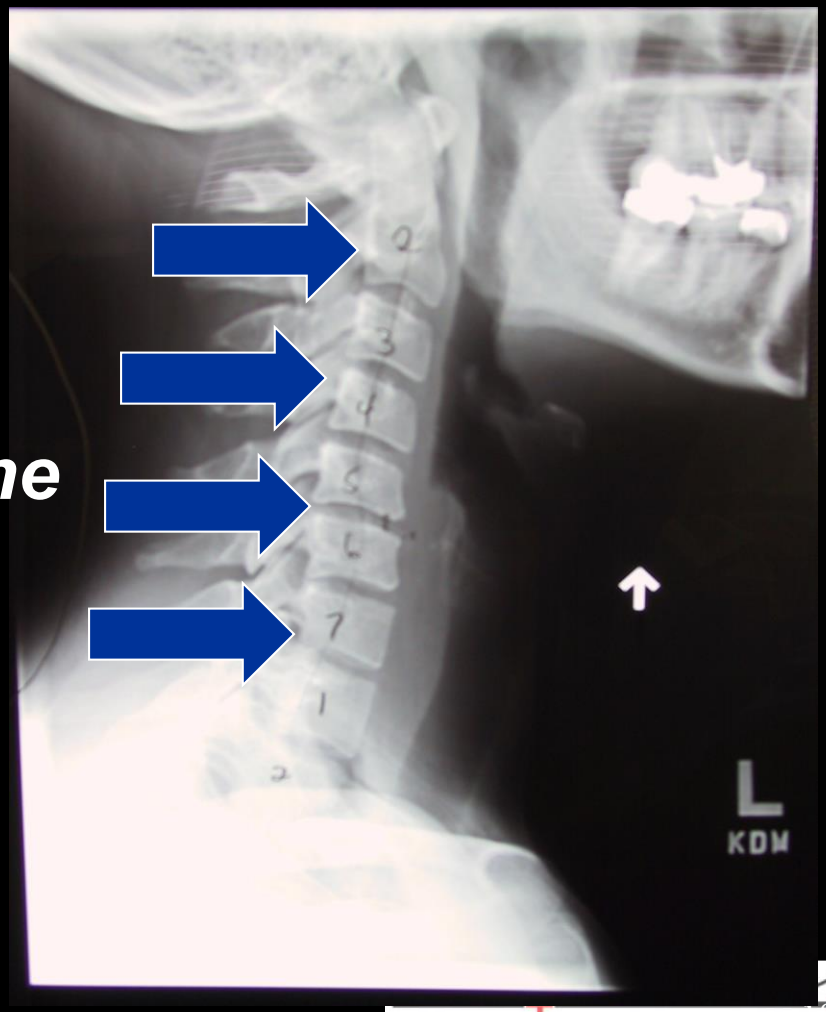
Lateral X-Ray:



Landmarks and Lines

Lateral X-Ray:

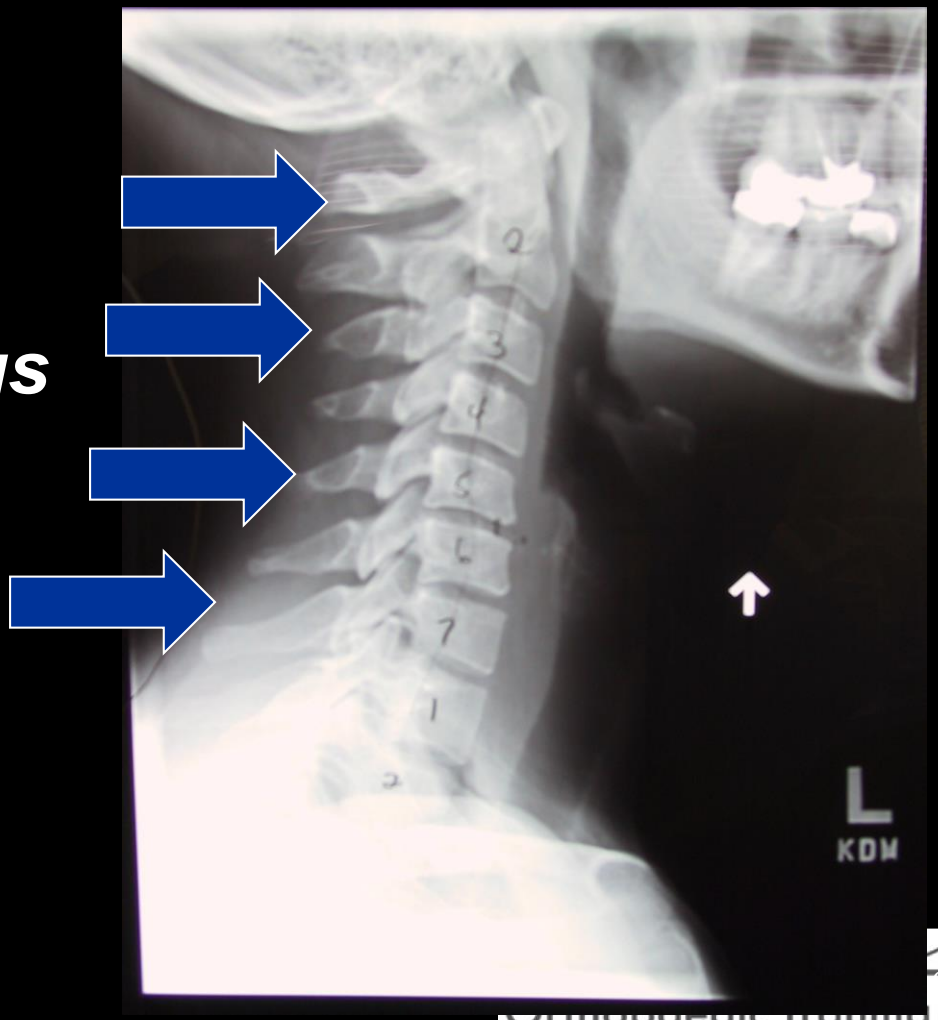
Posterior Longitudinal Line (PLL)



Landmarks and Lines

Lateral X-Ray:

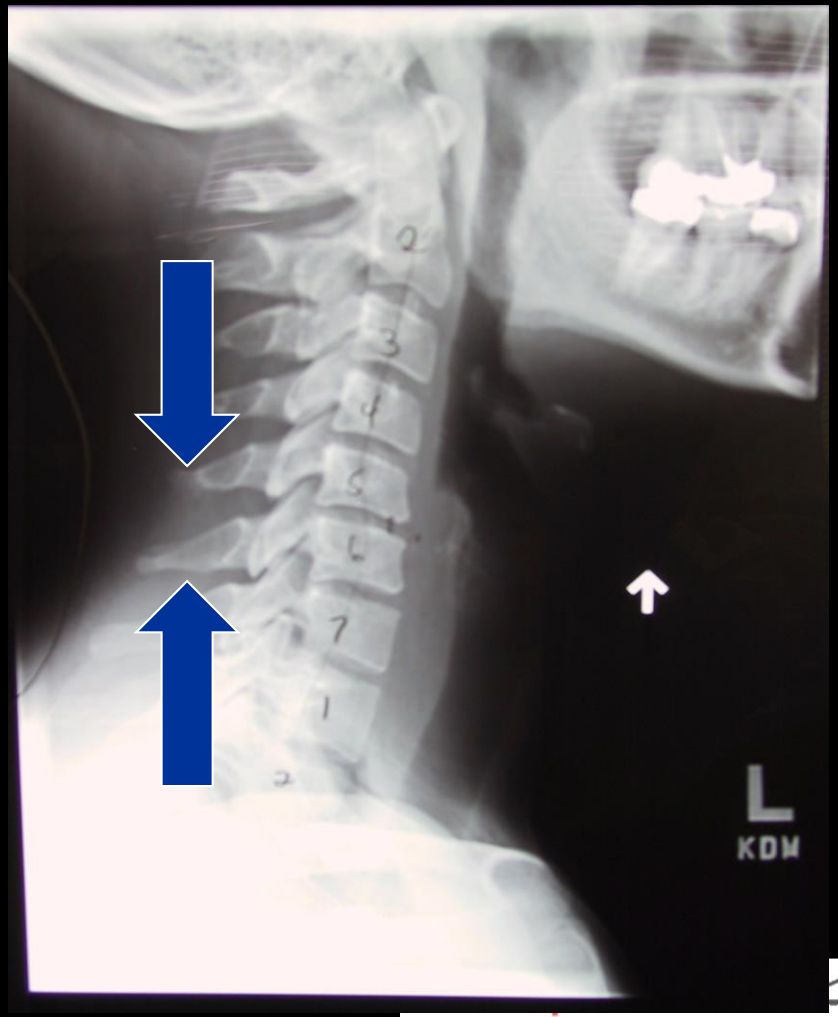
Alignment of Spinous Processes



Landmarks and Lines

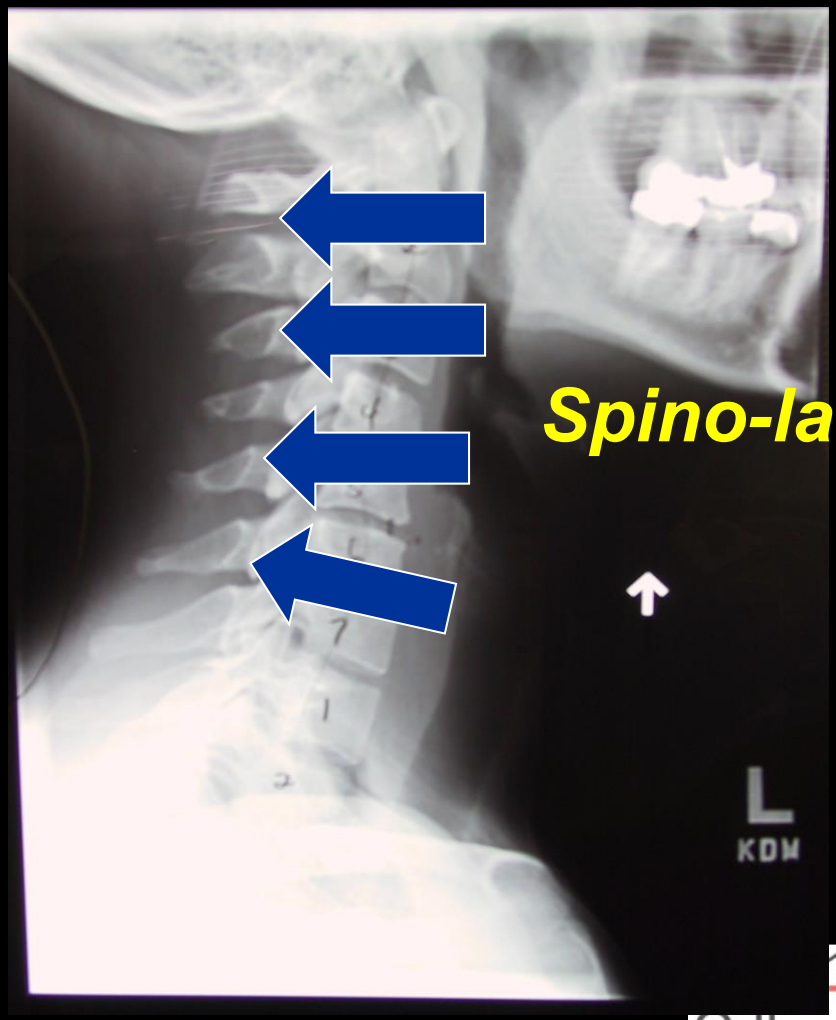
Lateral X-Ray:

Inter-spinous Distance



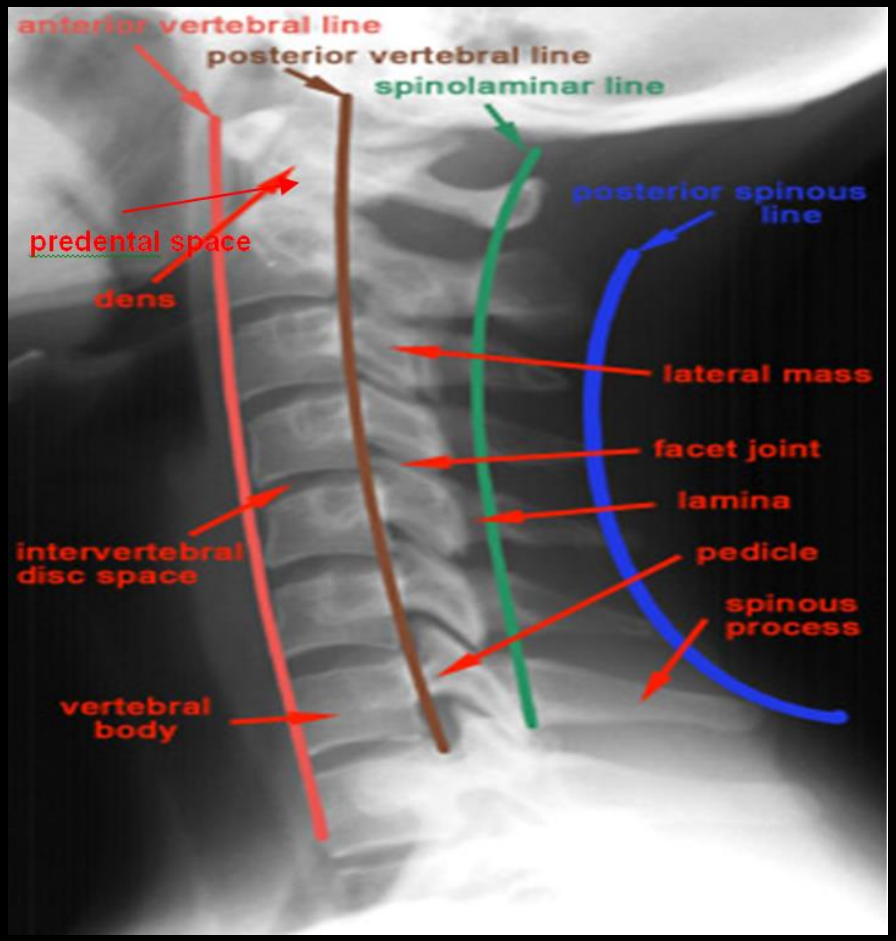
Landmarks and Lines

Lateral X-Ray:

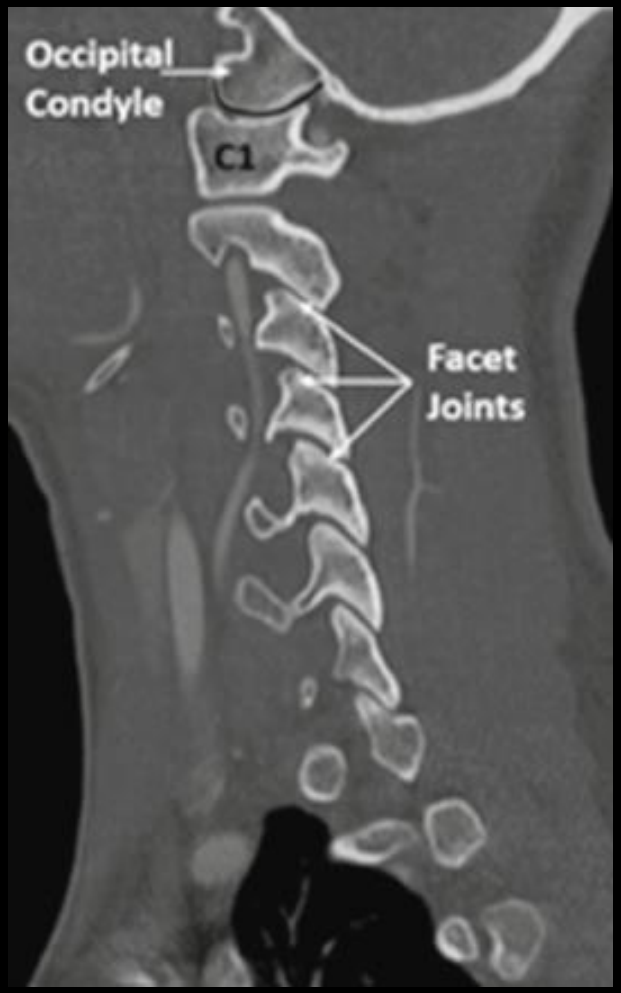


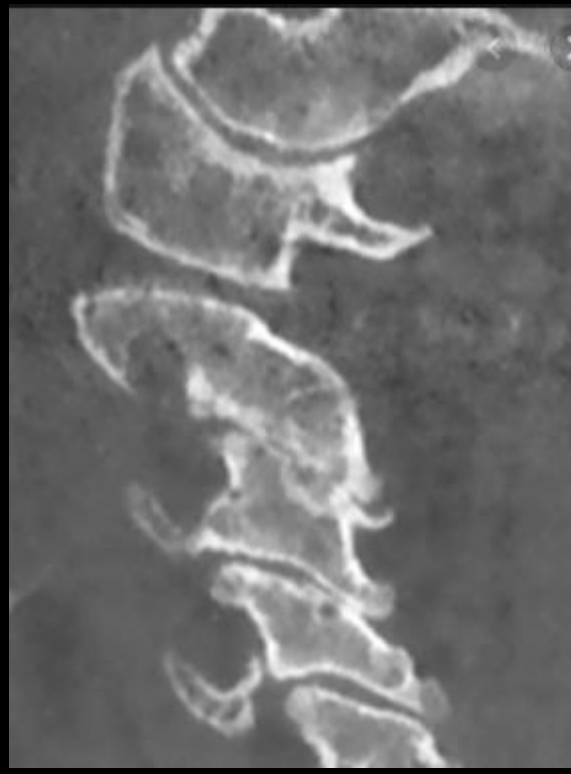
Spino-laminar Line

Landmarks and Lines



Landmarks and Lines



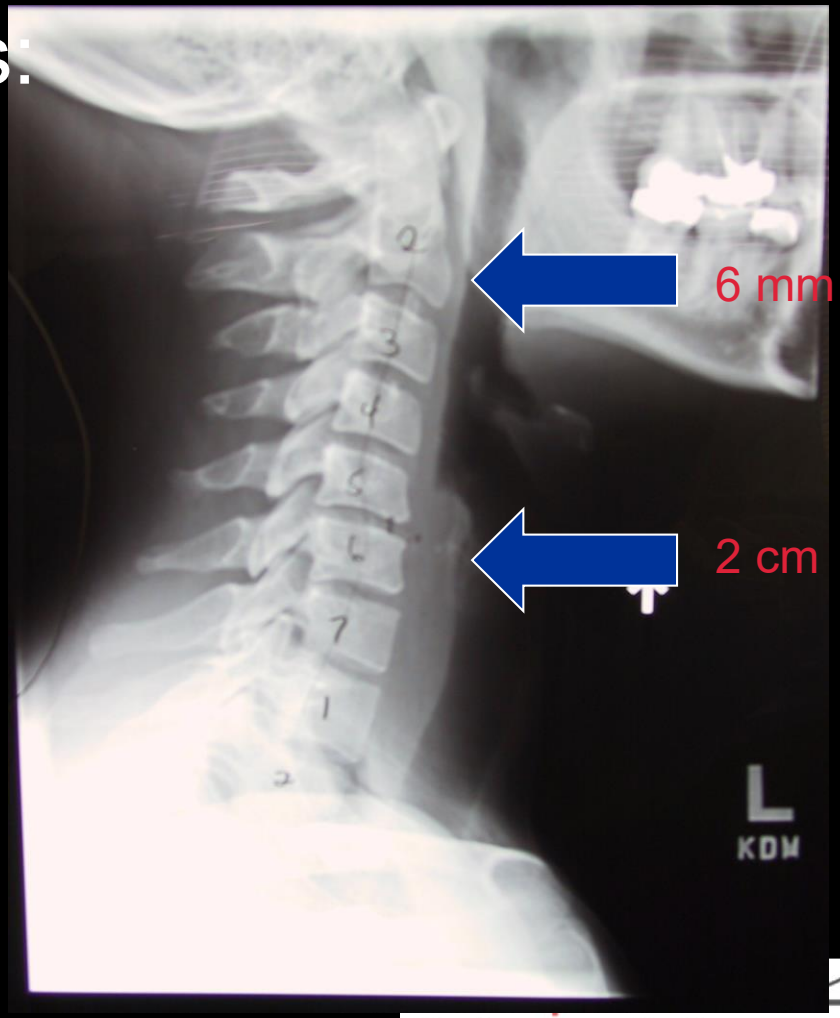


Anterior soft tissue swelling

Soft Tissue Shadows:

6mm @ C2

2 cm @ C6



Operative Indications

- Decompress what is compressed
- Stabilize what is unstable

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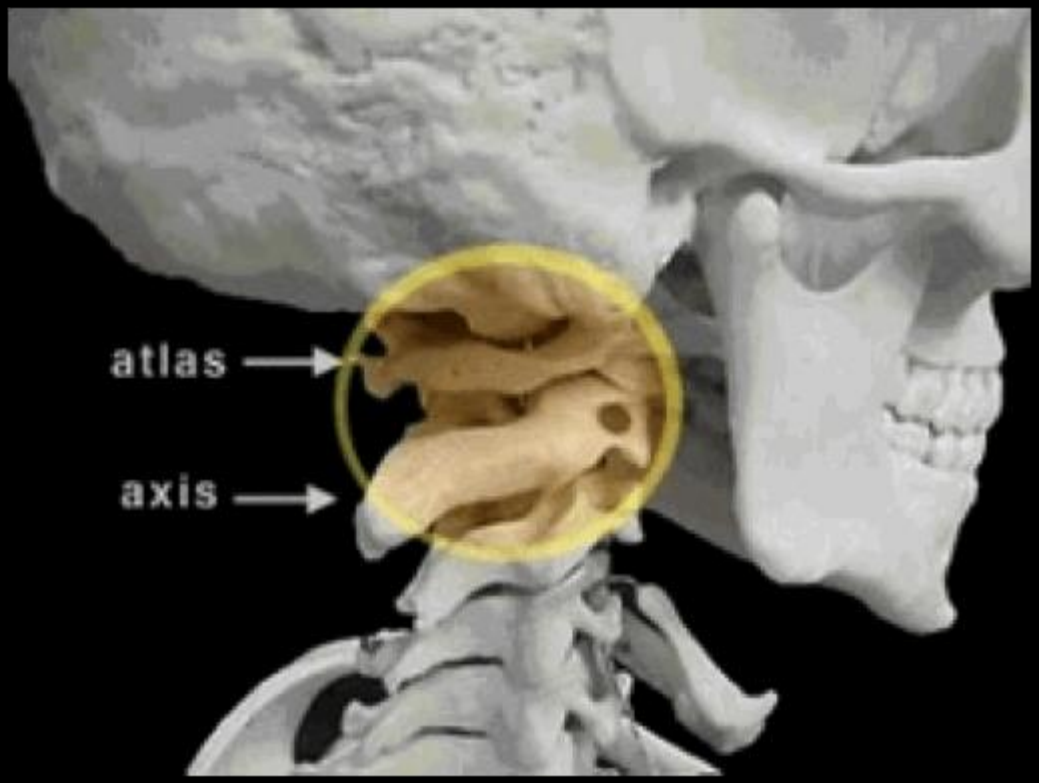


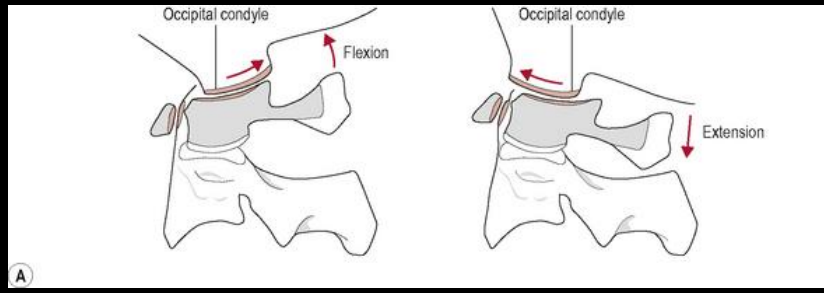
UPPER CERVICAL SPINE

(OCCIPUT TO C2)

Anatomy

Atlas (C1)- supports the occipital condyles

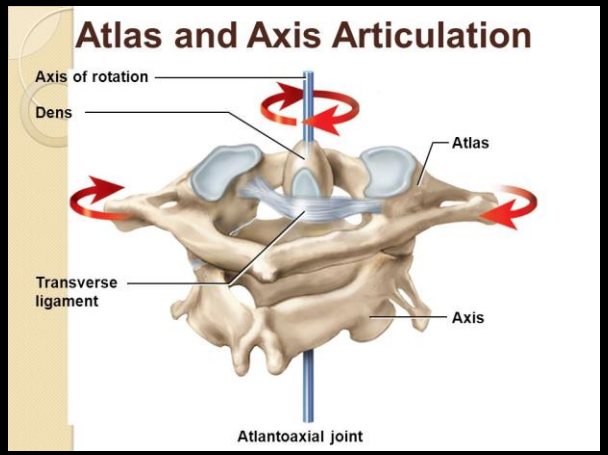
- 50% of flexion extension



Axis (C2)- supports atlas

The dens (odontoid) and its stabilizing transverse ligament enable rotation between C1 and C2

- C1-C2 accounts for 50% percent of lateral rotation



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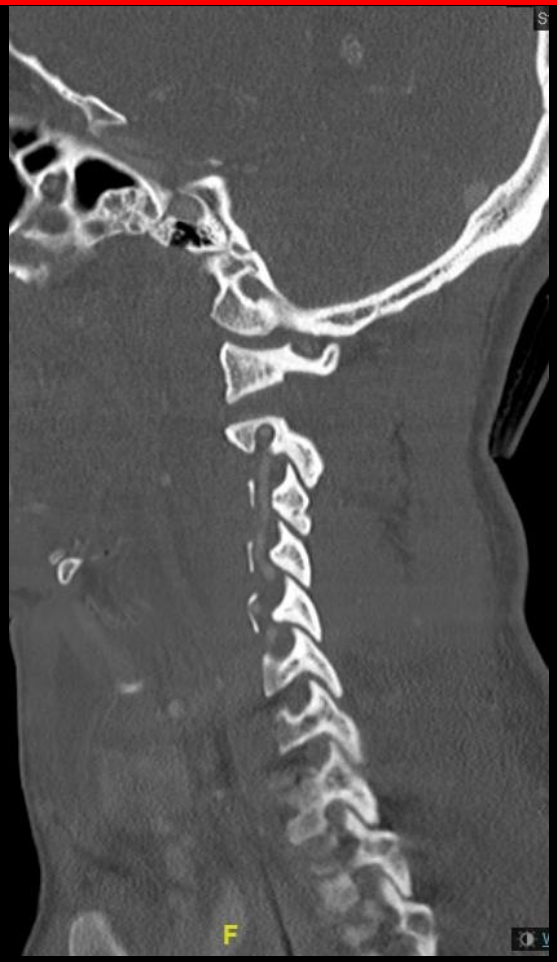
Specific Injuries

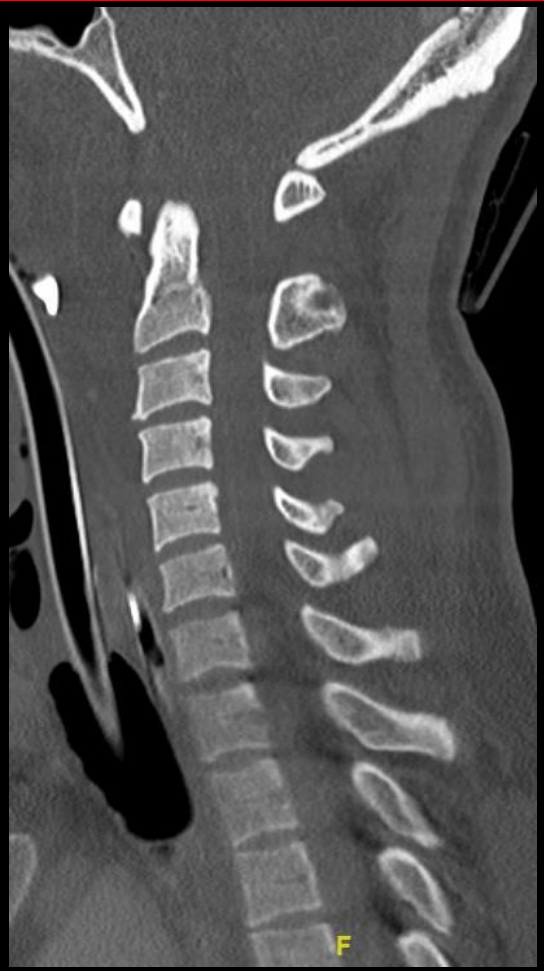
- Occipital cervical dissociation
- Occipital condyle fracture
- C1 ring fractures
- Dens fractures
- Hangman's fracture

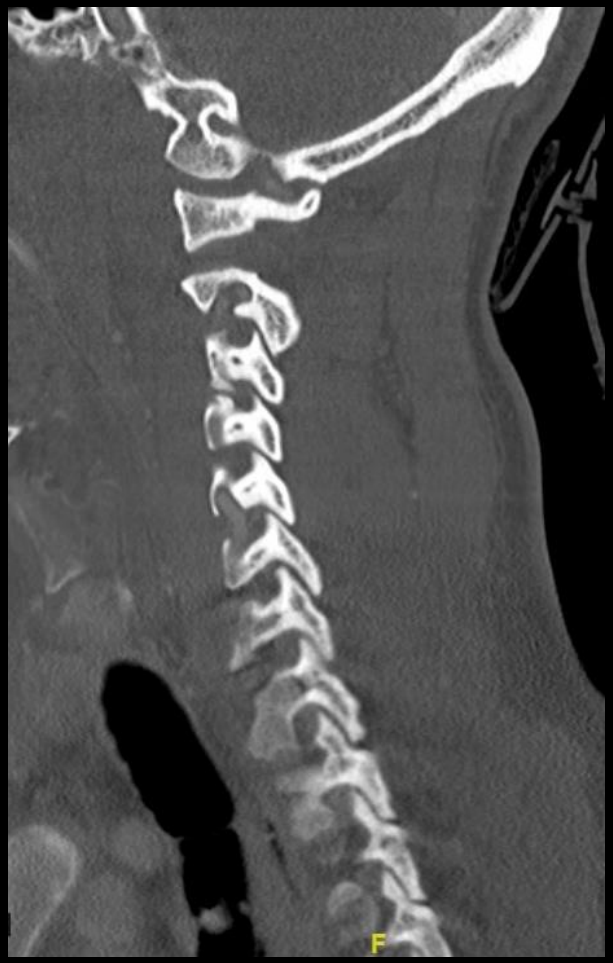
History

- 37 y/o male hit by car
- Intubated in the field
- Seen to move all extremities
- Medical history unknown

Imaging







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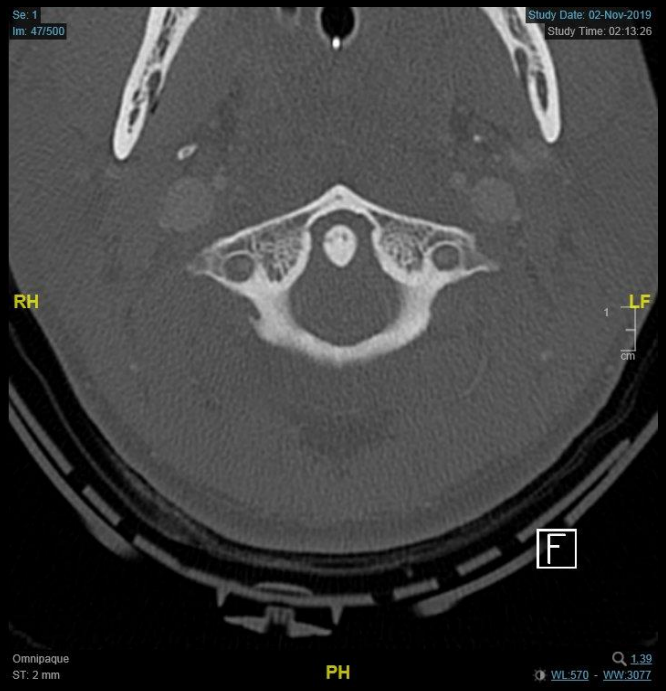

