

IMAGING SUB-AXIAL CERVICAL SPINE INJURIES

Trauma Radiology: 8th Nordic Course

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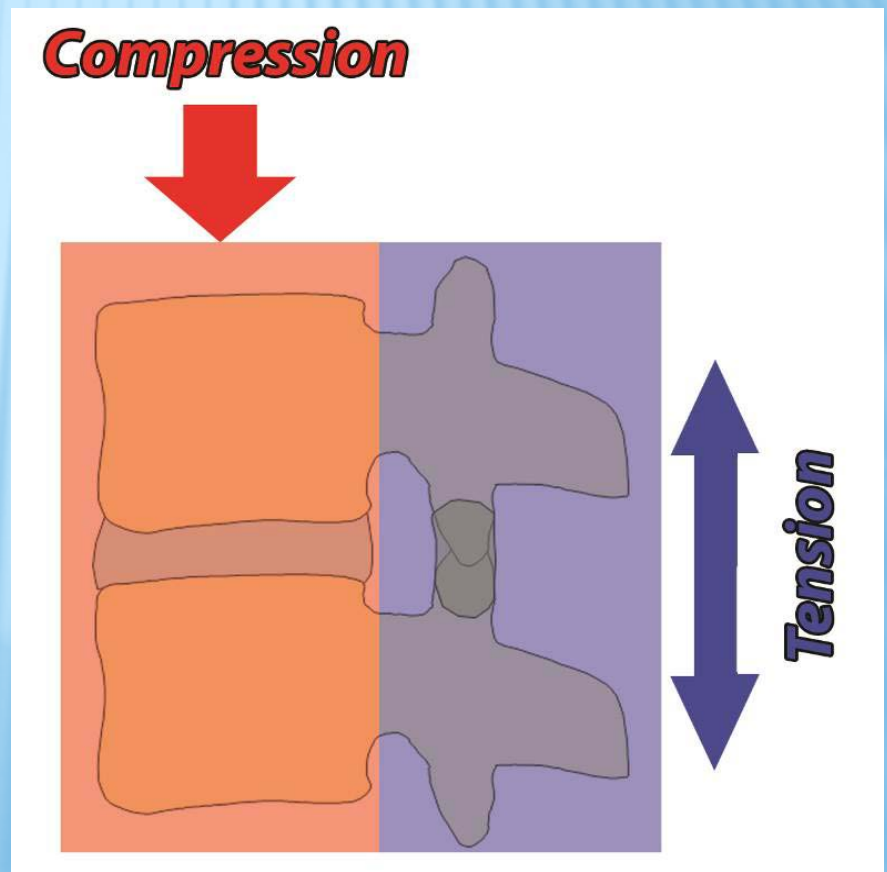
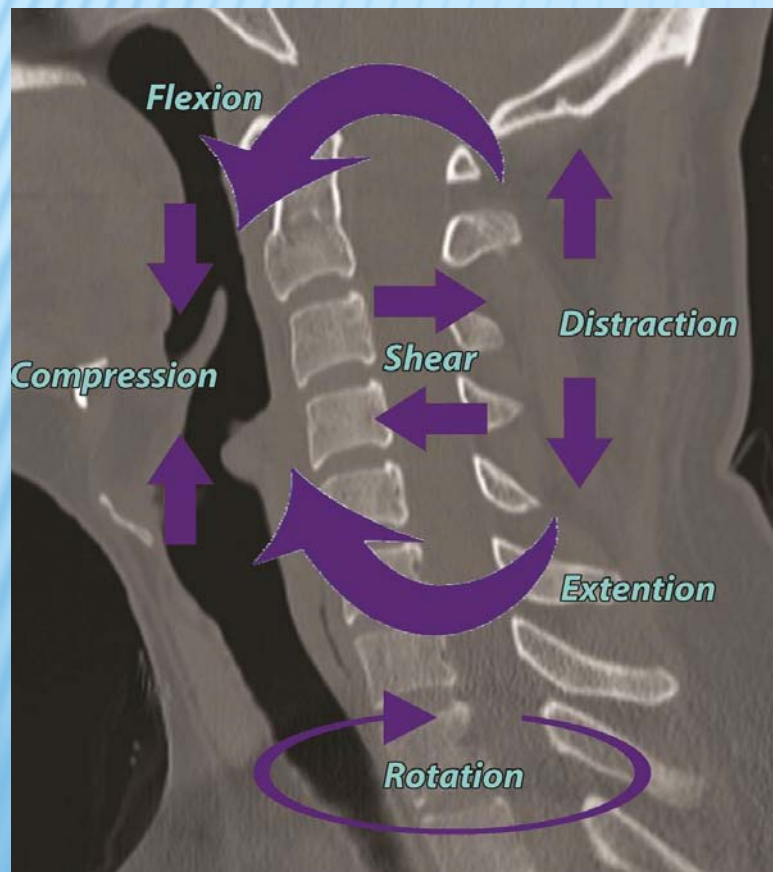
MDCT of acute subaxial cervical spine
trauma- A mechanism based approach
Radiographics 2013. (drawings)

Sub-axial cervical spine – injury mechanisms

- Axial compression: anterior column load, lateral, burst
- Hyperflexion: flexion sprain, flexion teardrop, bifacet dislocation, anterior compression,
- Hyperflexion - rotation: unilateral facet dislocation (perch/lock), unilateral fracture-subluxation, isolated articular pillar
- Hyperextension – teardrop, sprain, posterior subluxation/dislocation, distraction-compression, rotation
- Hyperdistraction (anterior, posterior, in-line) (rare)
- Sub-axial spine increased vulnerability to injury - mobility
- 65% fractures (C6, C7) and 75% dislocations (C5-6, C6-7)

2-COLUMN METHOD

- Supraspinous ligament to PLL
- ALL column to PLL
- Complete column injury produces instability



DEFINING STABILITY

- *Mechanical* - spine able to resist non-physiologic movement under physiologic load
- *Neurologic* – injury will not cause or worsen a neurologic injury under physiologic load
- Most mechanically unstable injuries are neurologically unstable. (Exceptions... lo-grade Hangman, Jefferson)
- To be considered **stable** an injury must not lead to chronic pain, deformity, neurologic damage

DEFINING STABILITY

- Stability can be **inferred** from static imaging, but only verified by application of physiologic stress.
- Mechanical stability is a **continuum**, some injuries permit greater disturbance of alignment than others and are more likely to create/exacerbate neurologic injury.
- Any patient with a **neurologic deficit** should be considered **mechanically unstable**.

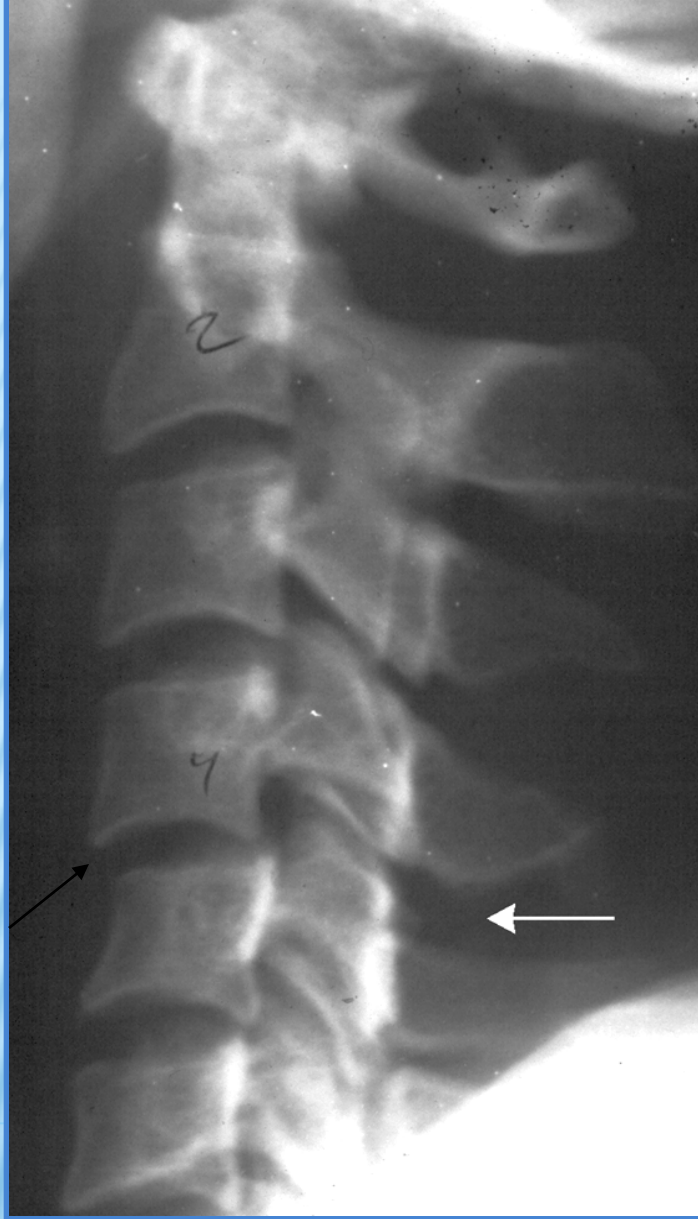
METHODS OF DIAGNOSIS

- Most unstable injuries can be diagnosed from radiographs – but sometimes misleading
- More (almost all) unstable injuries diagnosed by MDCT
- MRI can show ligament injuries, but does not correlate well with surgical findings (tears, partial tears, stripping, stretching)

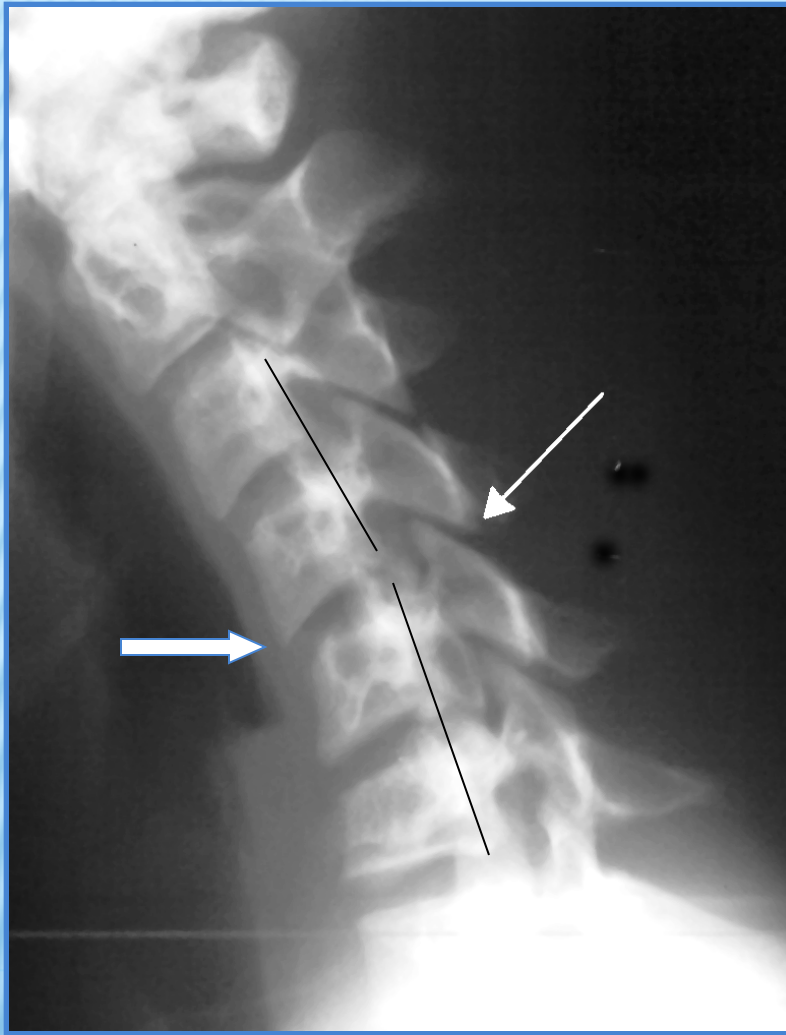
HYPERFLEXION INJURIES

- Anterior column loading
- Posterior column distraction
- Anterior body compression
- Distractive posterior column failure
- Flexion-teardrop
- Asymmetric compressive loading
- Mixed forces

- Flexion stability determined by ligament status (posterior and middle column)
- May appear in anatomic alignment in neutral view but still may be unstable
- Signs:
 - widened facet joints
 - widened lamina
 - widened posterior disc space
 - loss of facet coverage
 - flared spinous processes



Flexion Sprains – stable?