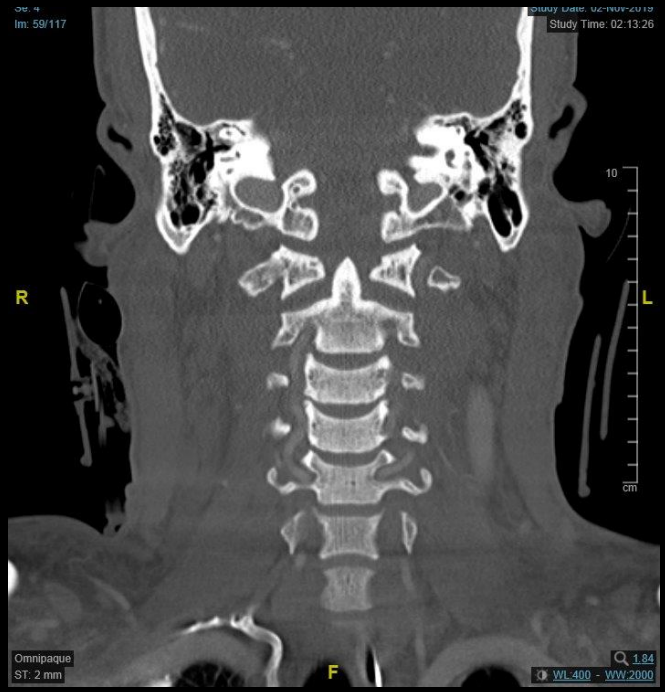

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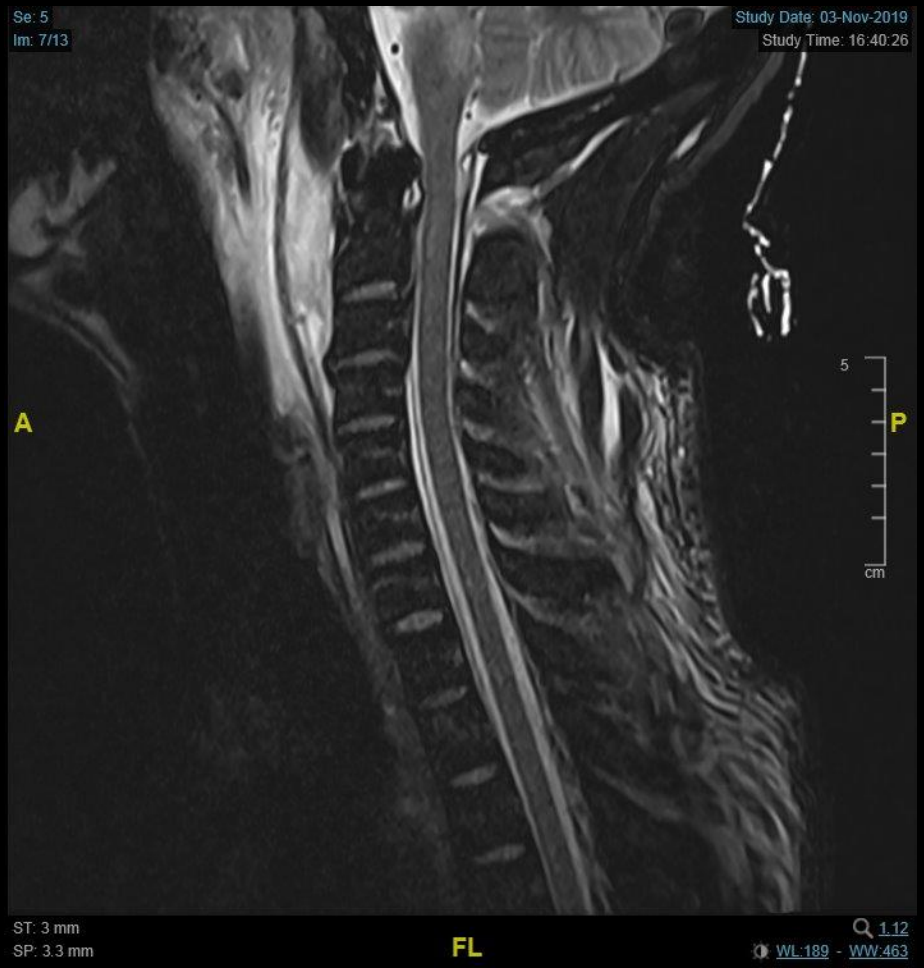
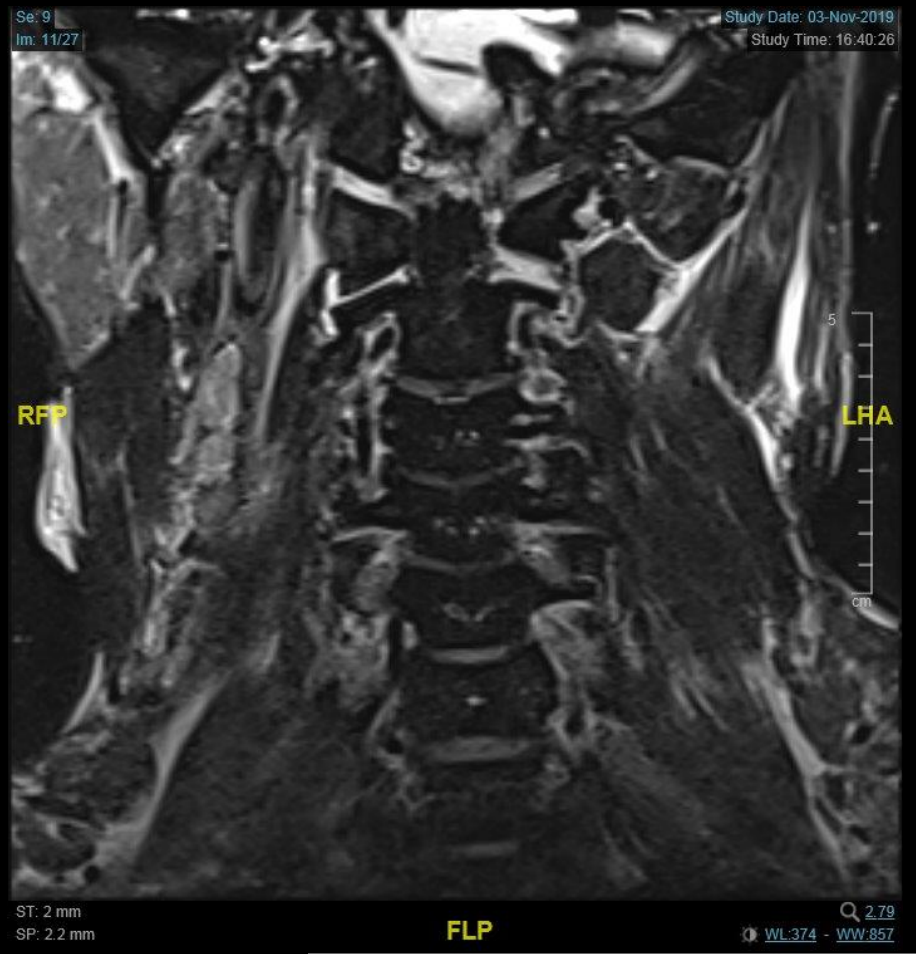
Imaging





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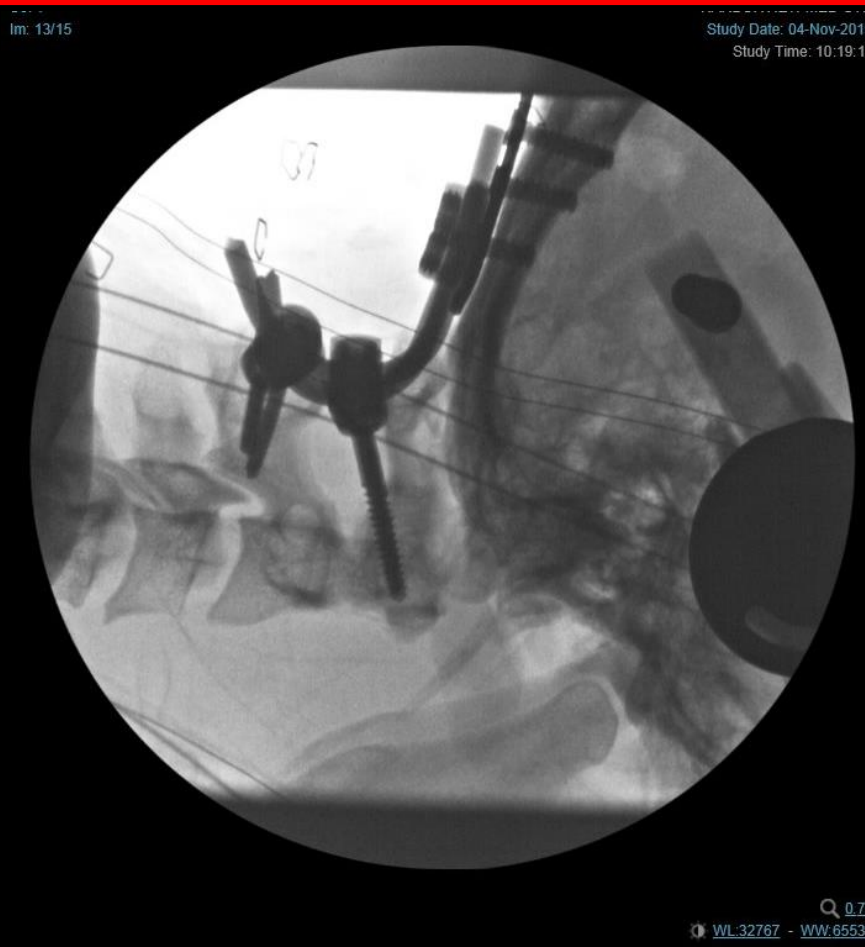
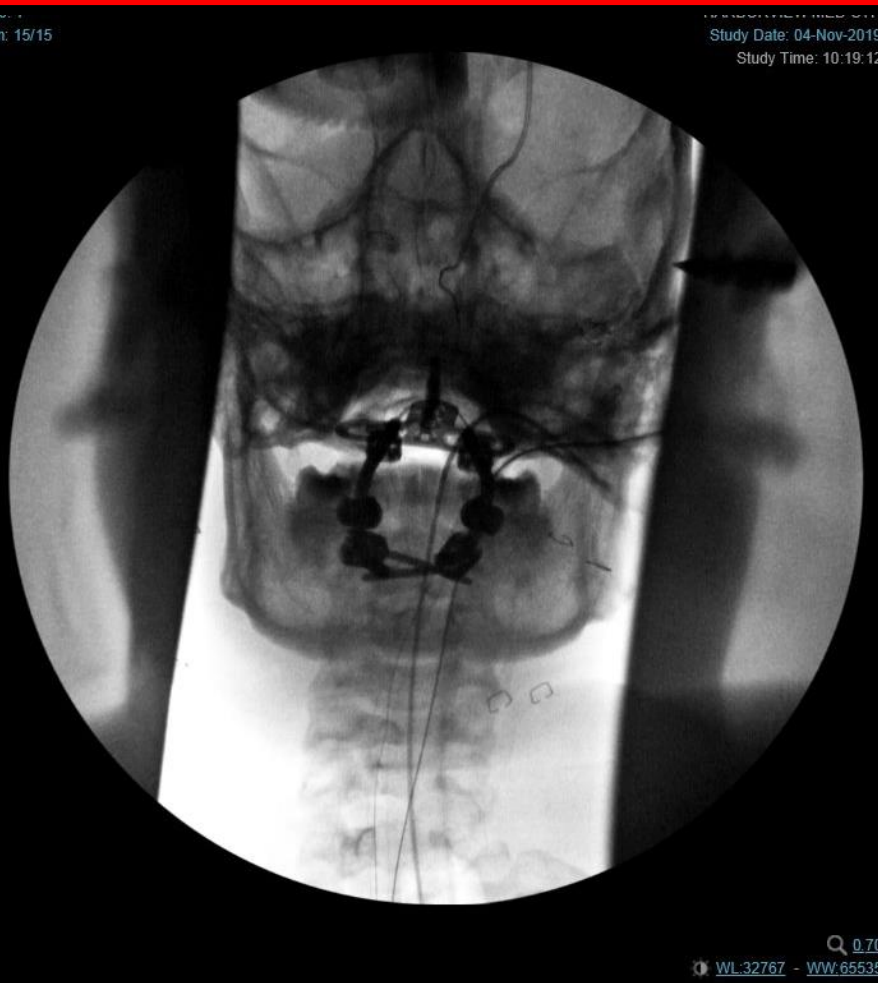
Intra-op





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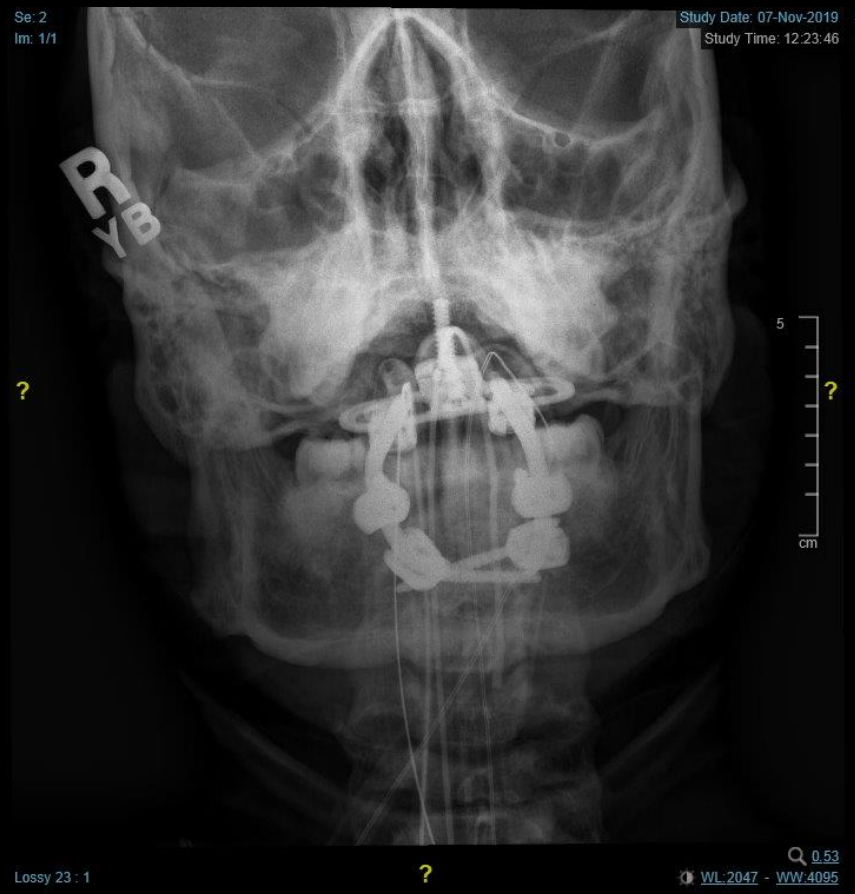
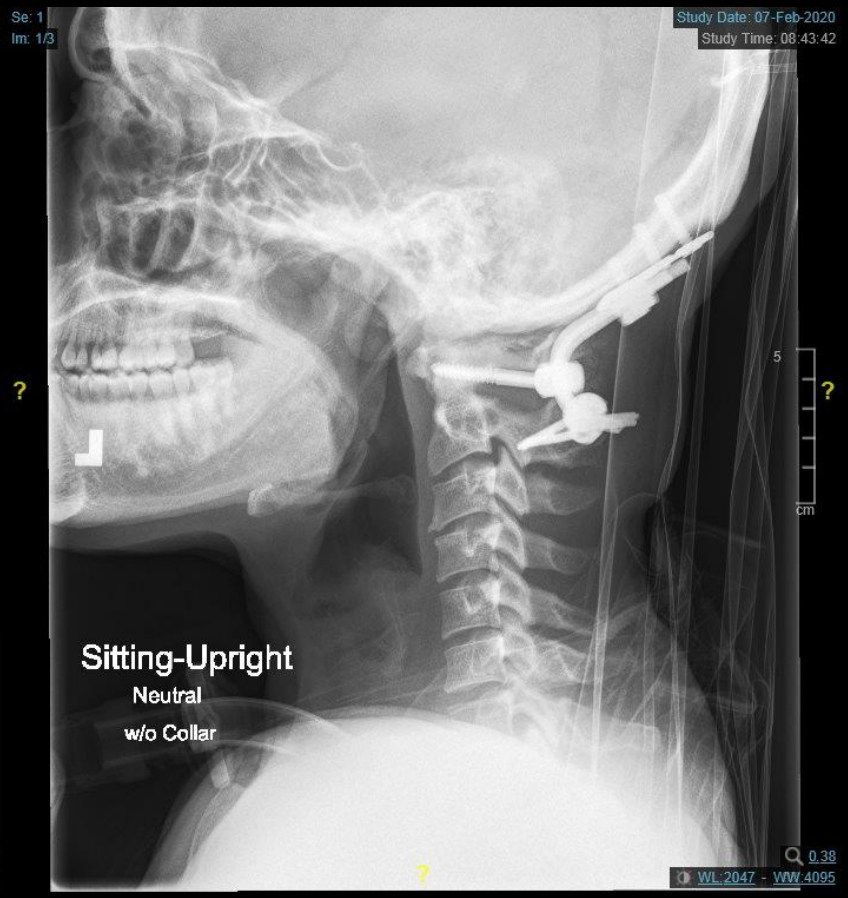
Post op imaging





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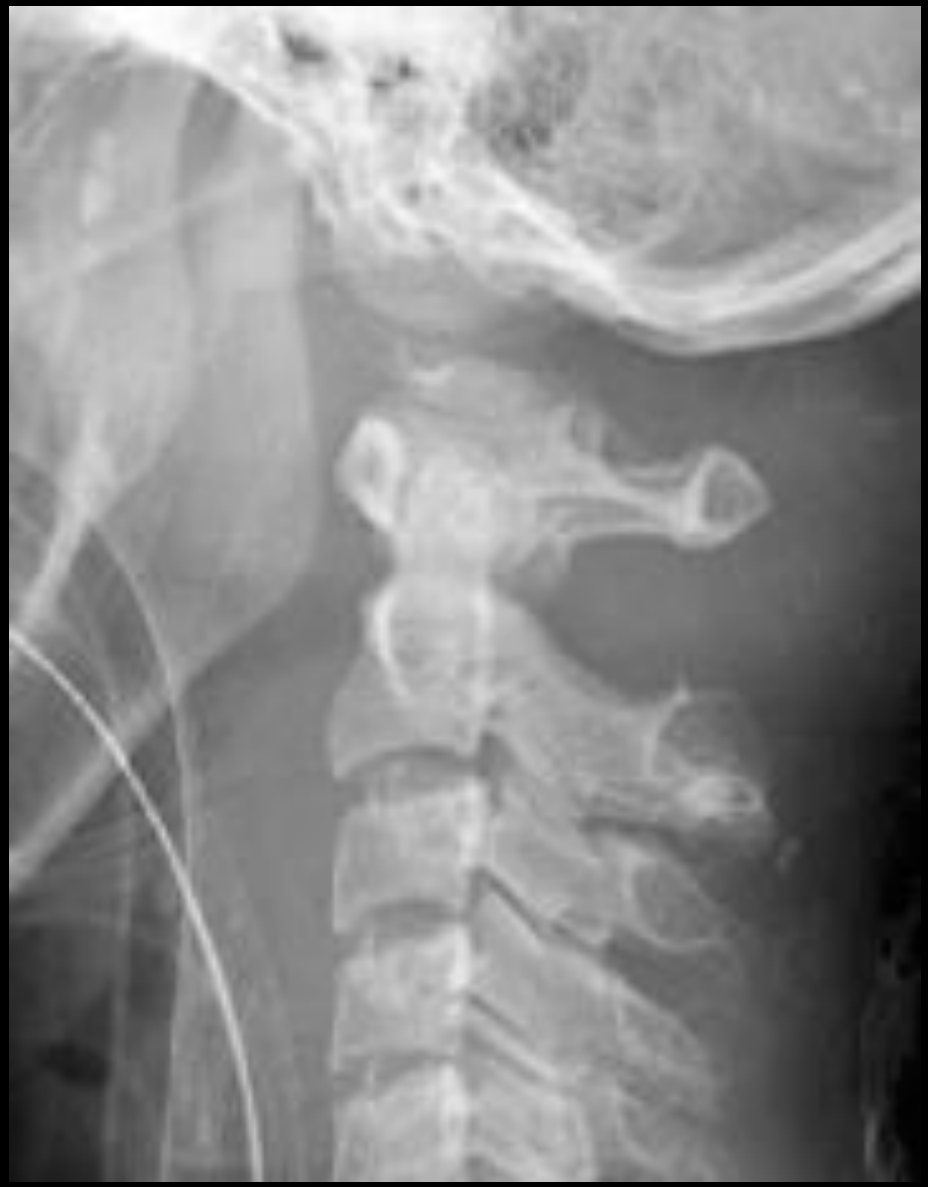
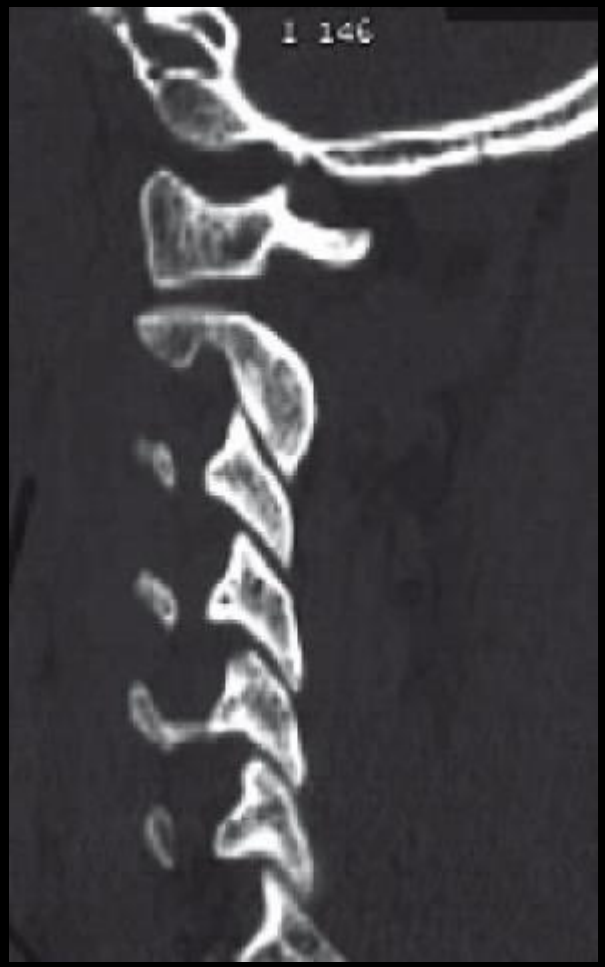
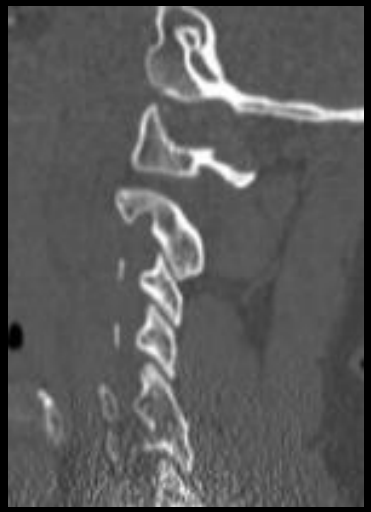
Craniocervical Dissociation

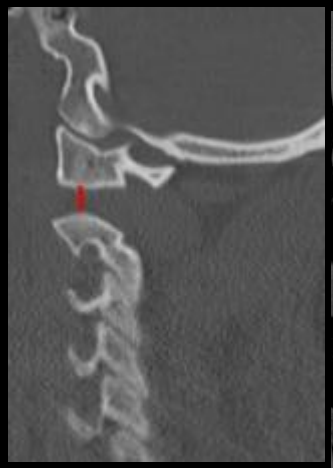


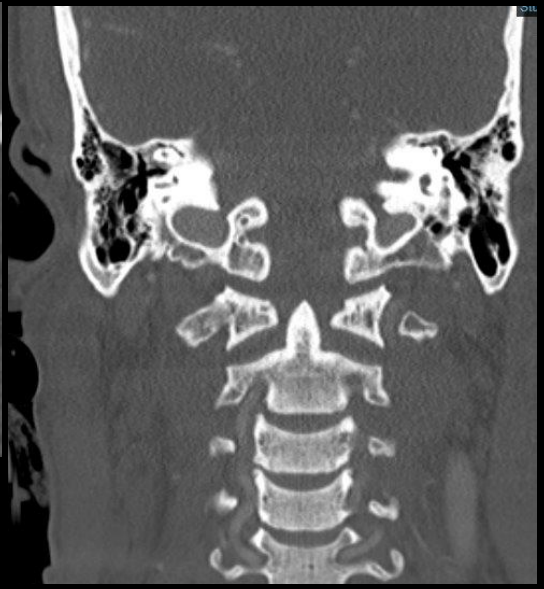
Craniocervical dissociation
Atlanto-Occipital Dislocation
Occipital Cervical Dislocation
Occipital Cervical Dissociation

Atlanocciptal Dissociation (AOD)









Any asymmetry of the Oc-C1, C1-C2 joint is problematic.

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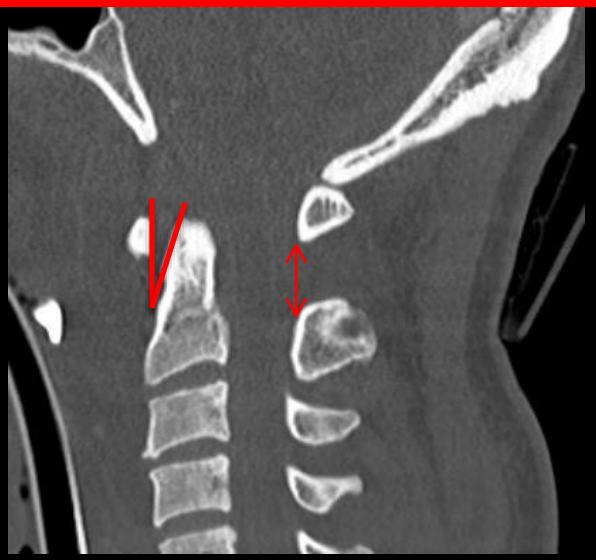
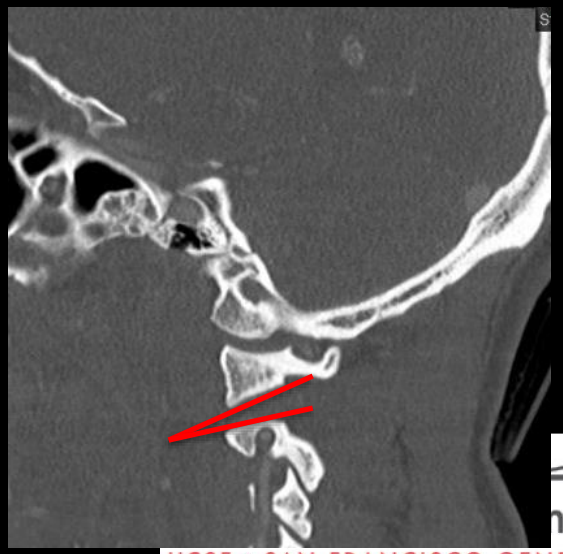
Atlanocciptal Dissociation (AOD)

C1 posterior arch often follows occiput:

- Widening of posterior C1-C2 interval
- Angulation of C1-C2 joint
- “V” sign in atlanto-dens interval

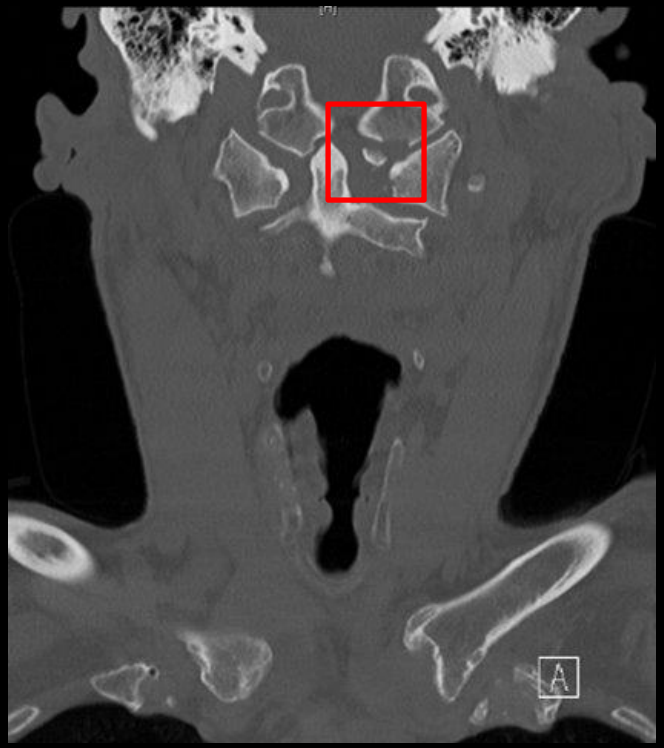




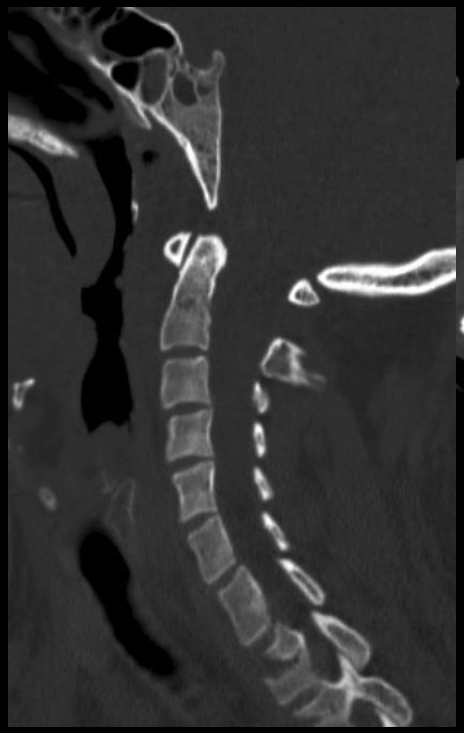
Atlanocciptal Dissociation (AOD)

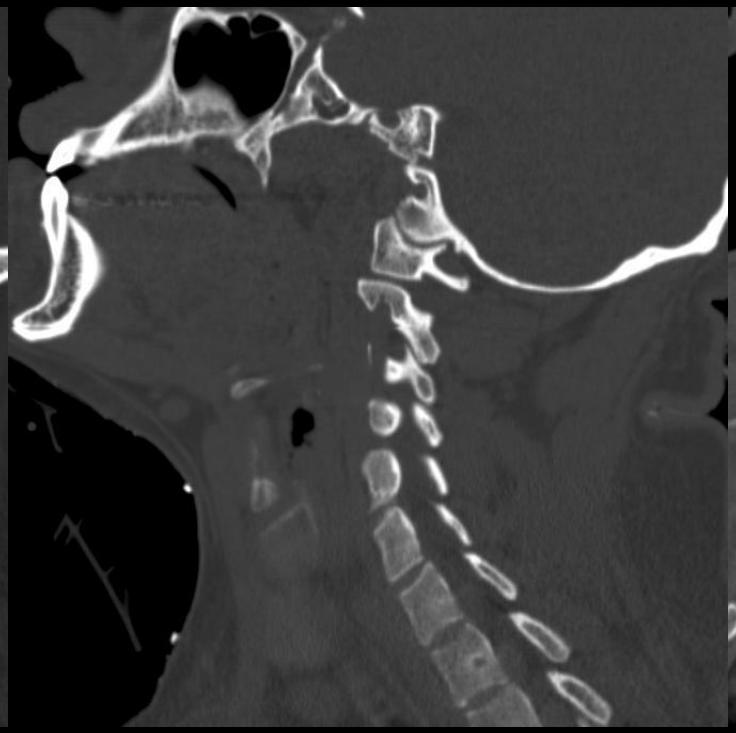
Avulsion fractures may signify AOD

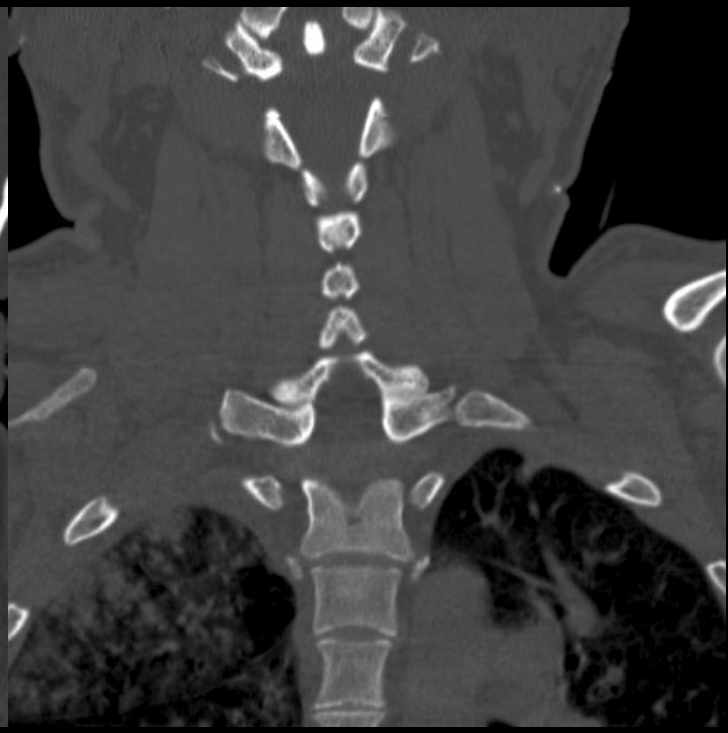
- Dens (Type 1)
- Occipital condyles (Type 3)



Rarely, it might be reduced on CT

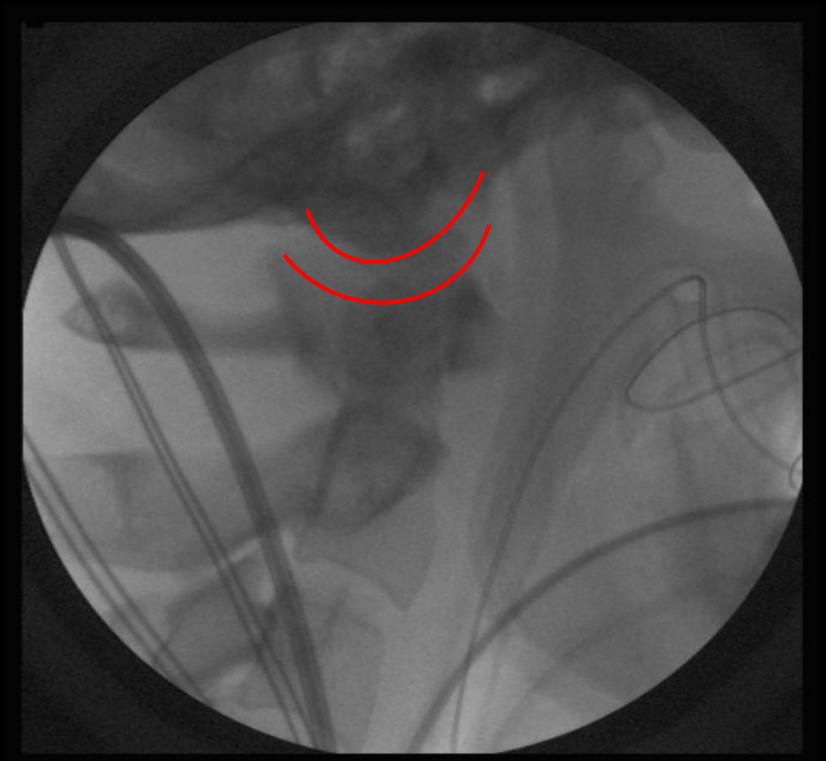


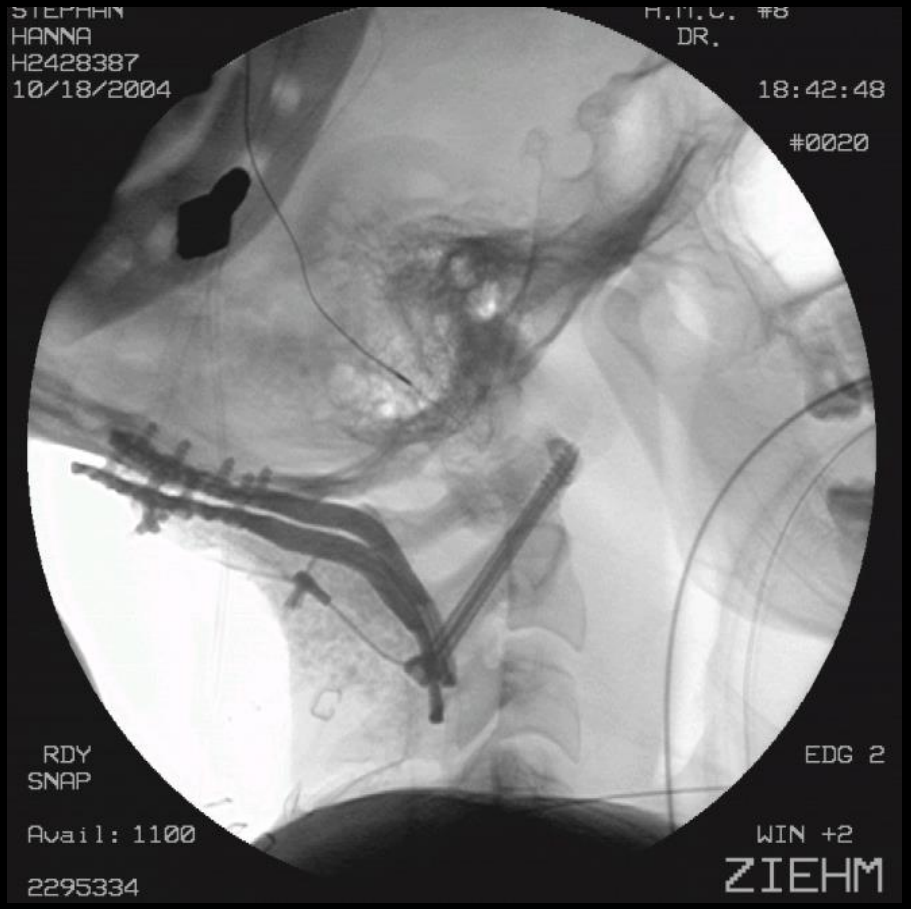




AOD initial management

- Time to diag ciated with mortality.
- Unusual co ns
  - Decussatio nerves in the midbrain m area
  - May have olvement
- Remove cervical collar and replace with sand/IV bags and tape.