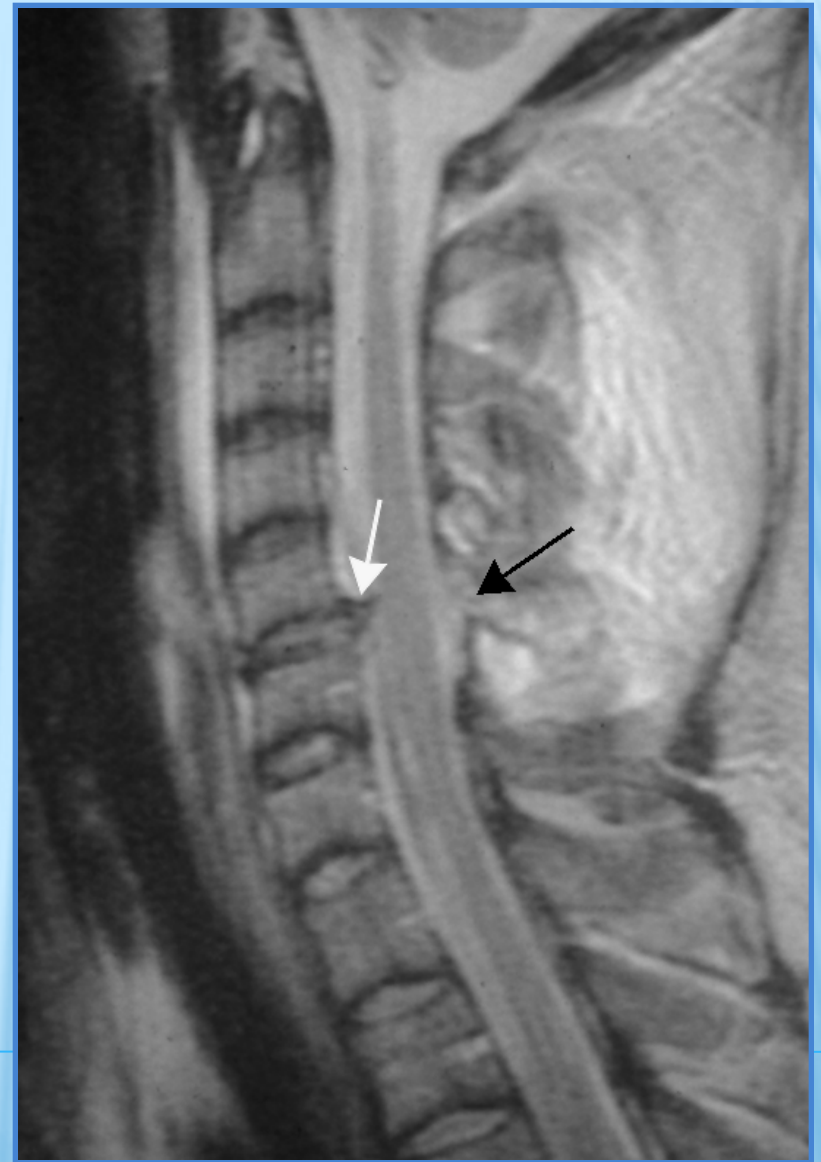
**Flexion Sprain –
stable?**

C4-5 Hyperflexion Sprain – Ligament

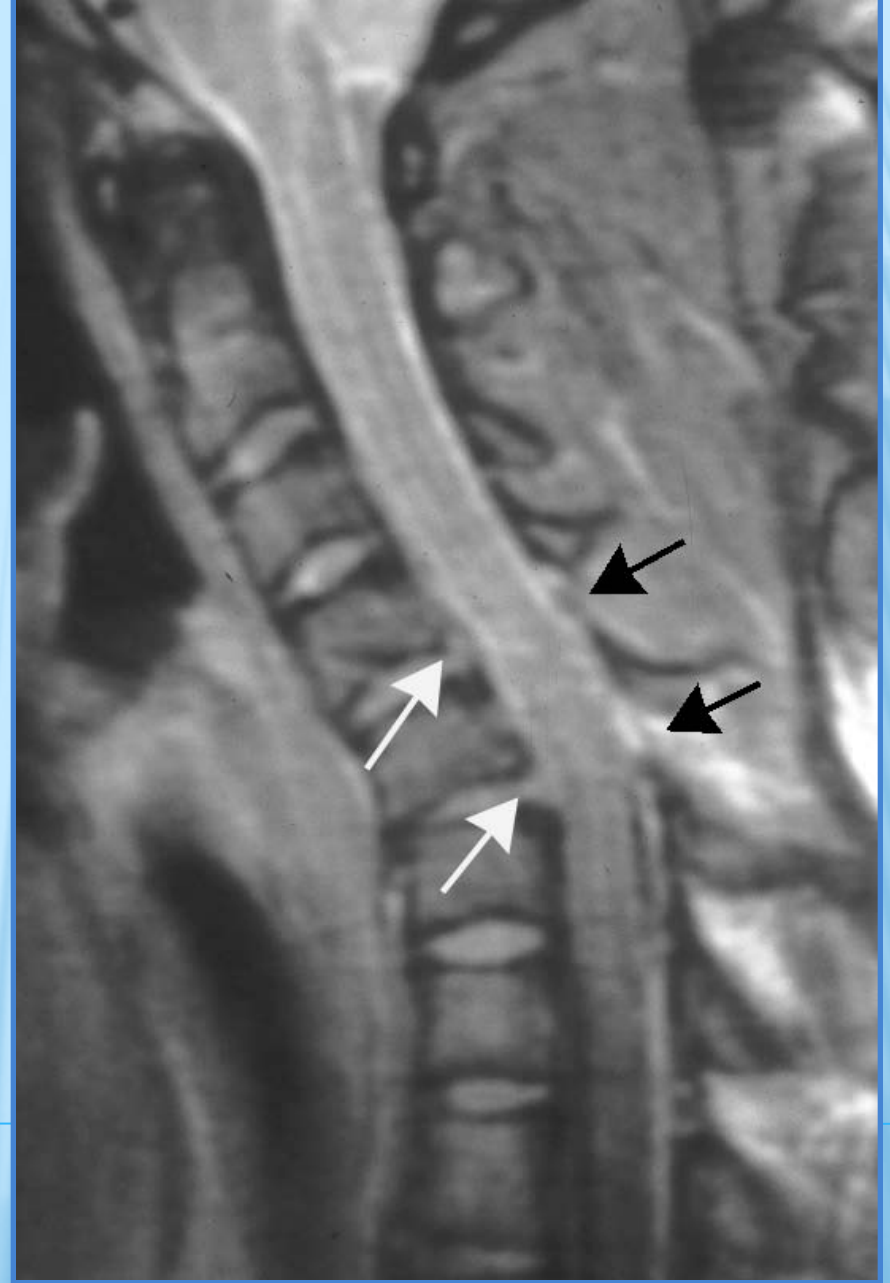
STABLE?



Rule of 2s



Flexion Sprain - ? unstable



Multiple levels



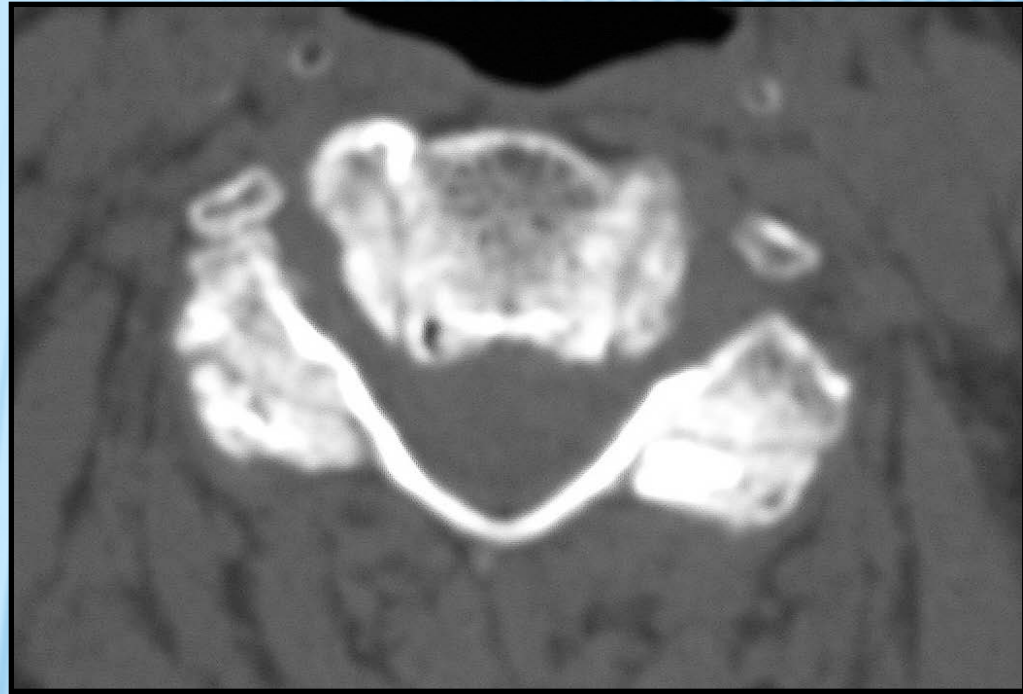
Flexion sprain: Rupture
middle and posterior
column (unstable)



Hyperflexion – Subluxation
(unstable)

Degenerative Subluxation





Degenerative subluxation

Cervical Spine Burst



Stable?

Support Failure





Full body
compression

+/- posterior
compression

Retropulsion

Seldom kyphosis or
translation

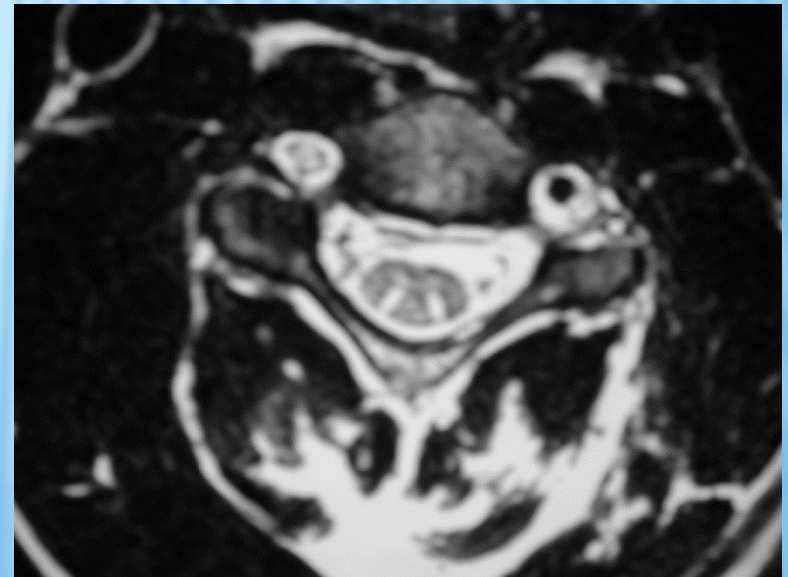
Centrifugal fracture
displacement (axial
CT)

Interpedicular
widening (AP or
coronal)

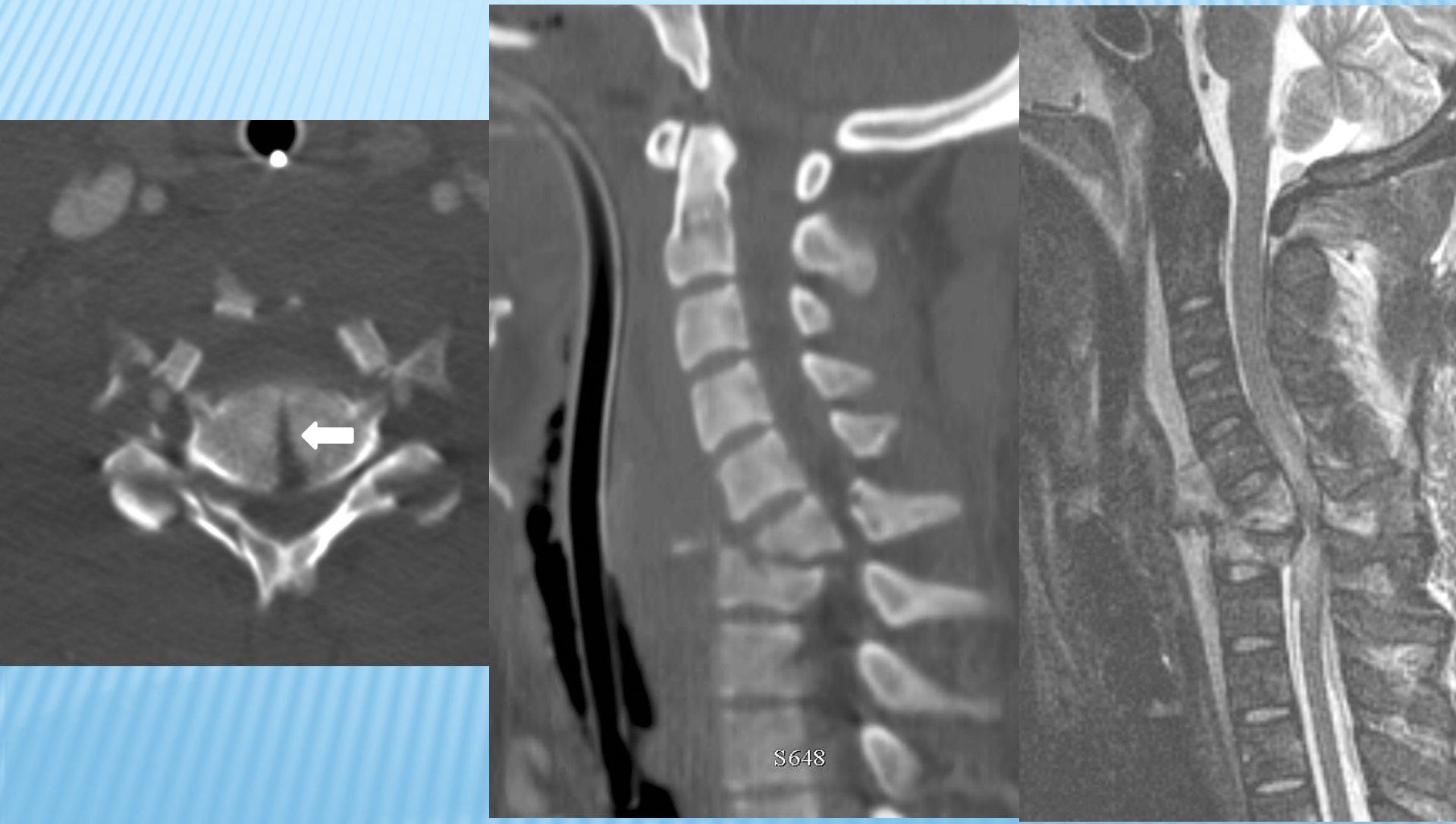
HYPERFLEXION TEARDROP

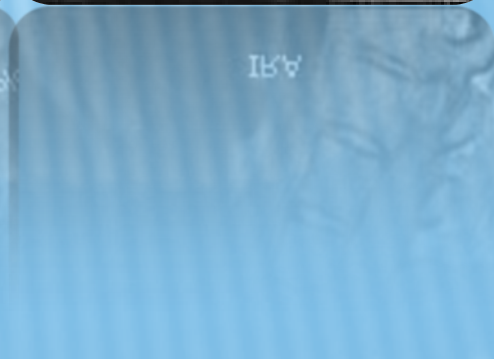
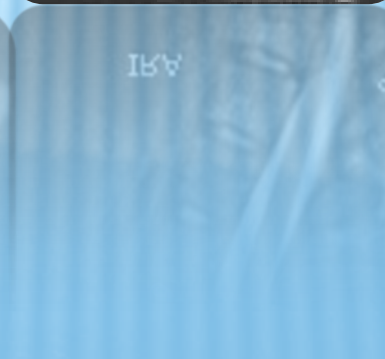


- Flexion-compression
- Followed by tensile failure
- Sagittal plane body fracture
- Body retropulsion
- All ligaments torn
- Highest incidence neurologic deficit