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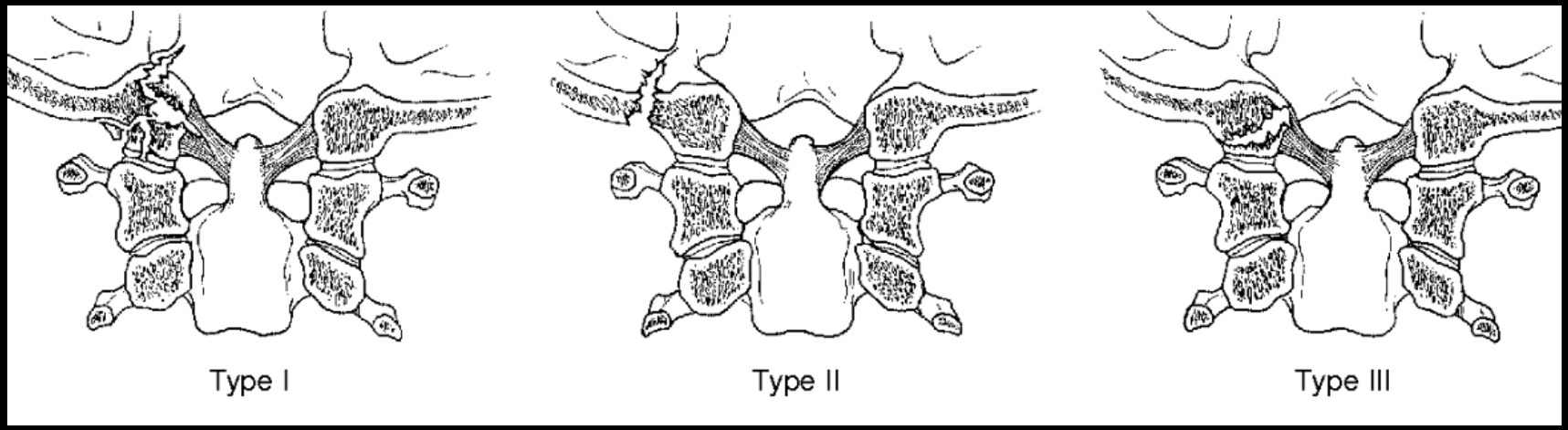
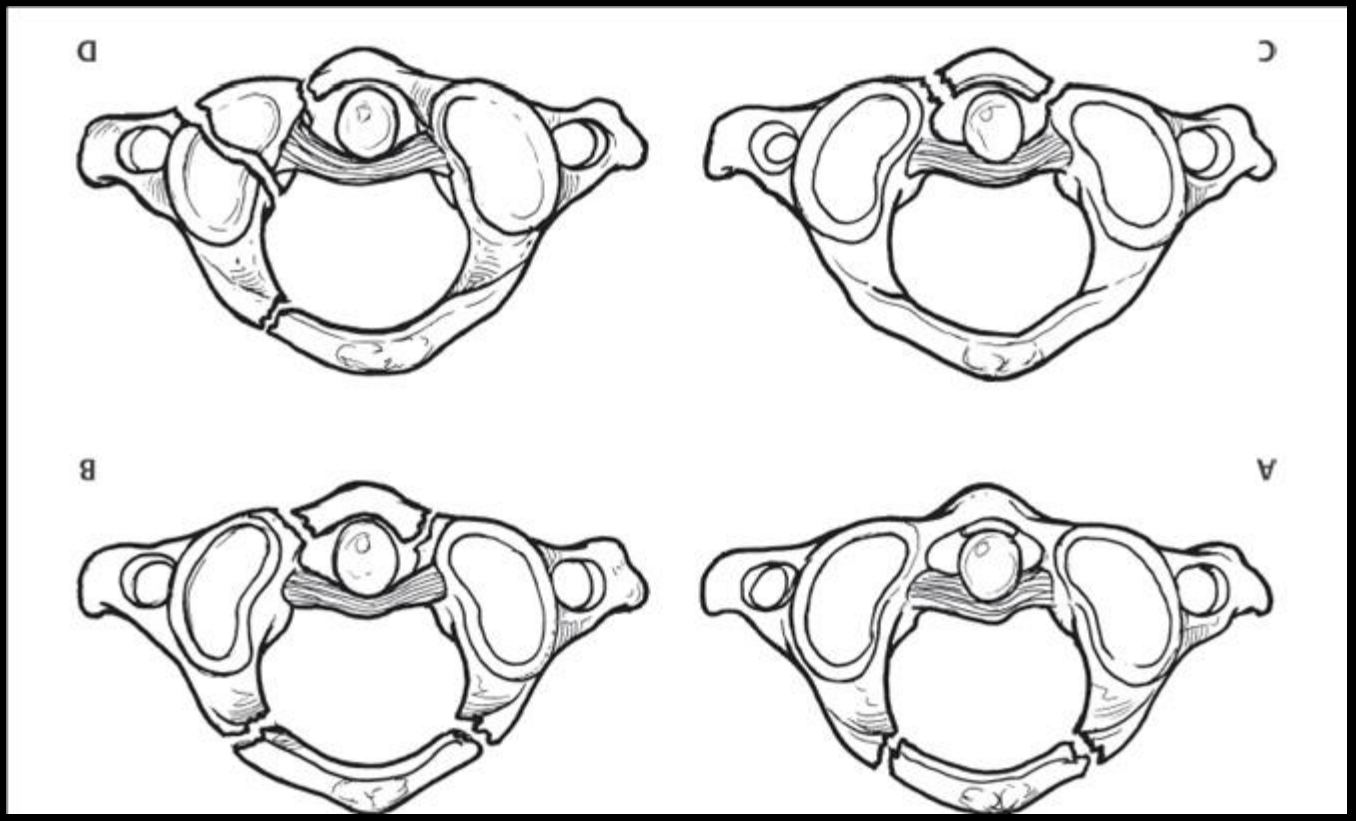
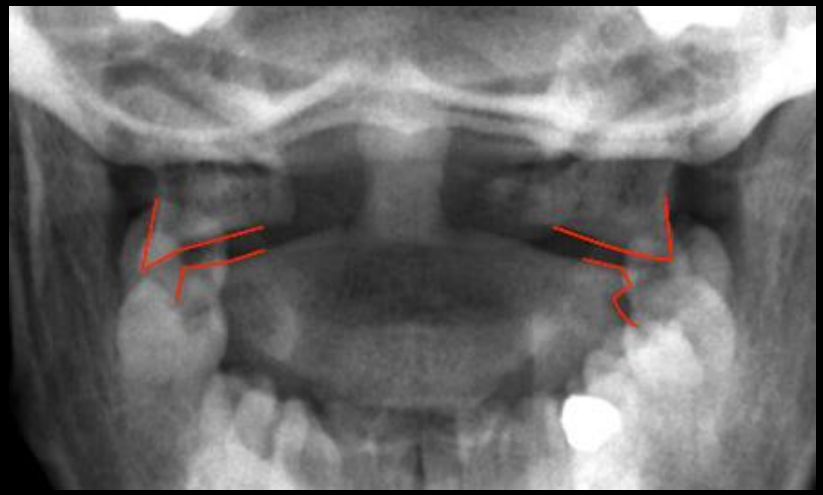
Occipital condyle fracture

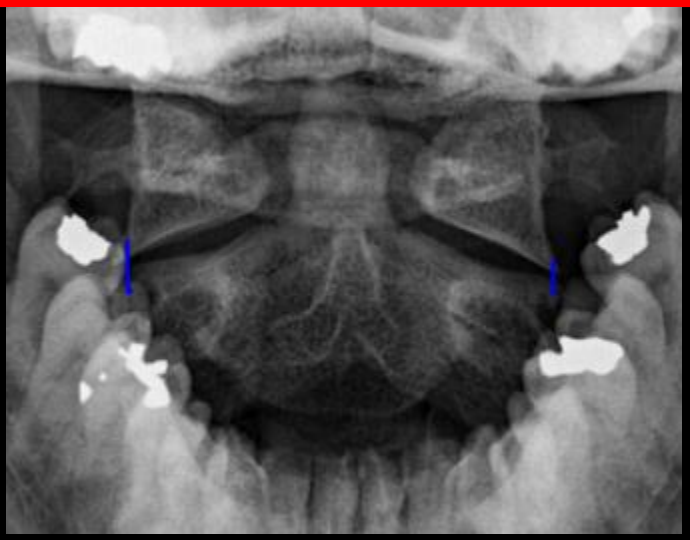


C1 ring fractures



C1 ring fractures

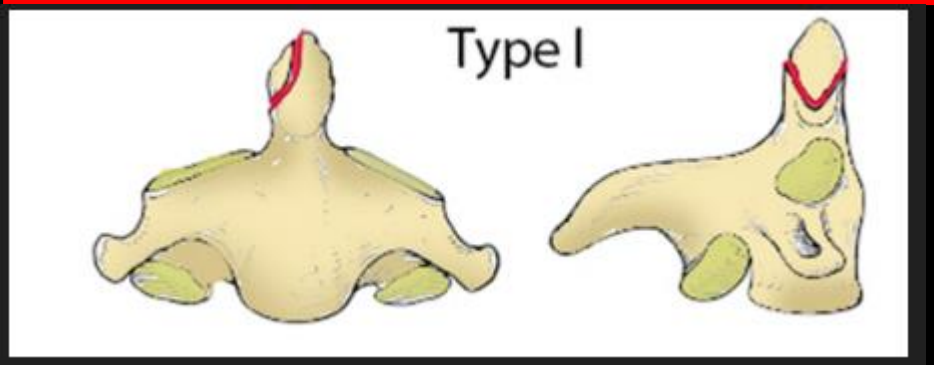




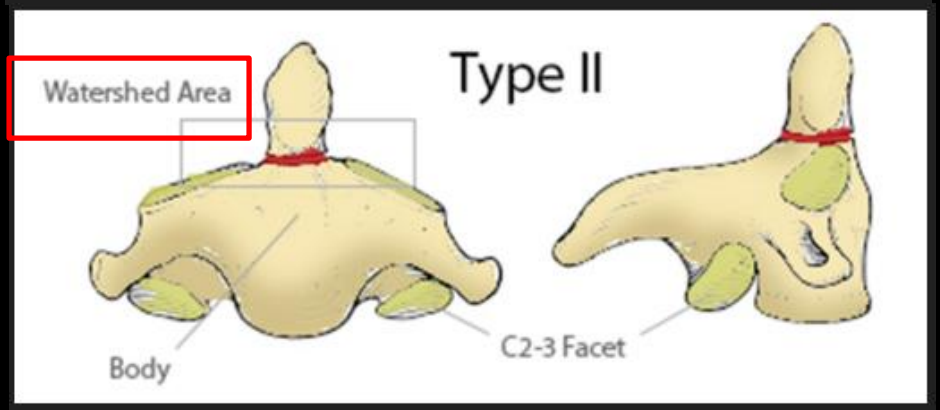
OPERATIVE

NONOPERATIVE

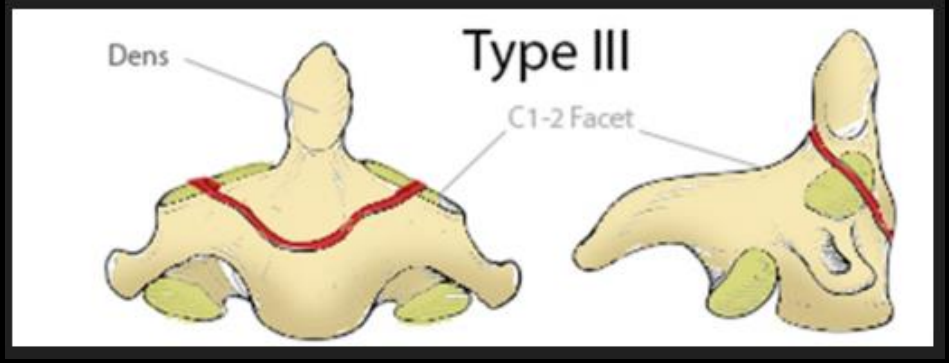
Dens fractures



Type 1- typically treated in a cervical collar as long as not part of an AOD



Type II – Controversial. Operative vs Halo vs collar in the young, controversial in the elderly



Type III – typically treated in a cervical collar

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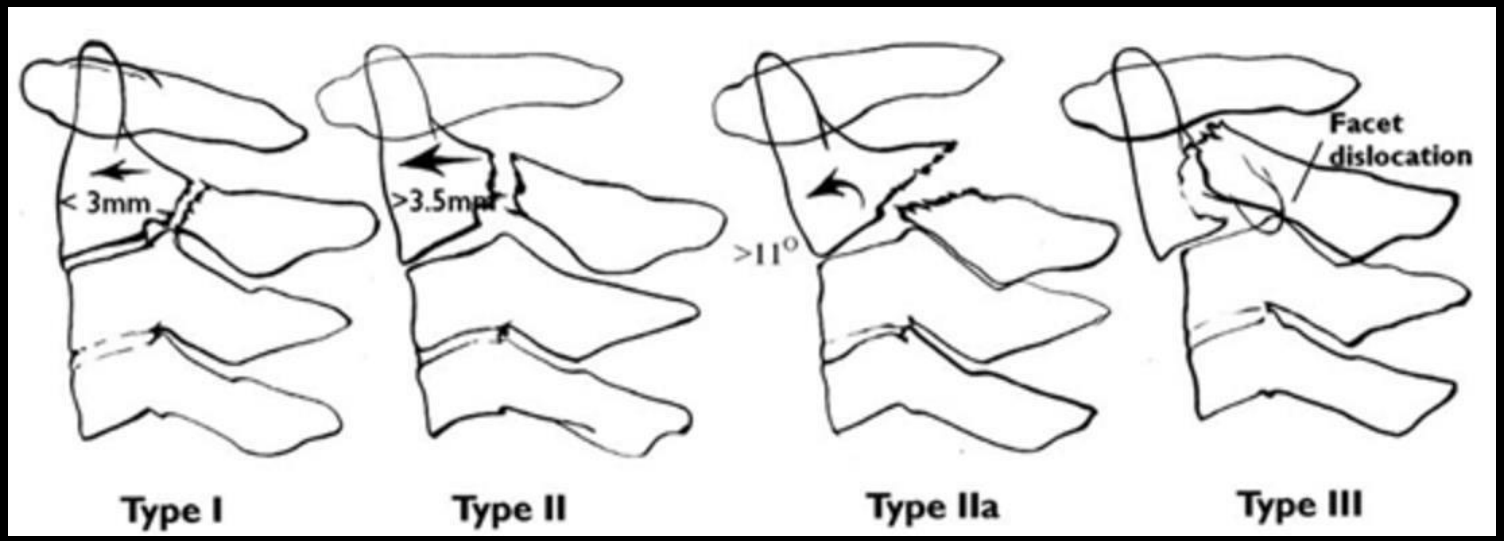
Hangman's fractures



-Hyperextension injuries (except IIAs)

-Typically treated with collar unless significant displacement on upright films

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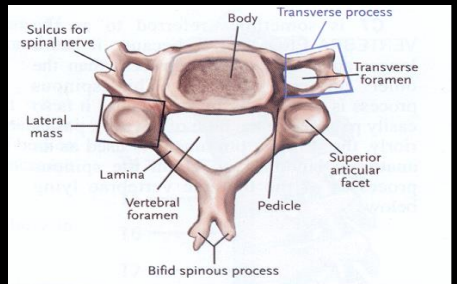

Figure 4-7. C4, superior view.

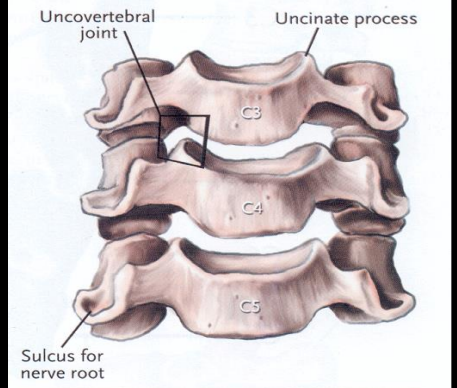

Figure 4-8. C3, C4, and C5, anterior view.