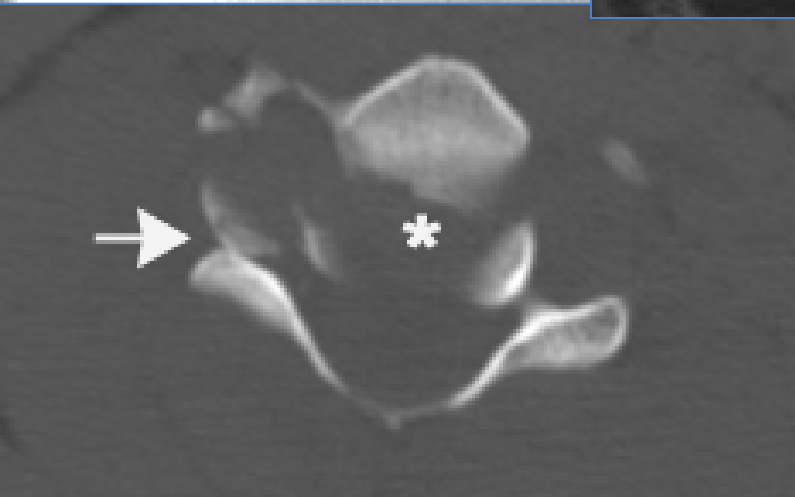
Severe flexion-teardrop





MULTI-LEVEL FLEXION-TEARDROP





Bilateral facet dislocation;
>50% AP translation

Vertebral occlusion

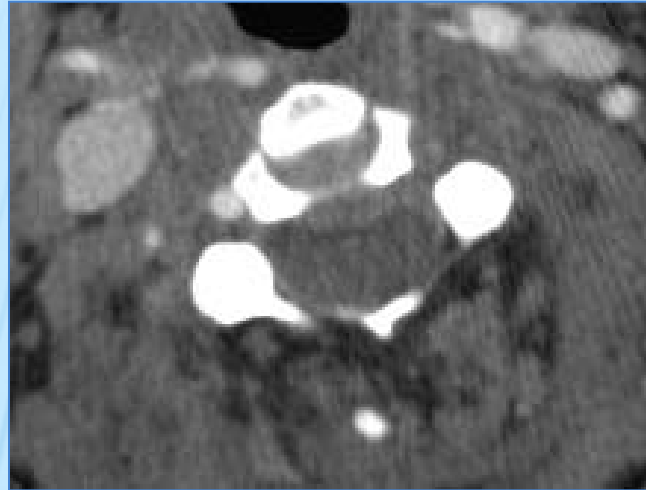


Flexion – Distraction
Varies from subluxation to bifacetal
dislocation



Ligament failure posterior to anterior

BID with Lf. vertebral occlusion



Typically ligamentous
injury; no fractures

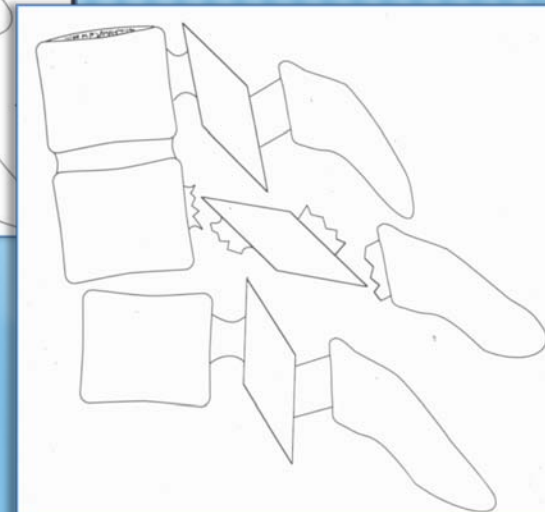
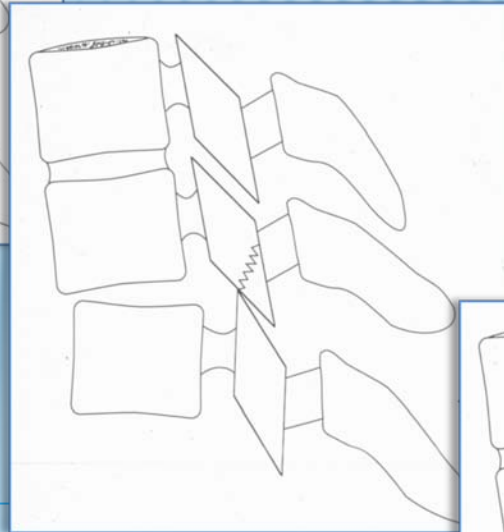
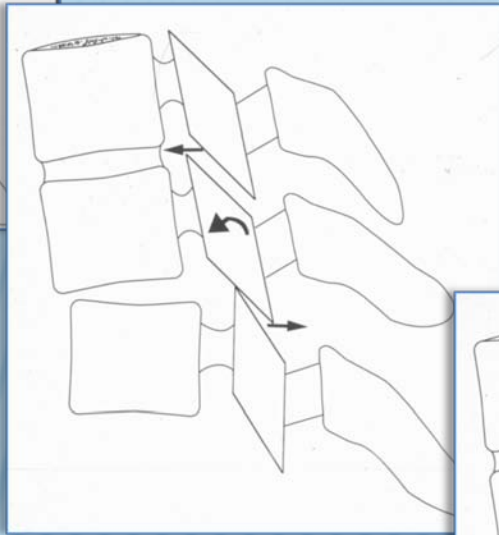
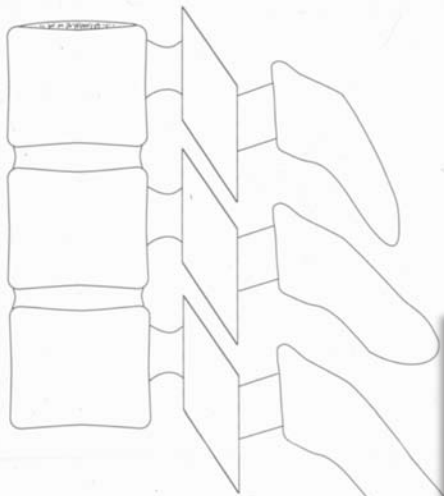
82% disc herniation

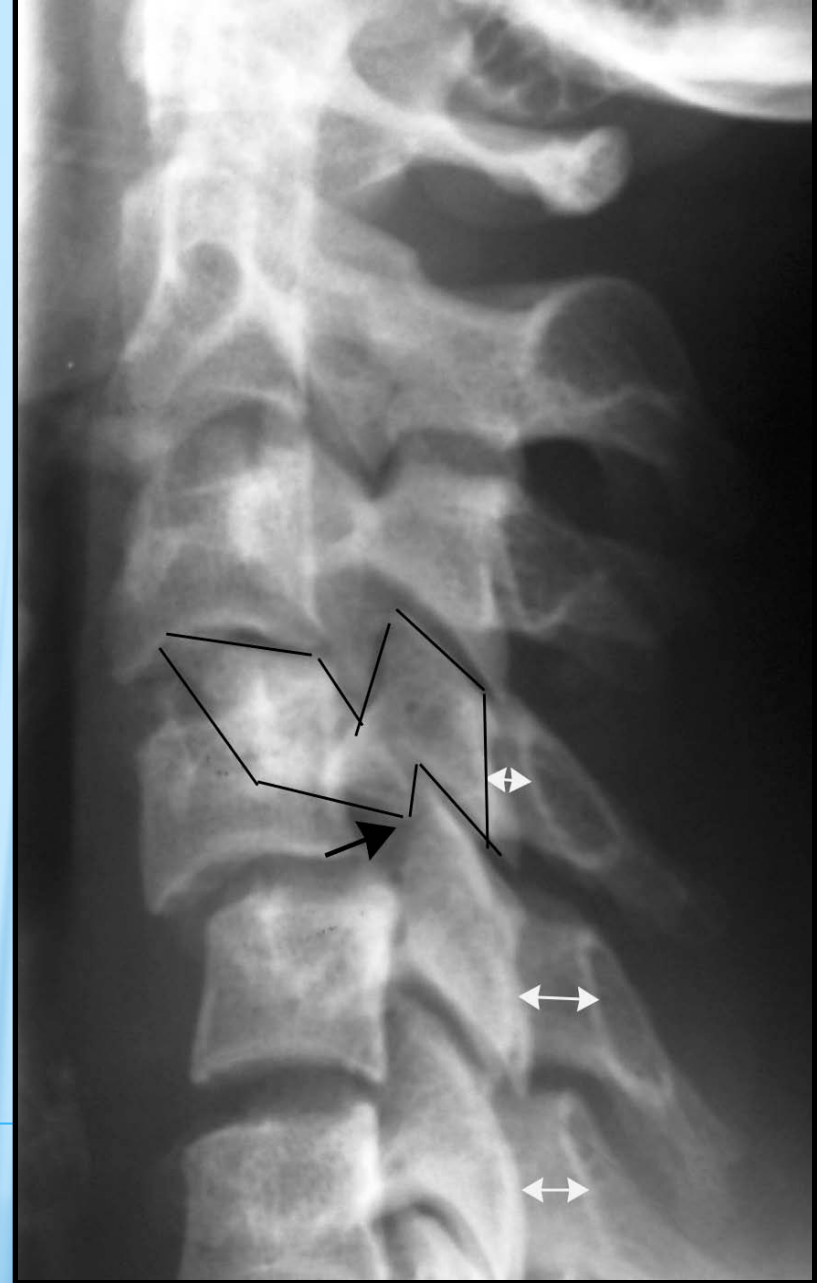


UNILATERAL FACET FRACTURE SUBLUXATION / DISLOCATION

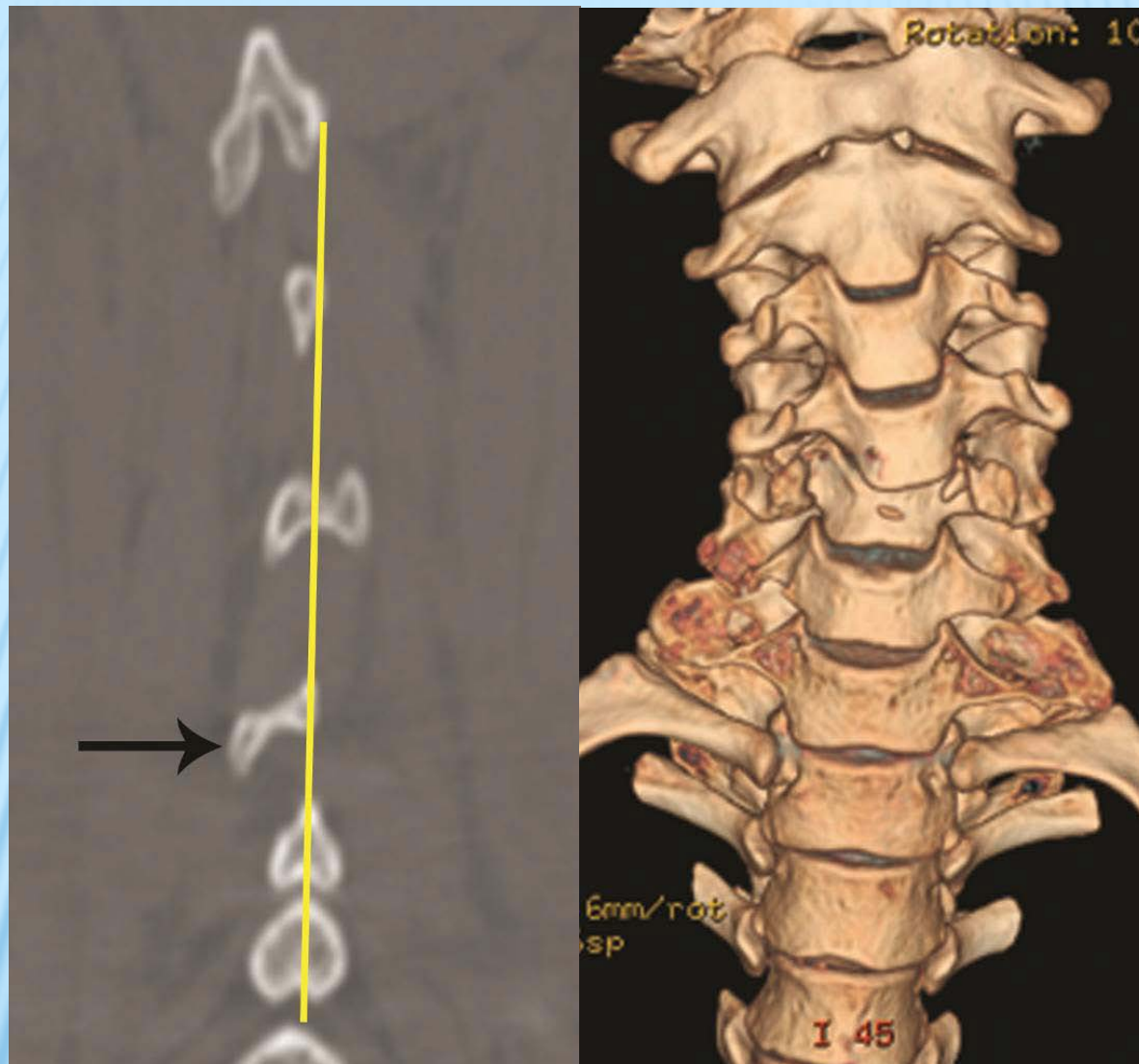
- 4-16% of C-spine injuries
- Varies from intact to complete paralysis
- High rate of ligament tearing (rotation)
- Potential vertebral artery injury
- Articular pillar fractures more common than pure dislocation
- Not stable in “locked” position
- 30-40% anterior displacement
- Contralateral facet abnormal (asymmetric injury)

Mechanism of IAP: The Hyperflexion Family

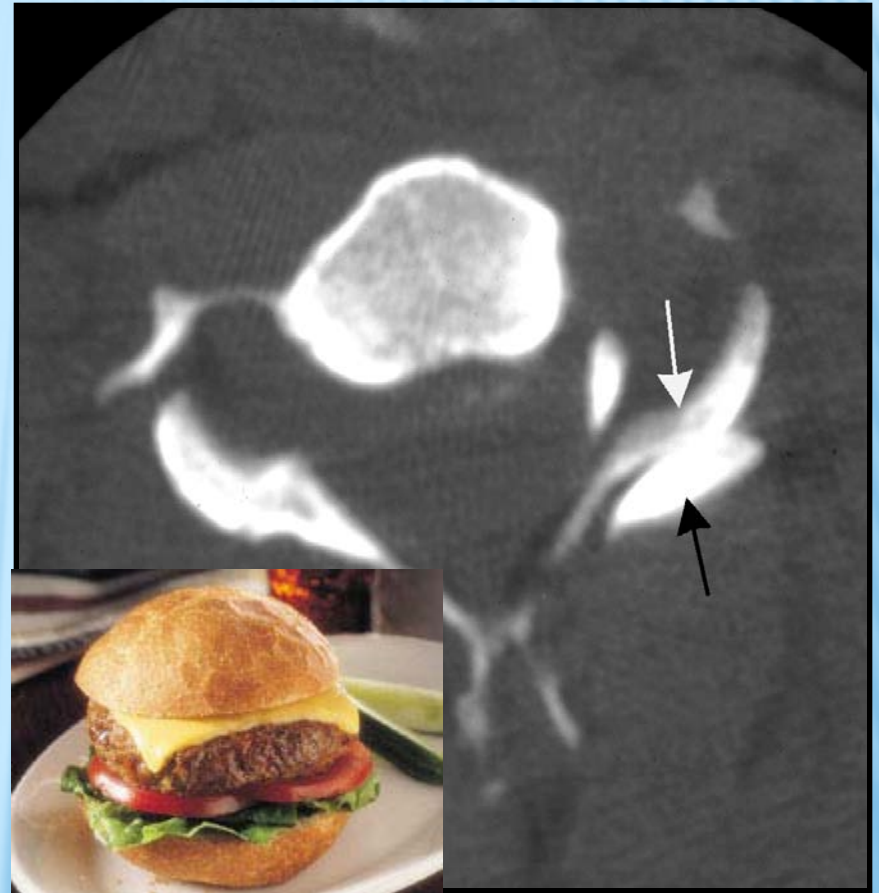




UID (bow-tie & laminar space)



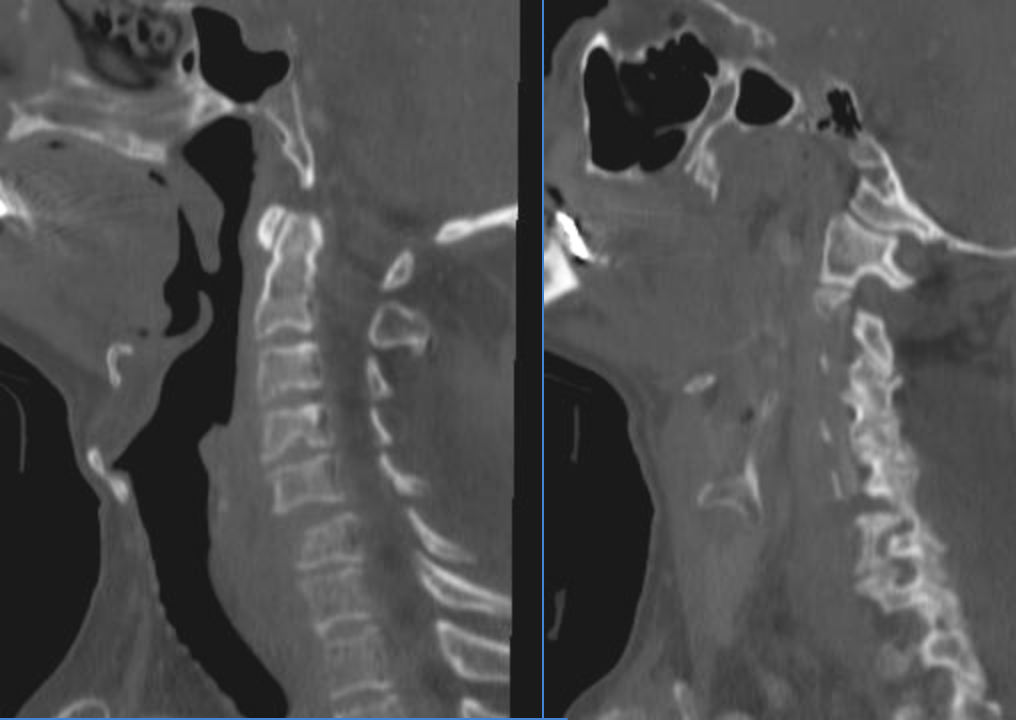
Rotation



Unilateral facet dislocation



Facet perch



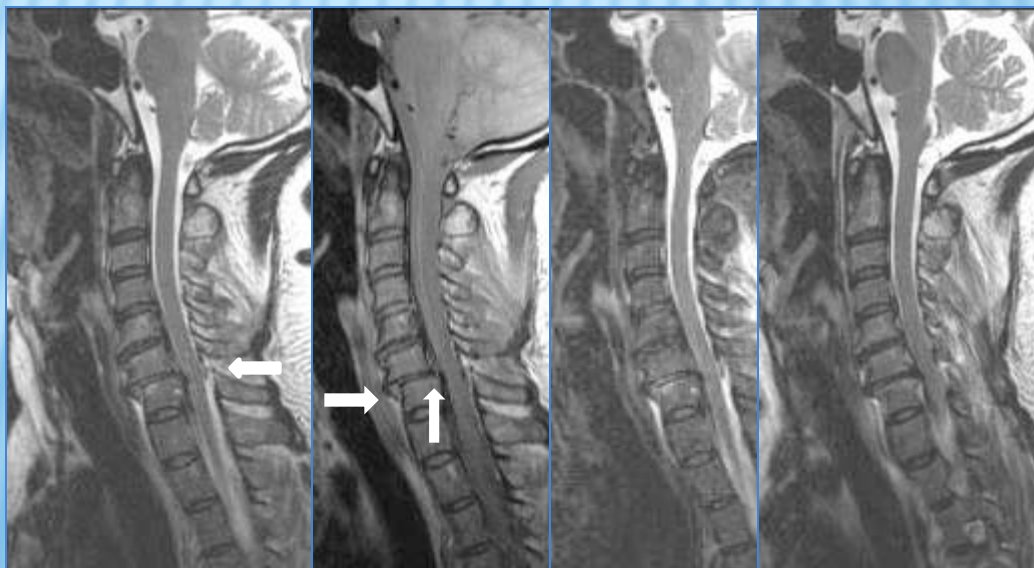
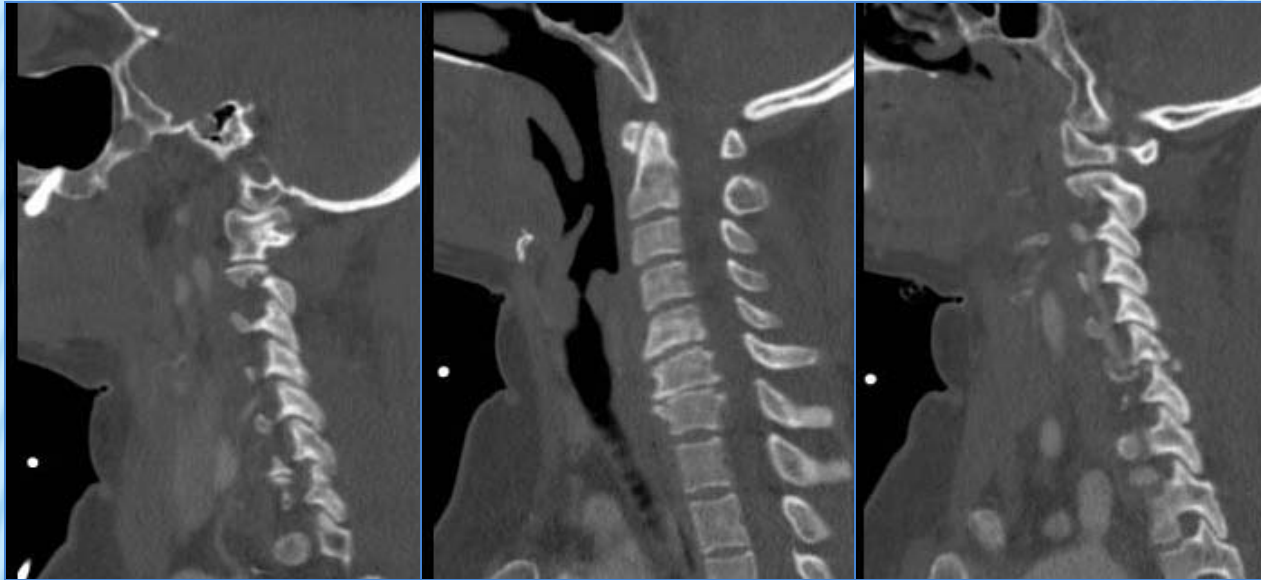
Unilateral facet dislocation:
rotation – distraction -
flexion

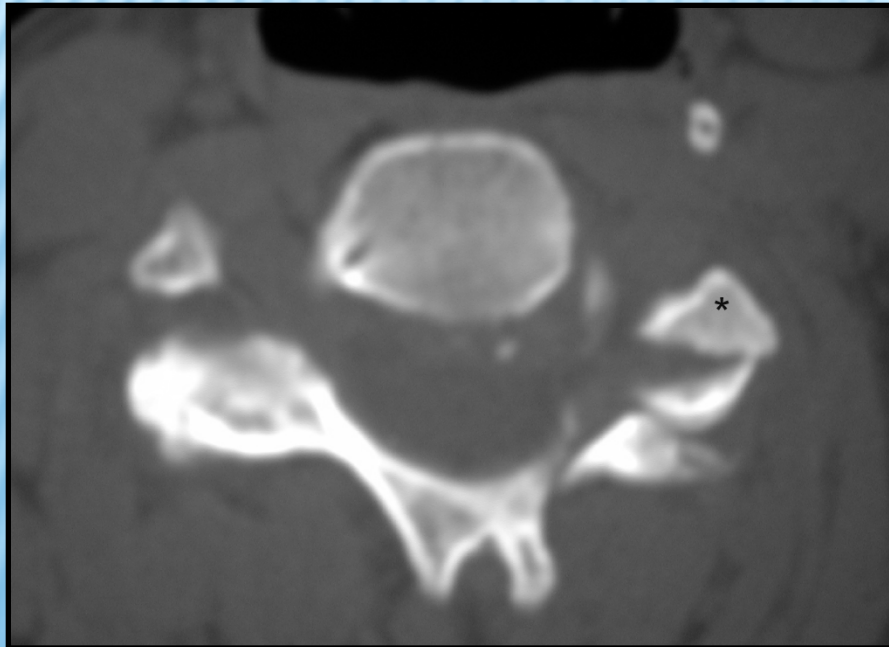
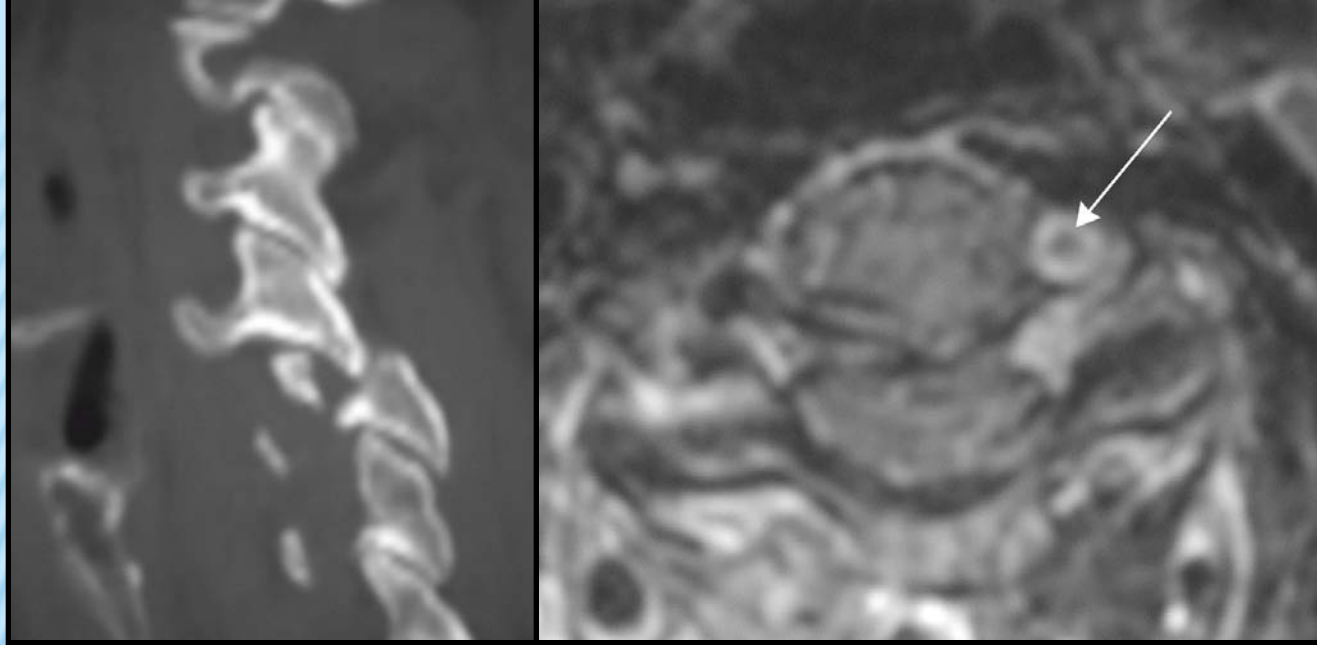