SUBAXIAL CERVICAL SPINE

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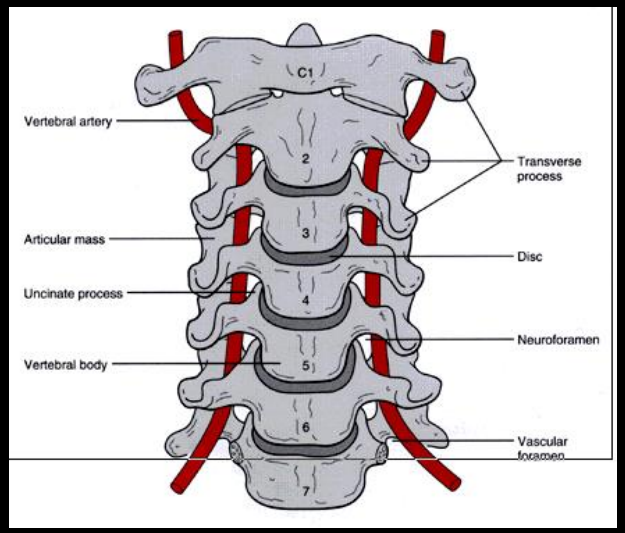
Anatomy

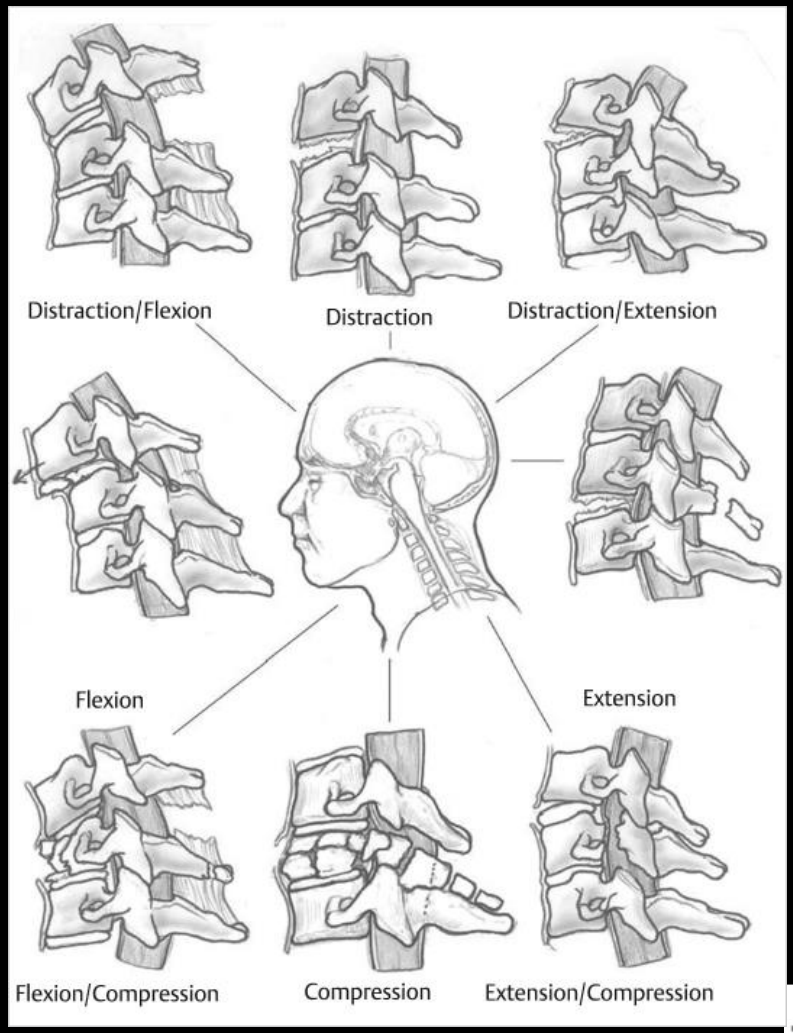
Lower C-Spine:

C3-C7= ***Subaxial C-spine***

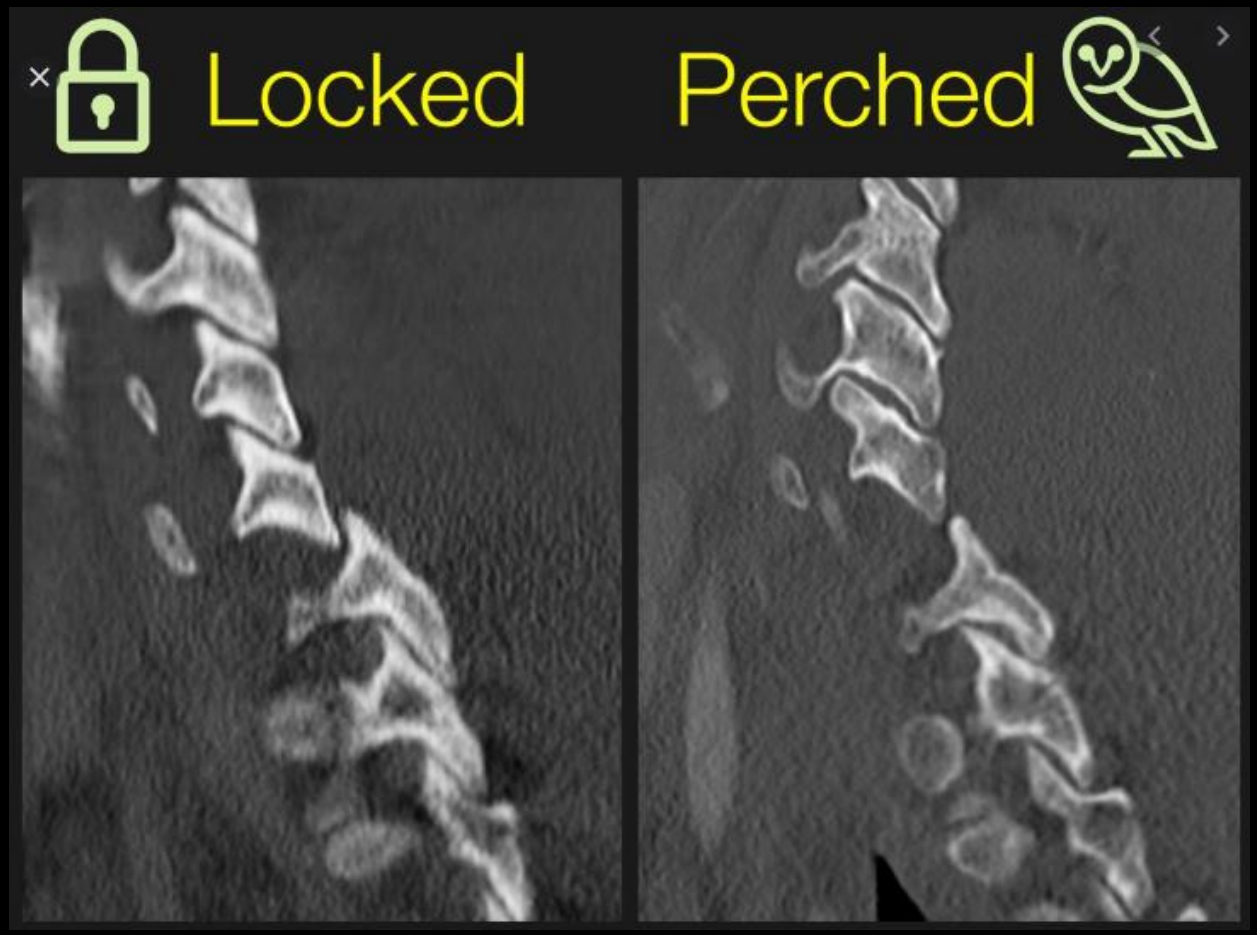
Primarily function to support the head and maintain posture



Mechanisms



Facet dislocations



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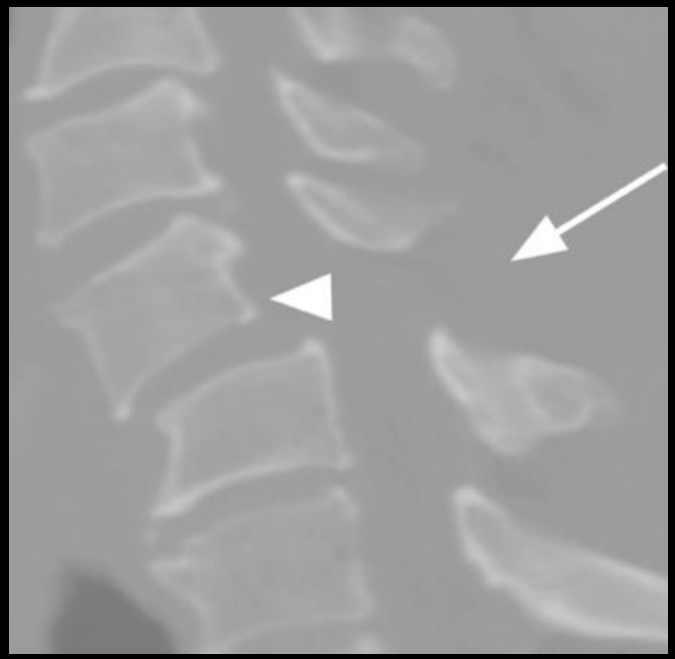
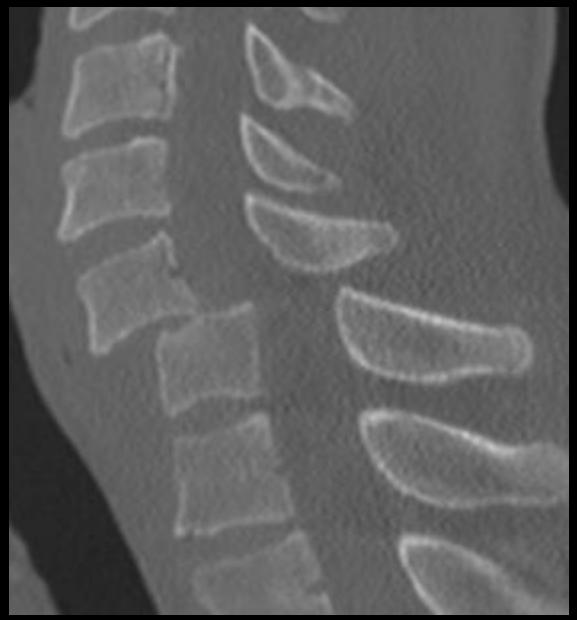
Facet dislocations

- Unilateral
  - 25% vertebral body step-off



- Bilateral
  - 50% vertebral body step-off



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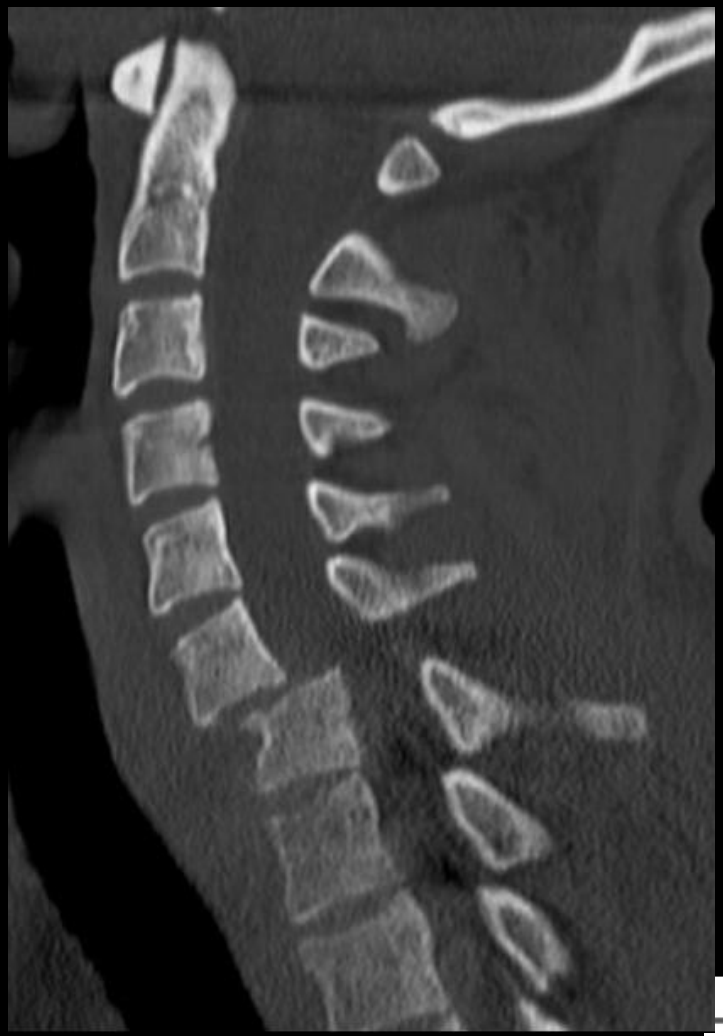
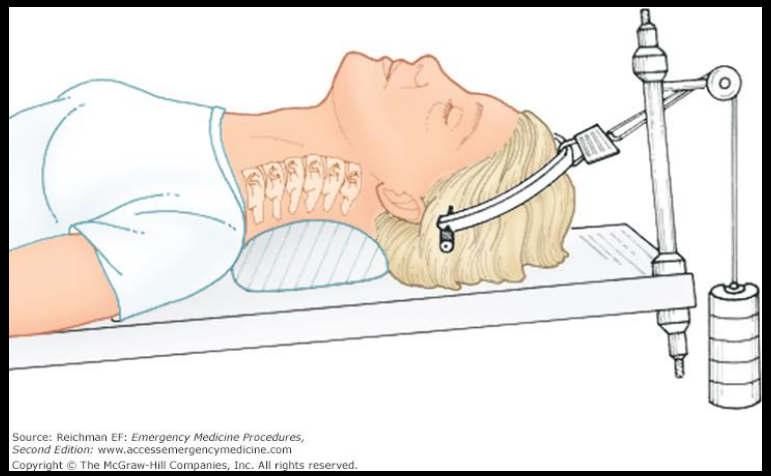
Facet dislocations

Facet dislocations



Facet dislocations

- In the intact or incomplete cord injury patient, next step is an awake reduction.
  - Need to be awake to let us know if exam worsening
  - If reduced, fixation no longer urgent
- Obtunded patient
  - To MRI then to OR



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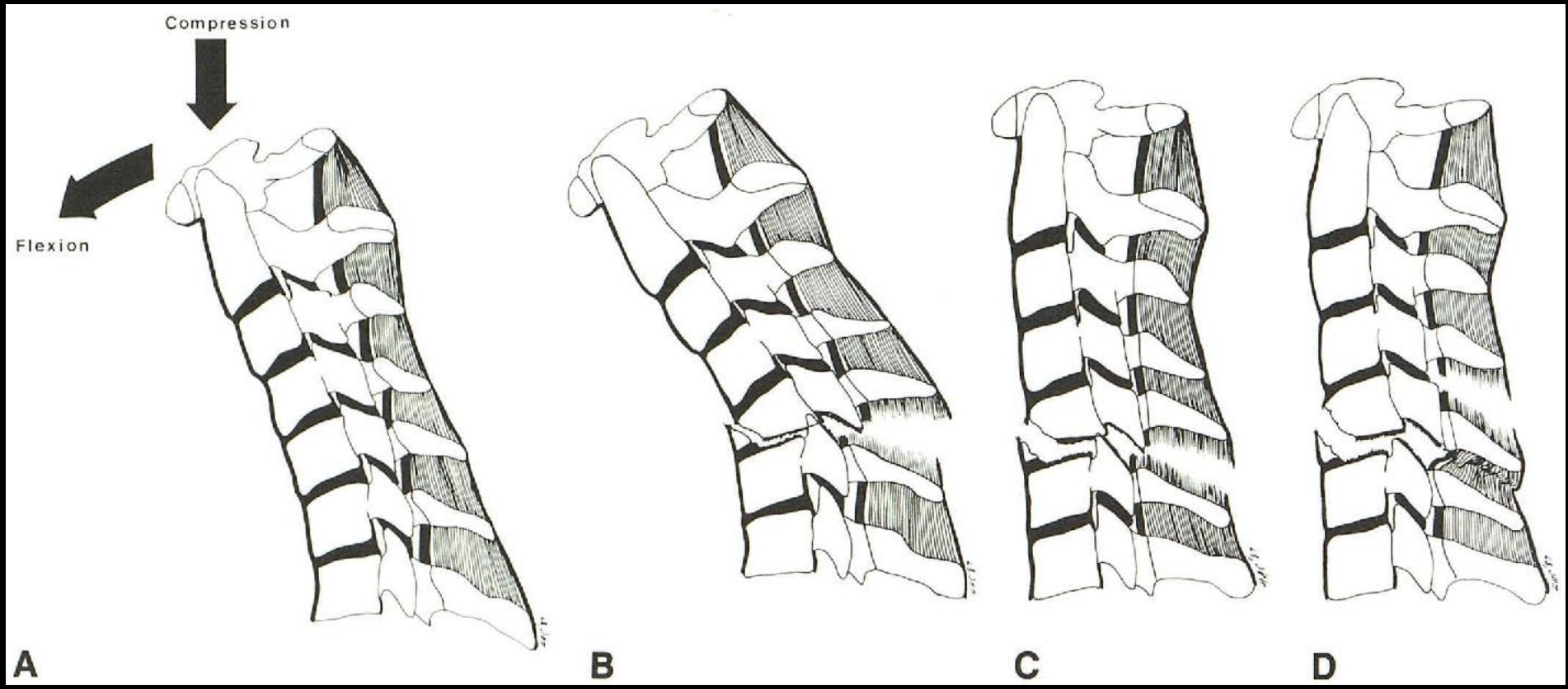
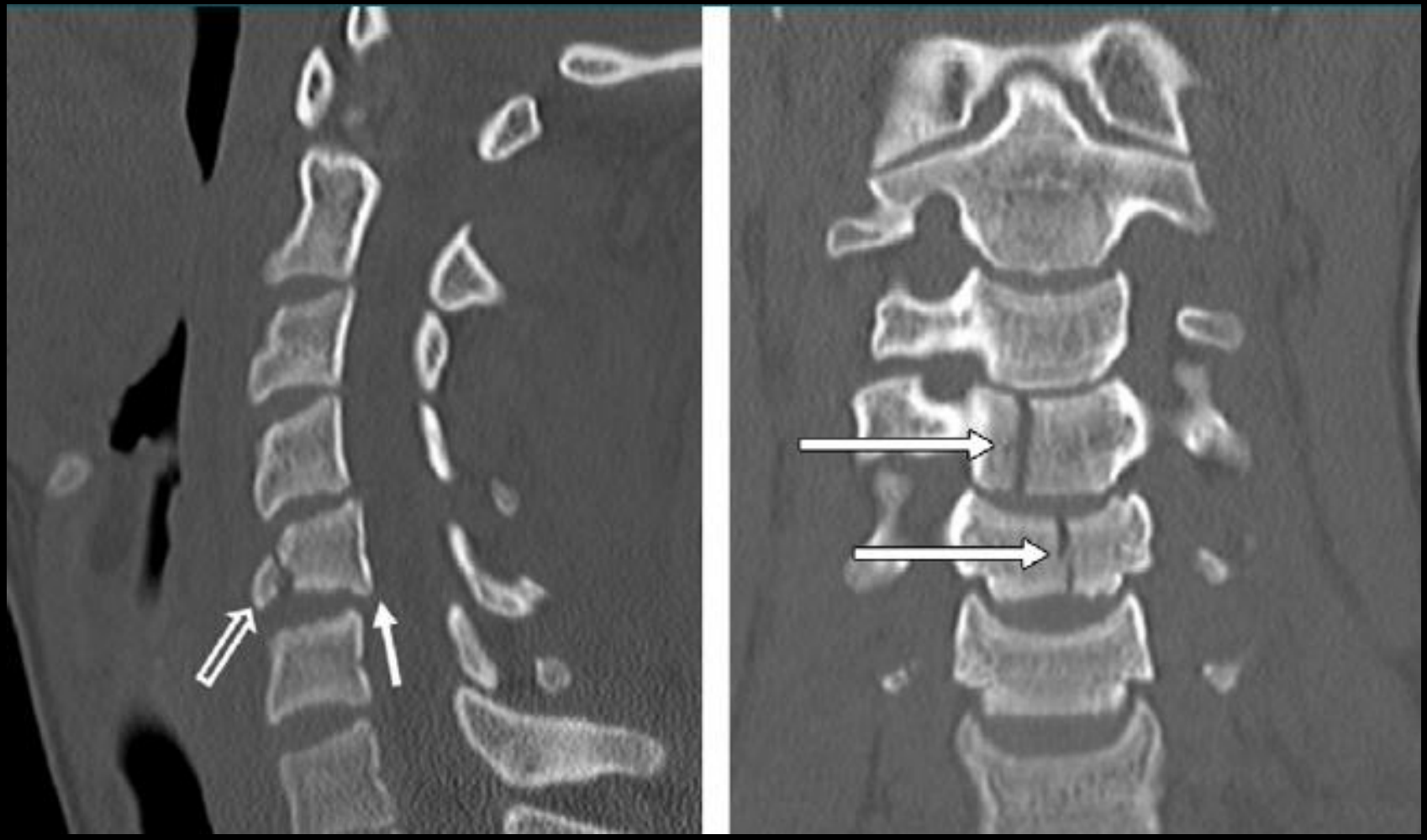
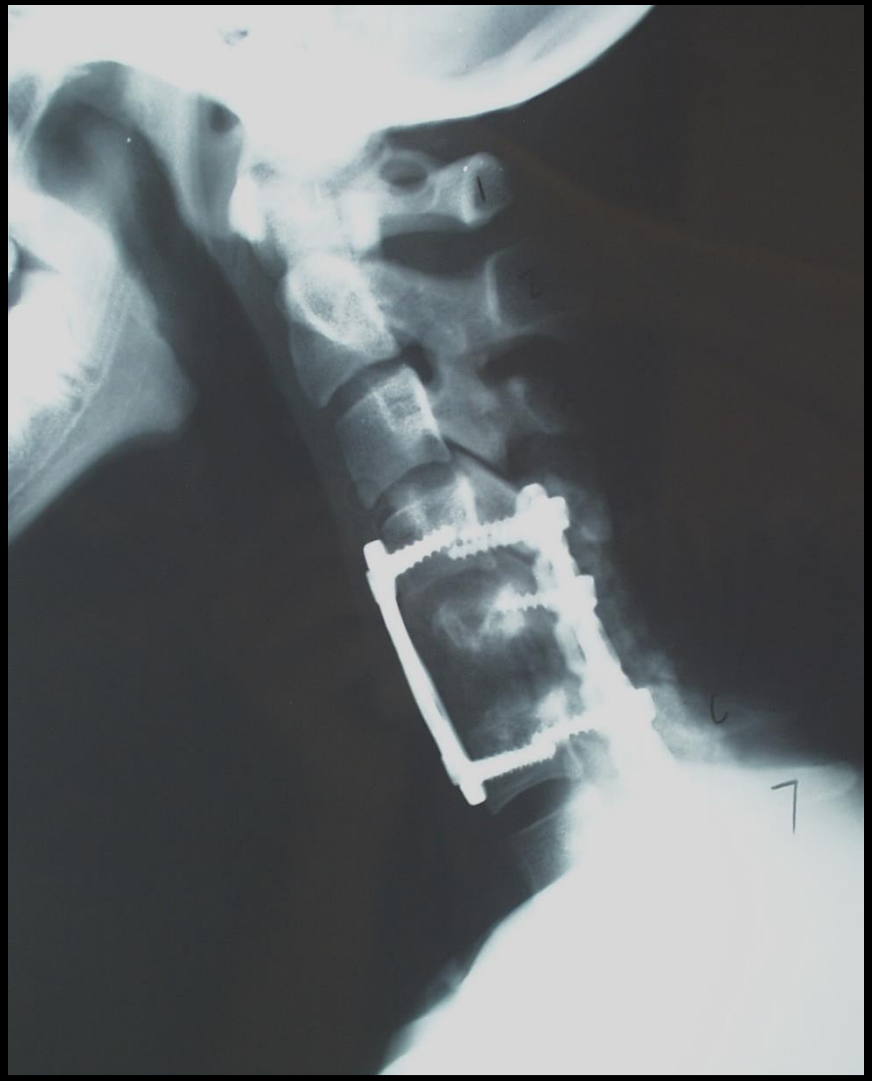
Unstable patterns (cont'd)



Flexion Tear drop

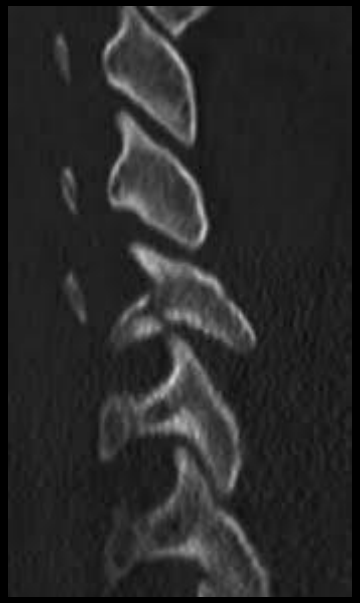


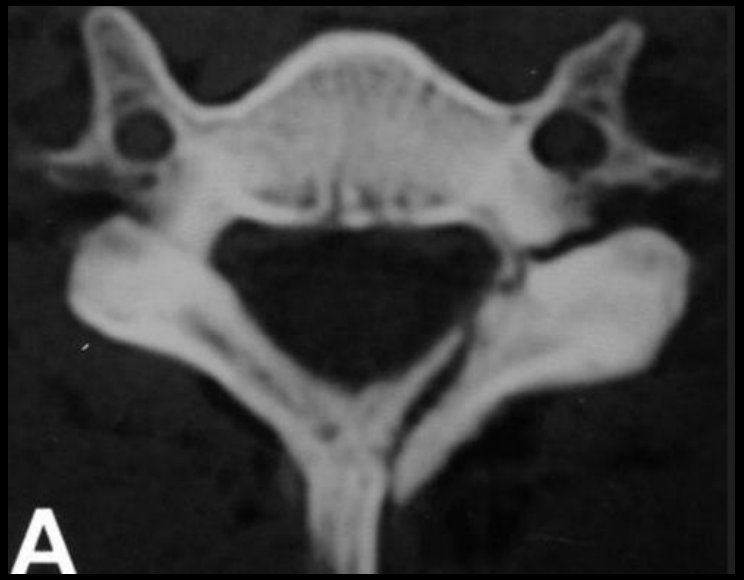
Flexion Tear drop



“Somewhat” unstable

- Isolated lateral mass fracture
  - Combined pedicle and lamina fracture
  - At risk for displacement and deformity

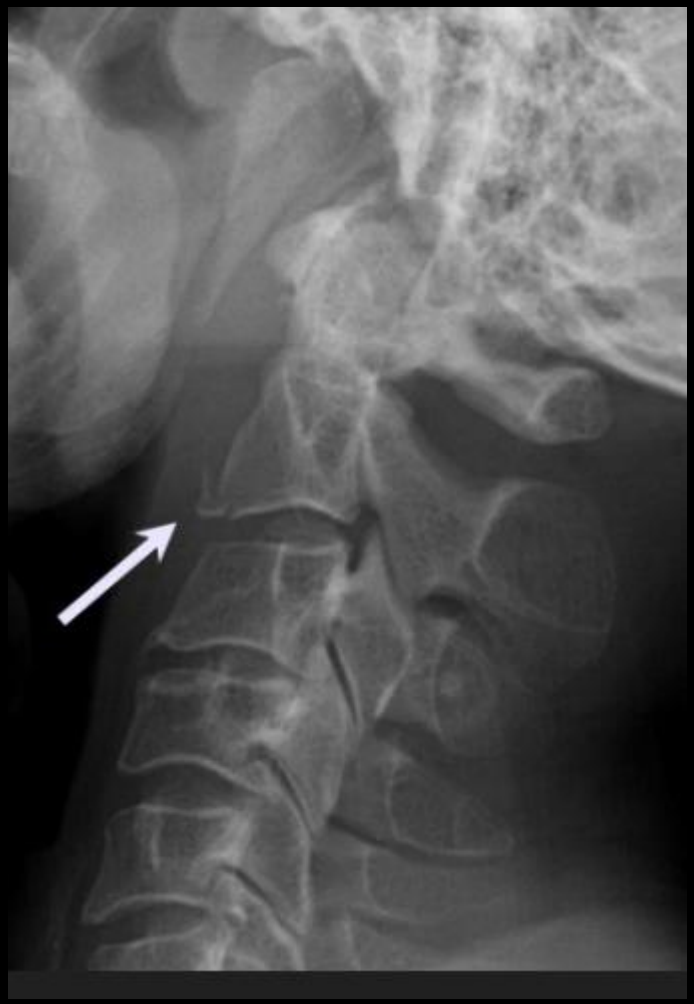




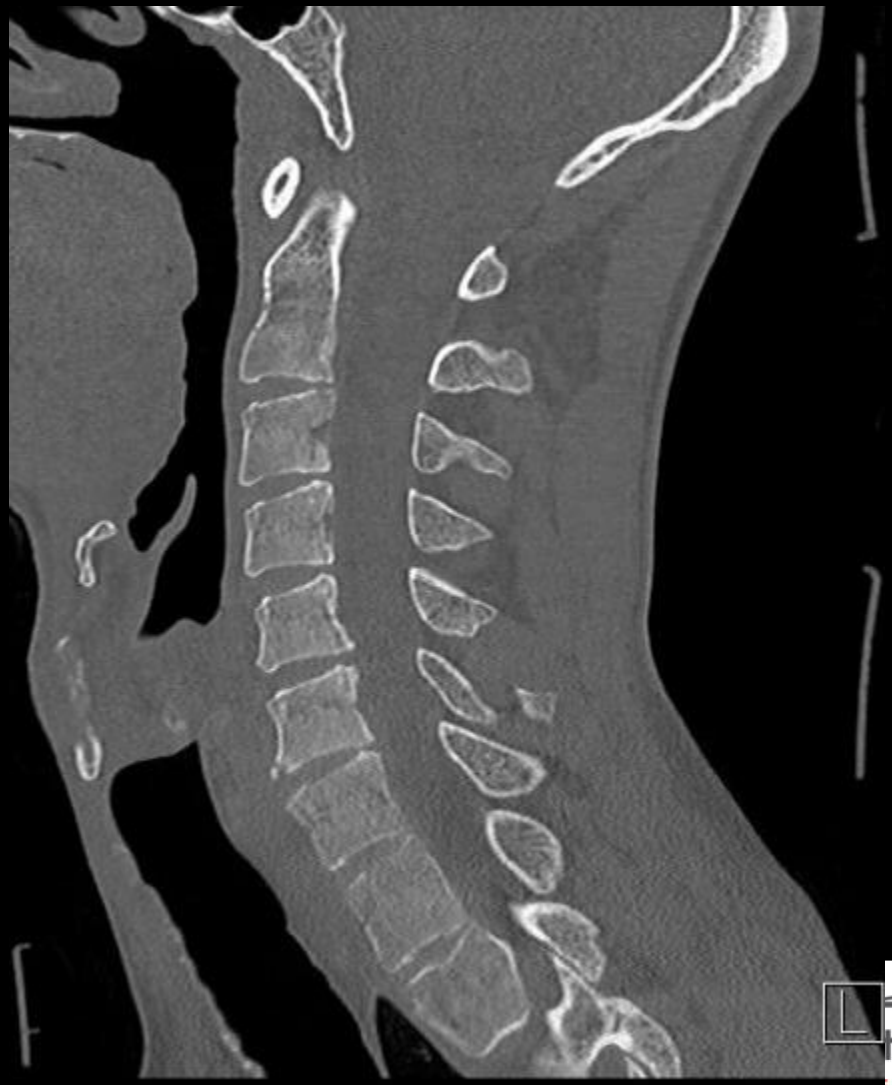
“Usually” stable patterns

- These are patterns that are usually stable.
- Typically obtain upright images (lateral) to assess for any subluxation or displacement
- If normal, typically okay to send out with follow up (repeat films in 1-2 weeks)

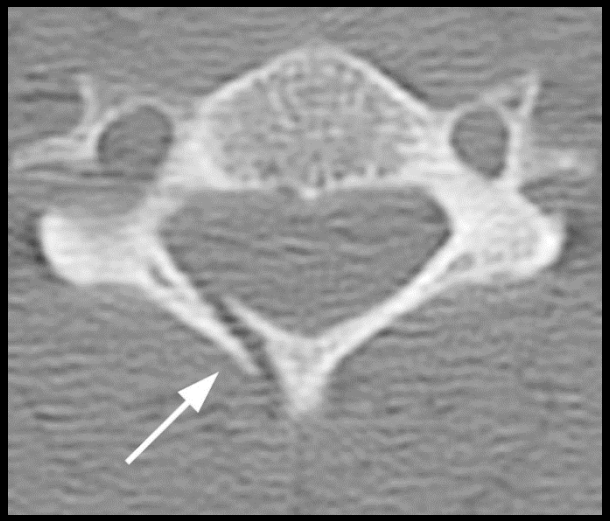
Extension teardrop

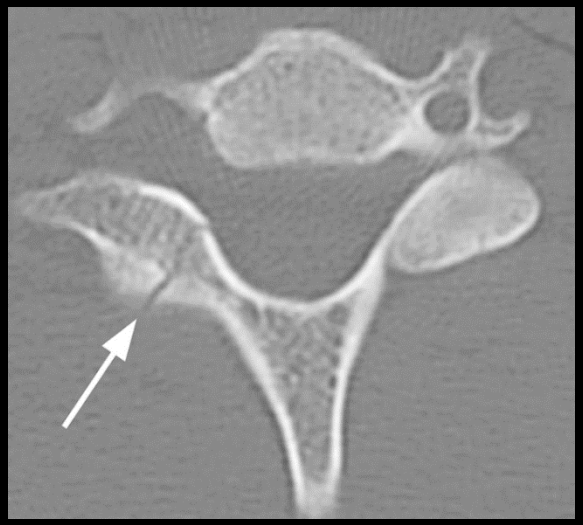


Extension teardrop fractures



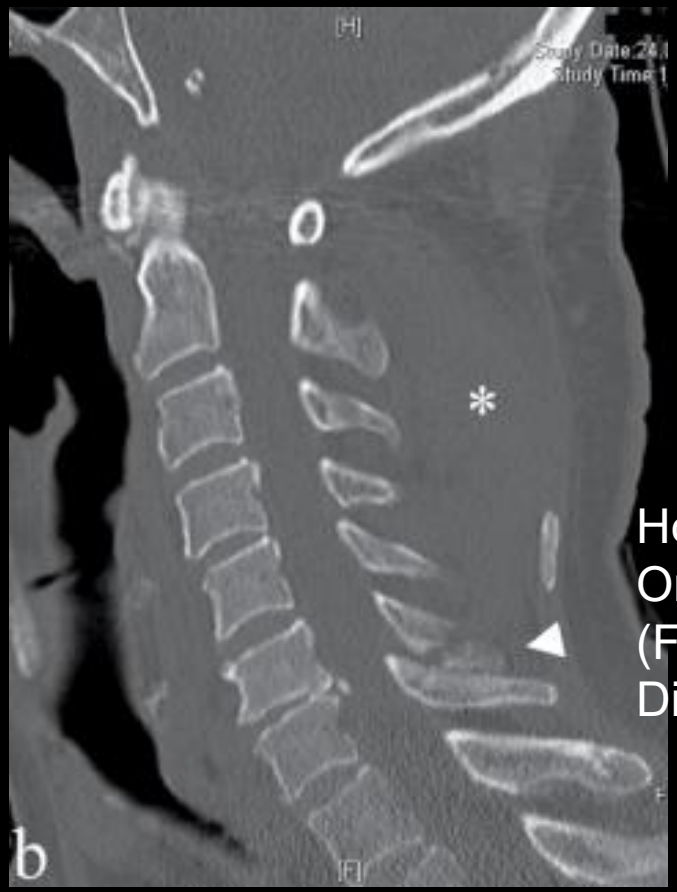
Isolated lamina fractures





Isolated spinous process fractures

Vertical Orientation (Non-Op)



Horizontal Orientation (Flexion Distraction)

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Cervical Fracture Summary

USUALLY STABLE

- Type 1 and Type 3 Dens*
- Occipital condyle fractures*
- C1 ring fractures**
- Non displaced facet fractures
- Transverse process fractures
- Isolates spinous process fractures
- Isolated osteophyte fractures

SOMETIMES UNSTABLE

- Type 2 Dens
- Type II Hangman's
- Atypical Hangman's
- Floating lateral mass fractures
- Burst fractures

ALWAYS UNSTABLE

- AOD
- Facet dislocations
- Flexion teardrop
- Type III Hangman's
- Flexion distraction
- Displaced facet fractures