Tear in ALL/PLL (highly
unstable)

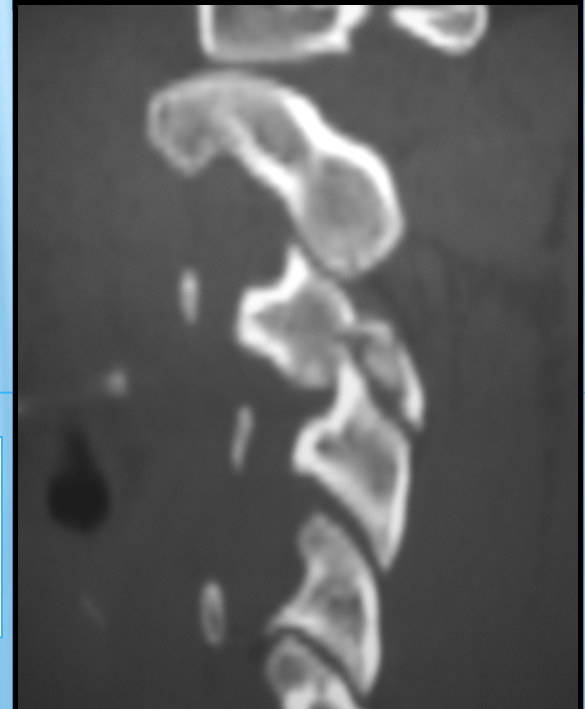
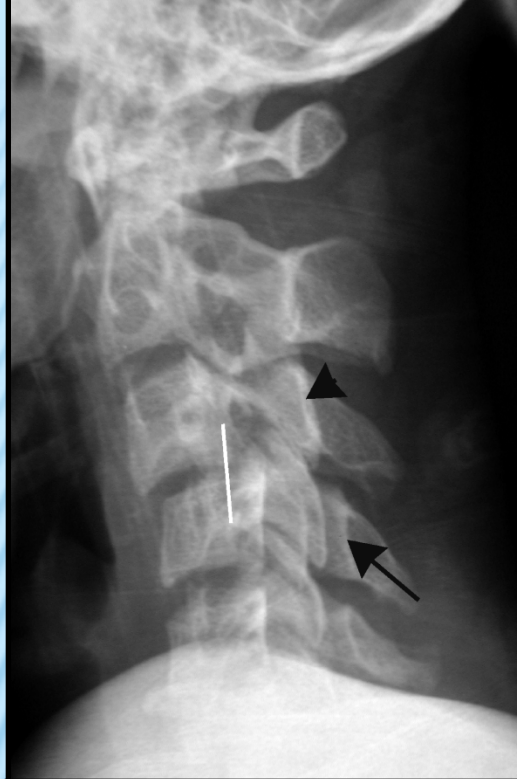
Shanmuganathan K, Mirvis SE, Levine A.
Rotational injury of cervical facets: CT
analysis of fracture patterns with implications
for management and neurologic outcome.
AJR Am J Roentgenol. 1994
Nov;163(5):1165-9.

Unilateral facet fracture-
subluxation/dislocation (25% purely
ligamentous)





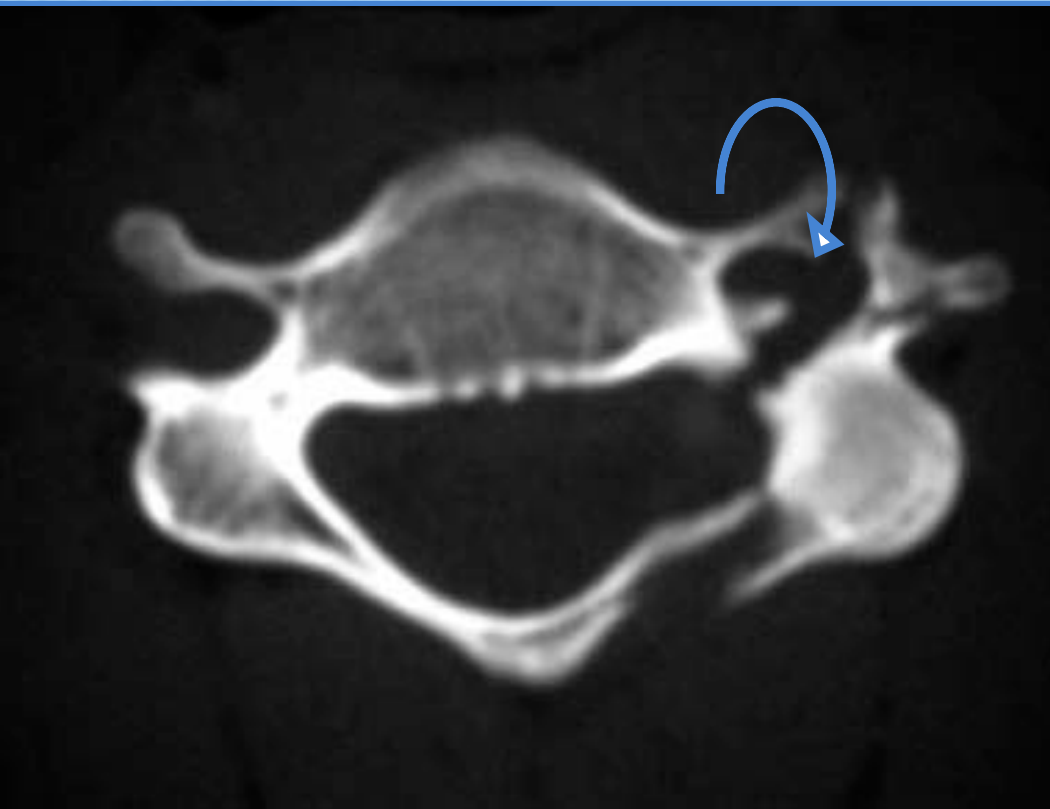
UID with vertebral
occlusion



Unilateral facet fracture-dislocation;
more difficult closed reduction

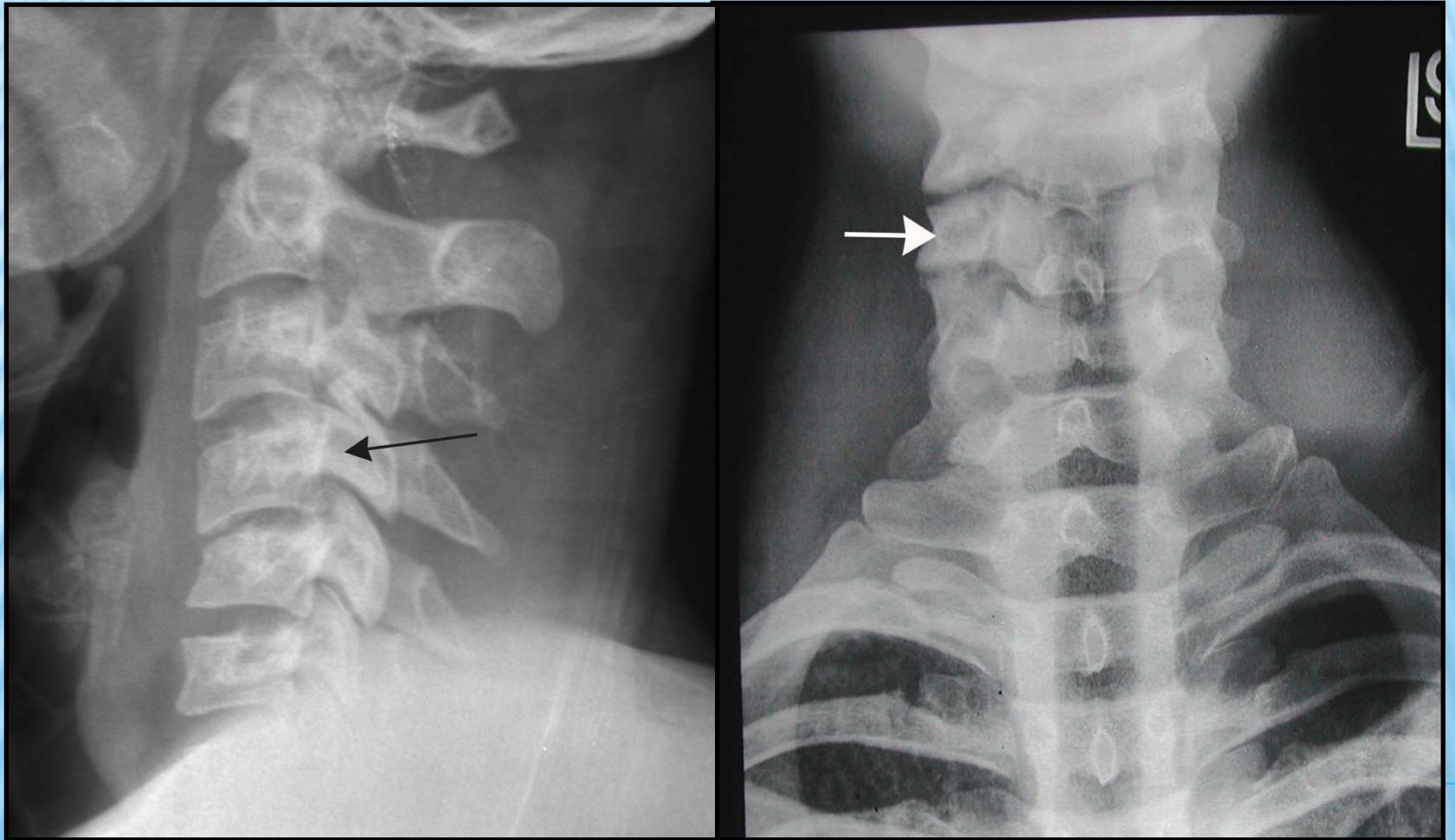
ISOLATED ARTICULAR PILLAR

- Laminar-pedicular separation
- Uncommon ?
- Hyperflexion mechanism in most cases
- AP radiograph (“horizontalization” of articular mass)
- May be concurrent with contralateral unilateral facet injury or isolated pillar
- Requires 3-level internal fixation

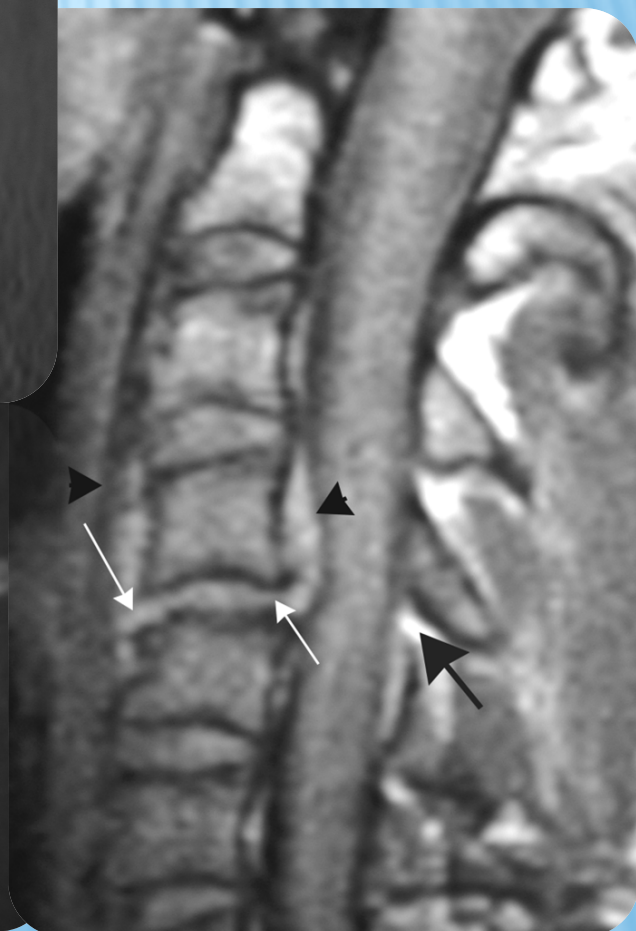
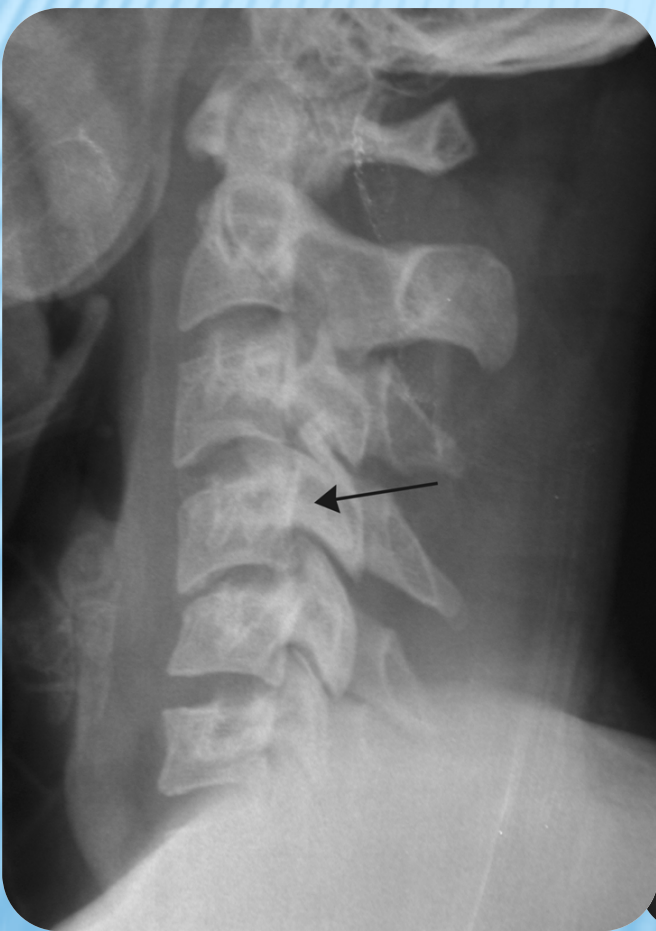


Isolated articular pillar

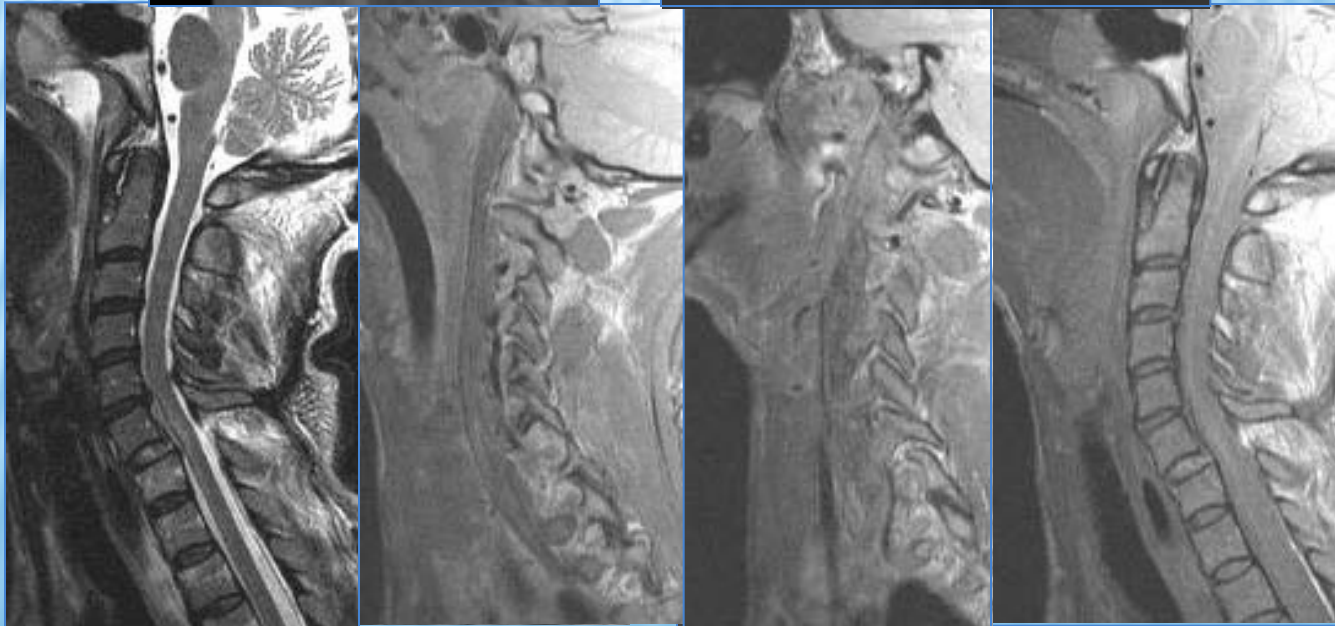
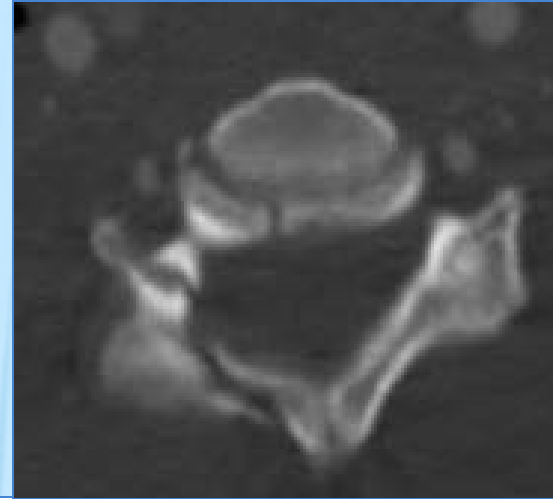
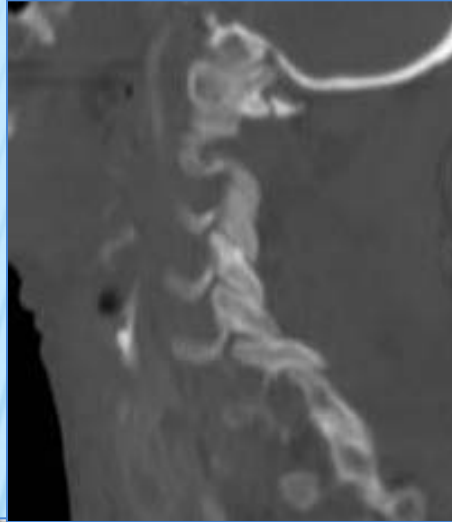