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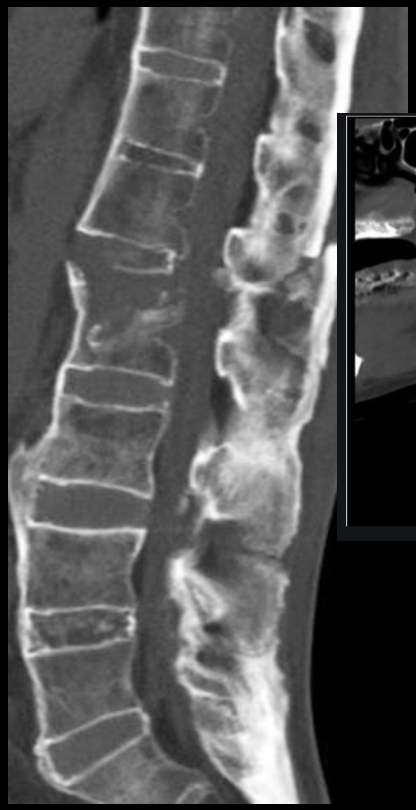
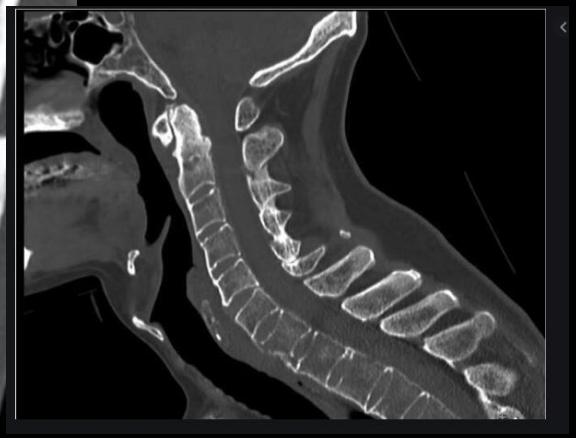
SPECIAL CONSIDERATIONS

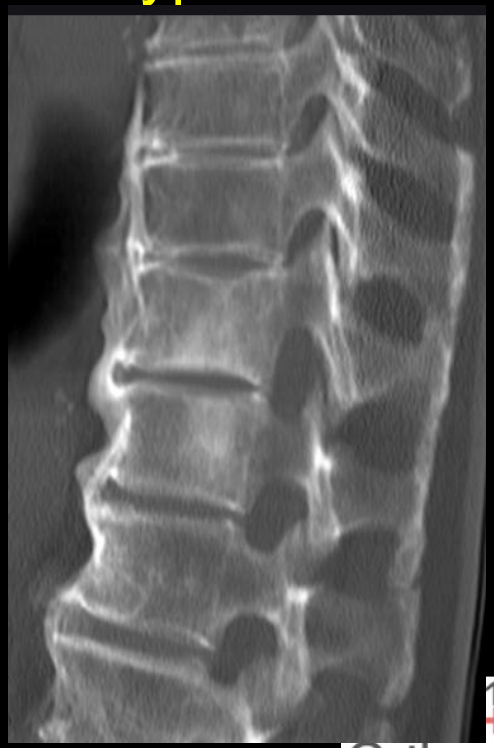
Ankylosed spine

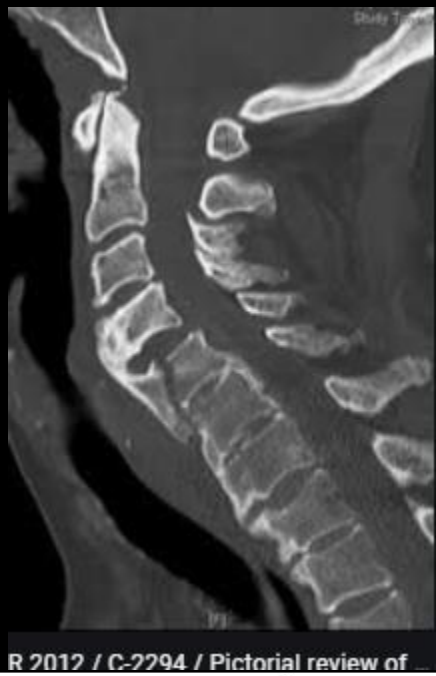
Subset of patient who present with ankylosed spines

- Ankylosing Spondylitis
- Diffuse idiopathic skeletal hyperostosis









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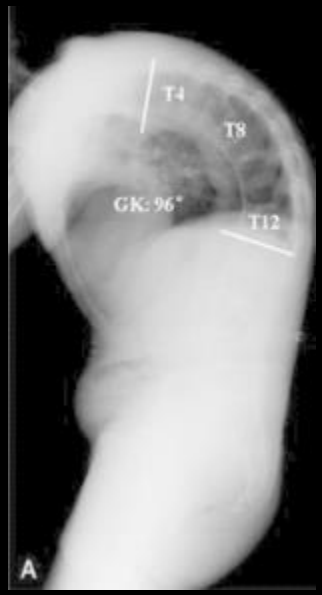
Ankylosed spine

- If presenting with neck or back pain, they have a fracture until proven otherwise
- If no fracture seen on CT, obtain MRI (so long as they can fit in the MRI scanner)
- These are the patients who go to the MRI intact and come out paraplegic



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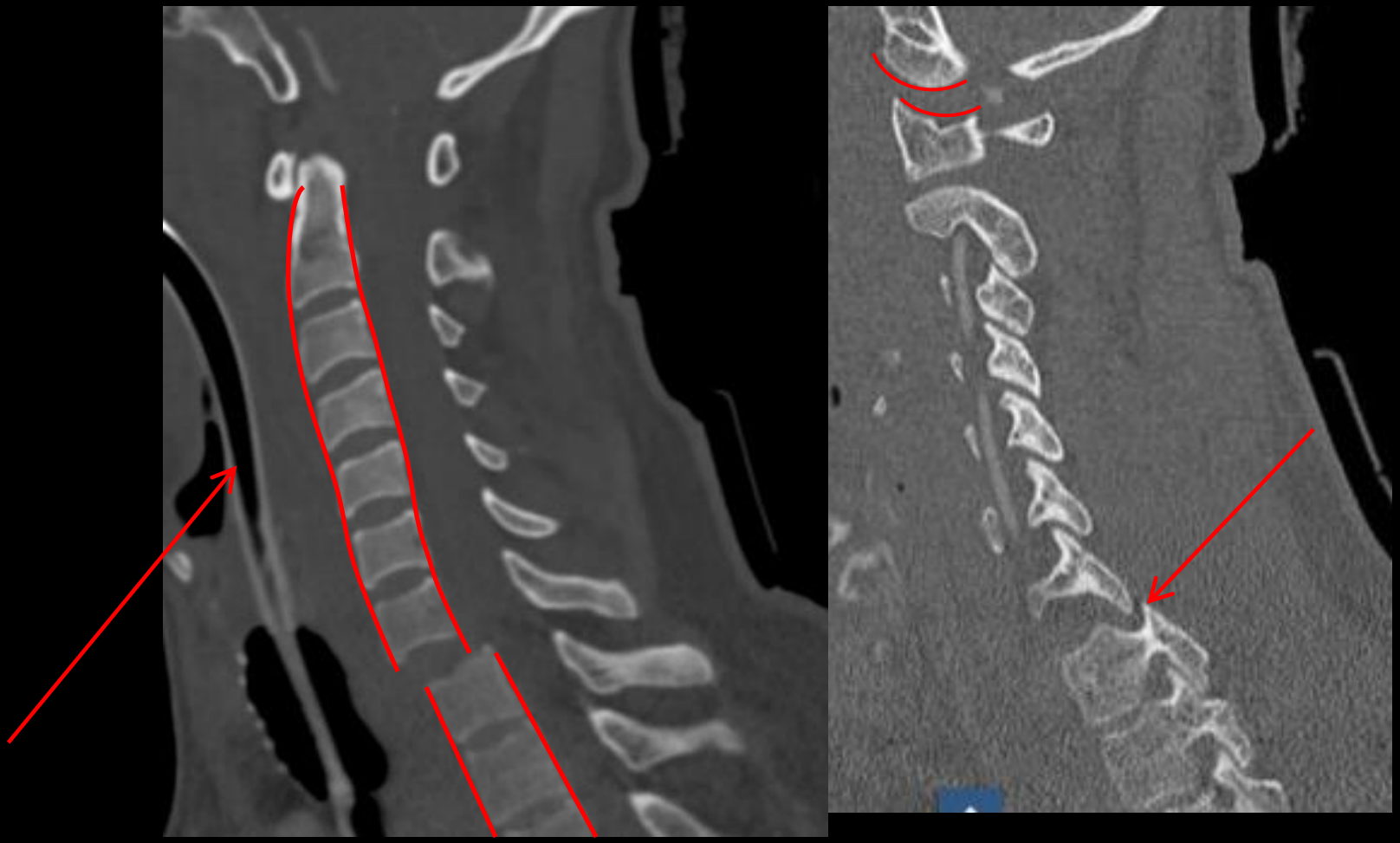
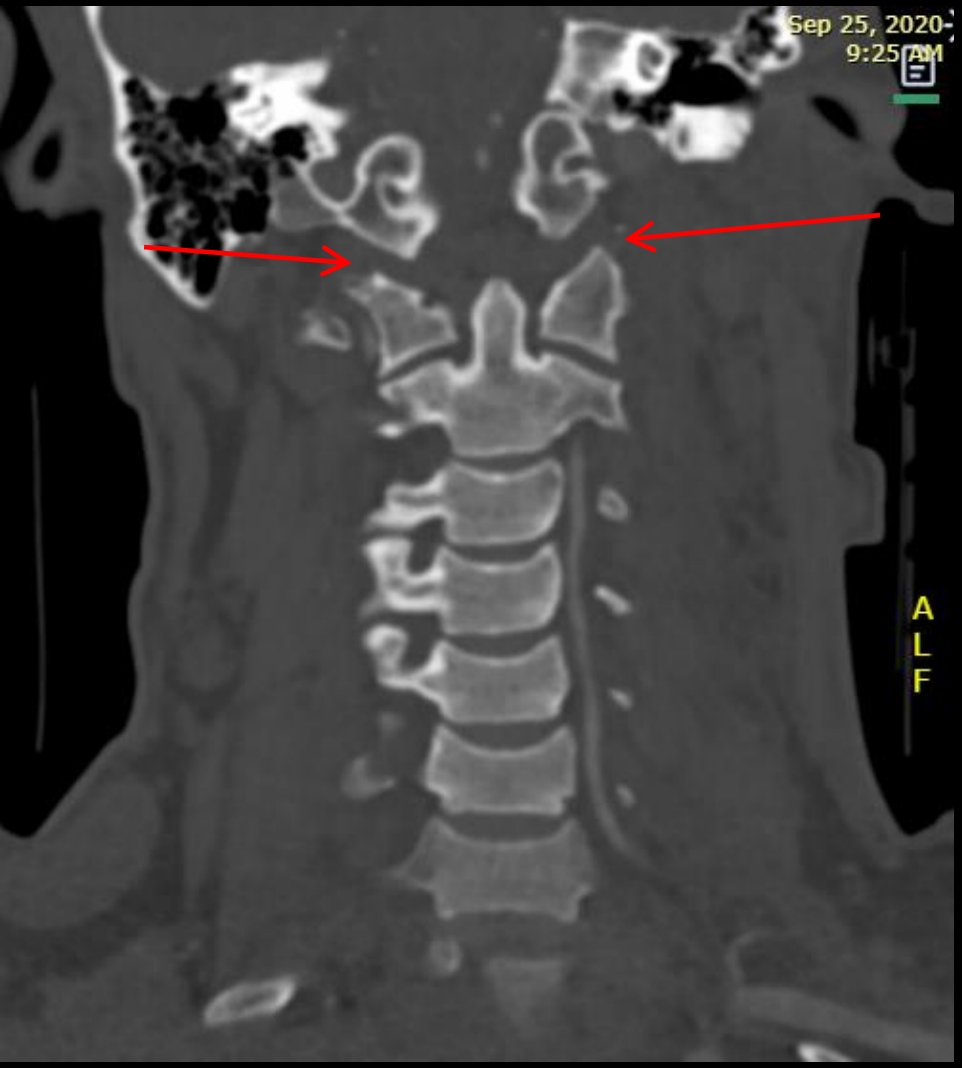
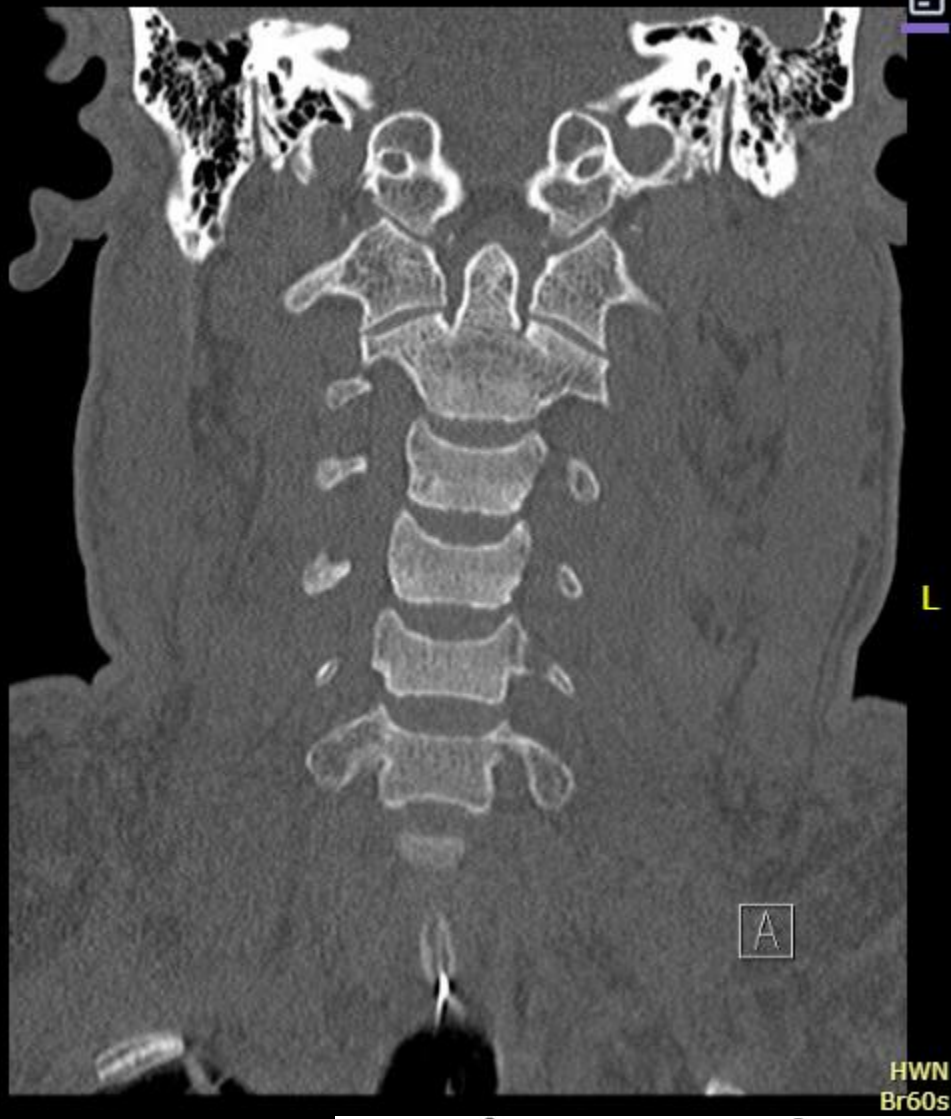
09/2020: 40 yo high speed autoped. Intubated at scene. TBI



09/2020: 40 yo high speed autoped





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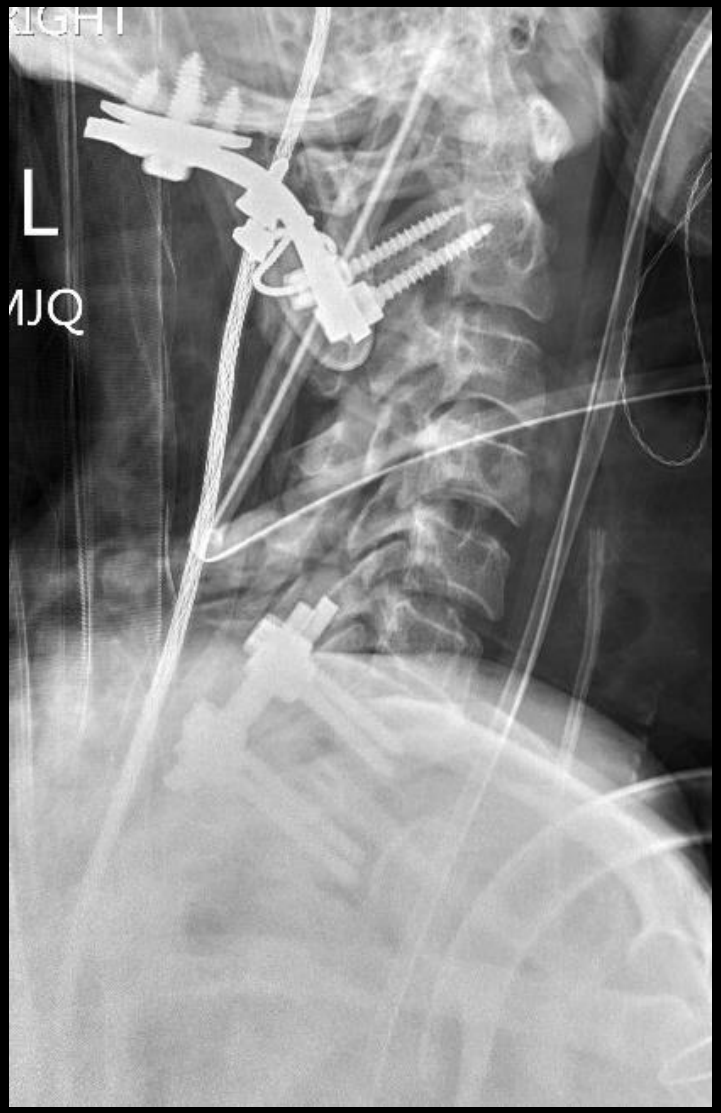
09/2020: 40 yo high speed autoped



1. Occiput to C2 PSIF

2. 2. C7-T1 PSIF

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Take Home Points

- Assume spinal injury until proven otherwise
- Thorough evaluation is critical
- Spine could be cleared with negative NEXUS criteria and painless range of motion
- On imaging evaluate lines and landmarks
- Pay attention to asymmetries on imaging

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Thank You!


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