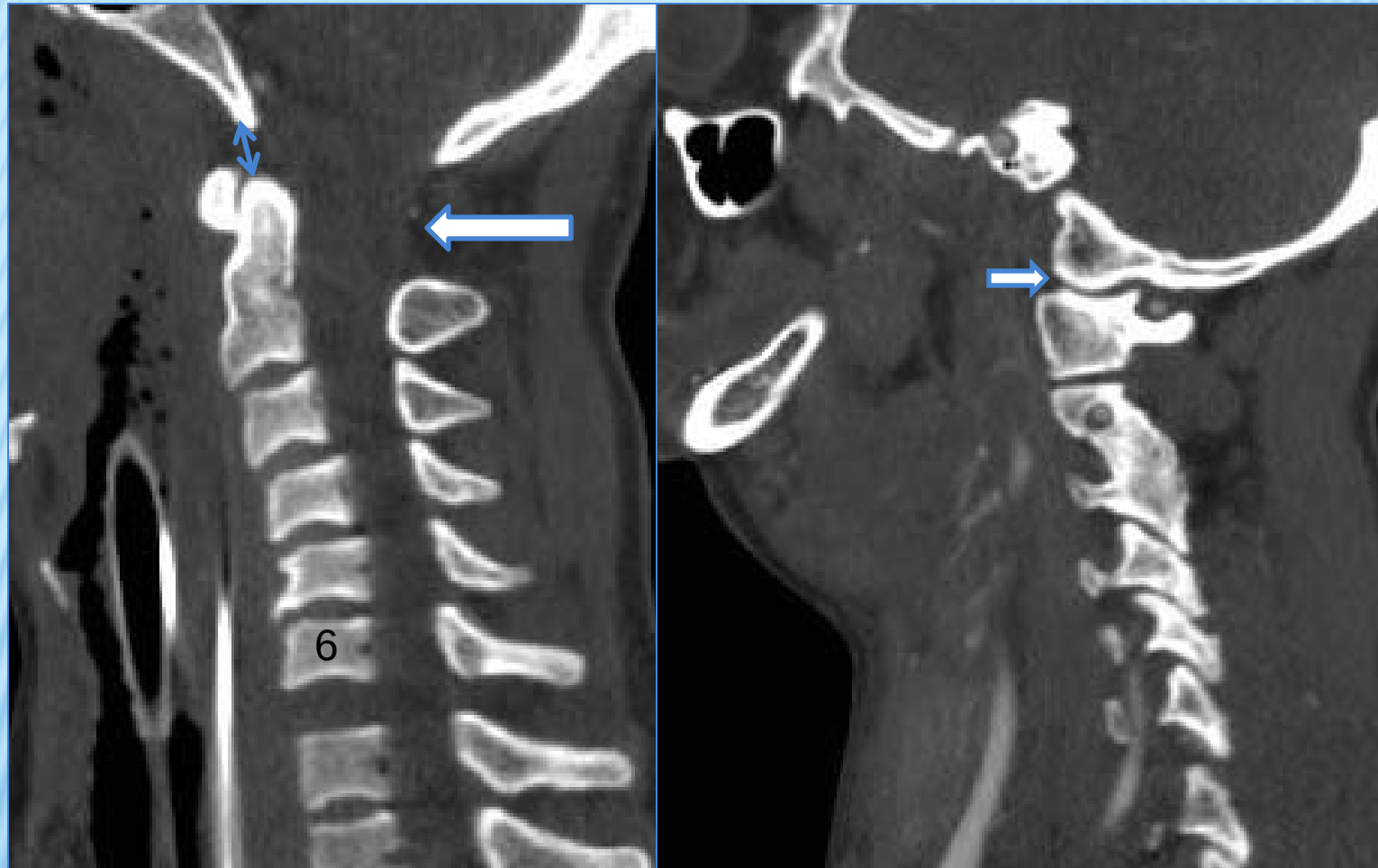


Isolated Articular Pillar



ISOLATED ARTICULAR PILLAR / PERCHED FACET



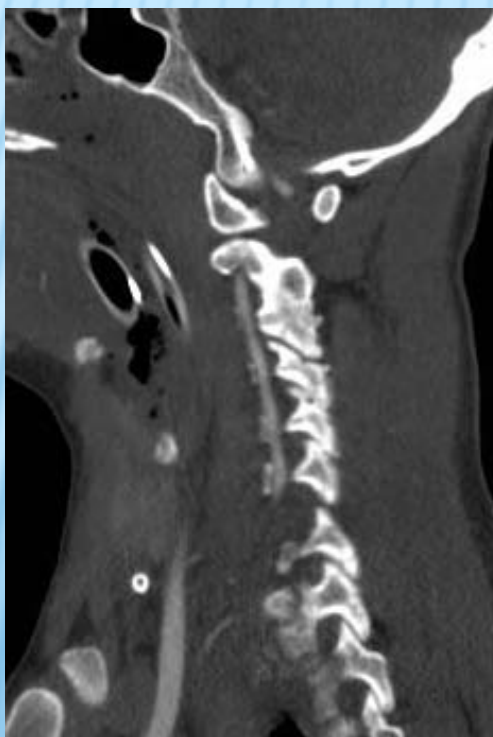


Hyperdistraction – how many levels?



C5-6 Hyperdistraction

Hyperdistraction

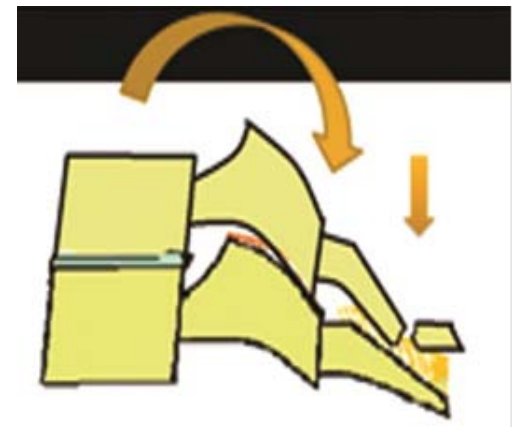


LATERAL HYPERFLEXION

- Rotation – extension (compression failure and contralateral distraction failure)
- Asymmetric compression VB
- Uncinate / transverse process fx
- Lateral vertebral arch fx
- Nerve root, brachial plexus (cord rare)

HYPEREXTENSION PATTERNS (7%)

- Hyperextension – compression
- Hyperextension – rotation (lateral masses)
- Hyperextension – distraction (subluxation / dislocation)
- Hyperextension teardrop
- Hyperextension sprain





Hyperextension Sprain



Hyperextension Teardrop

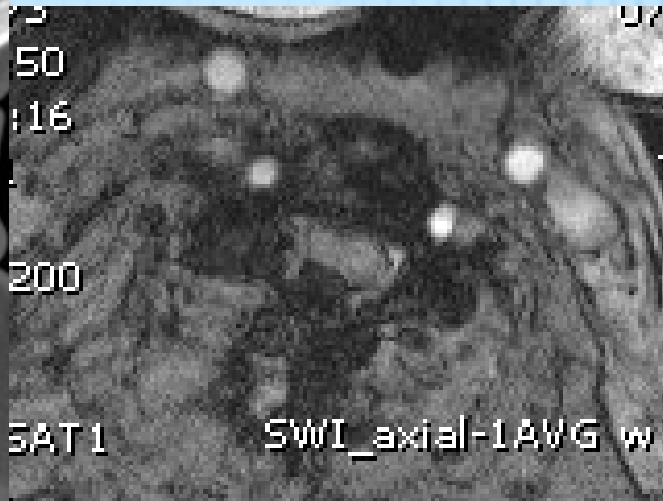
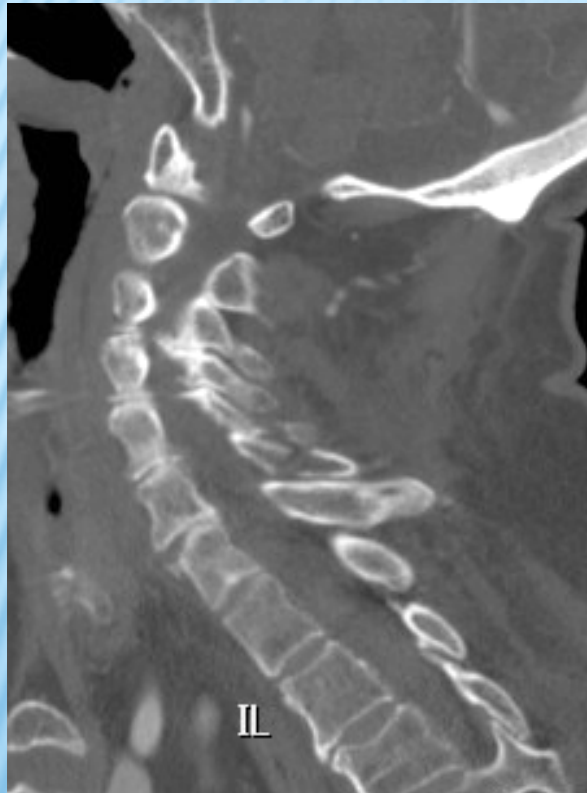


Hyperextension -
Distraction

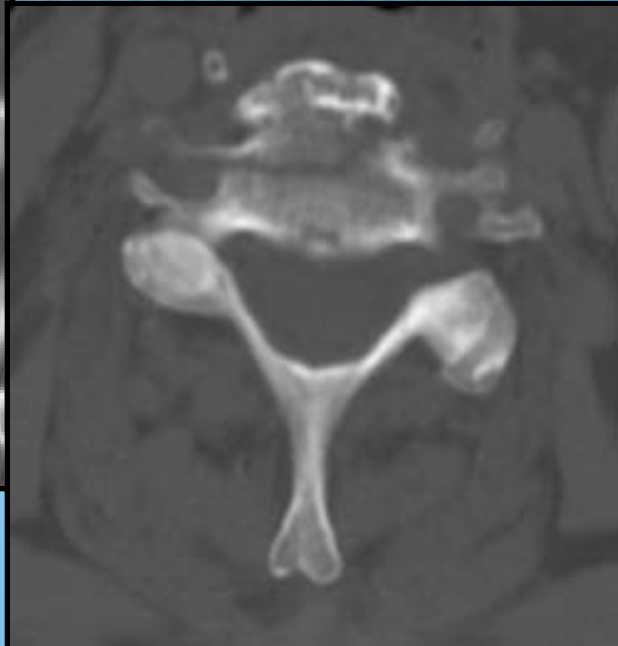
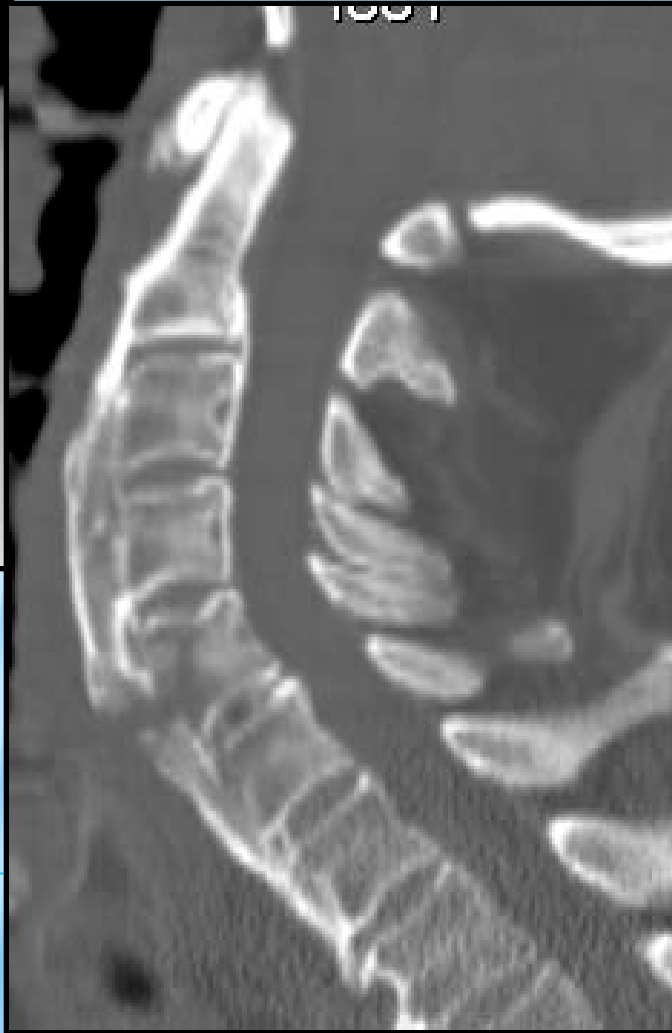
Subtle Hyperextension Sprain



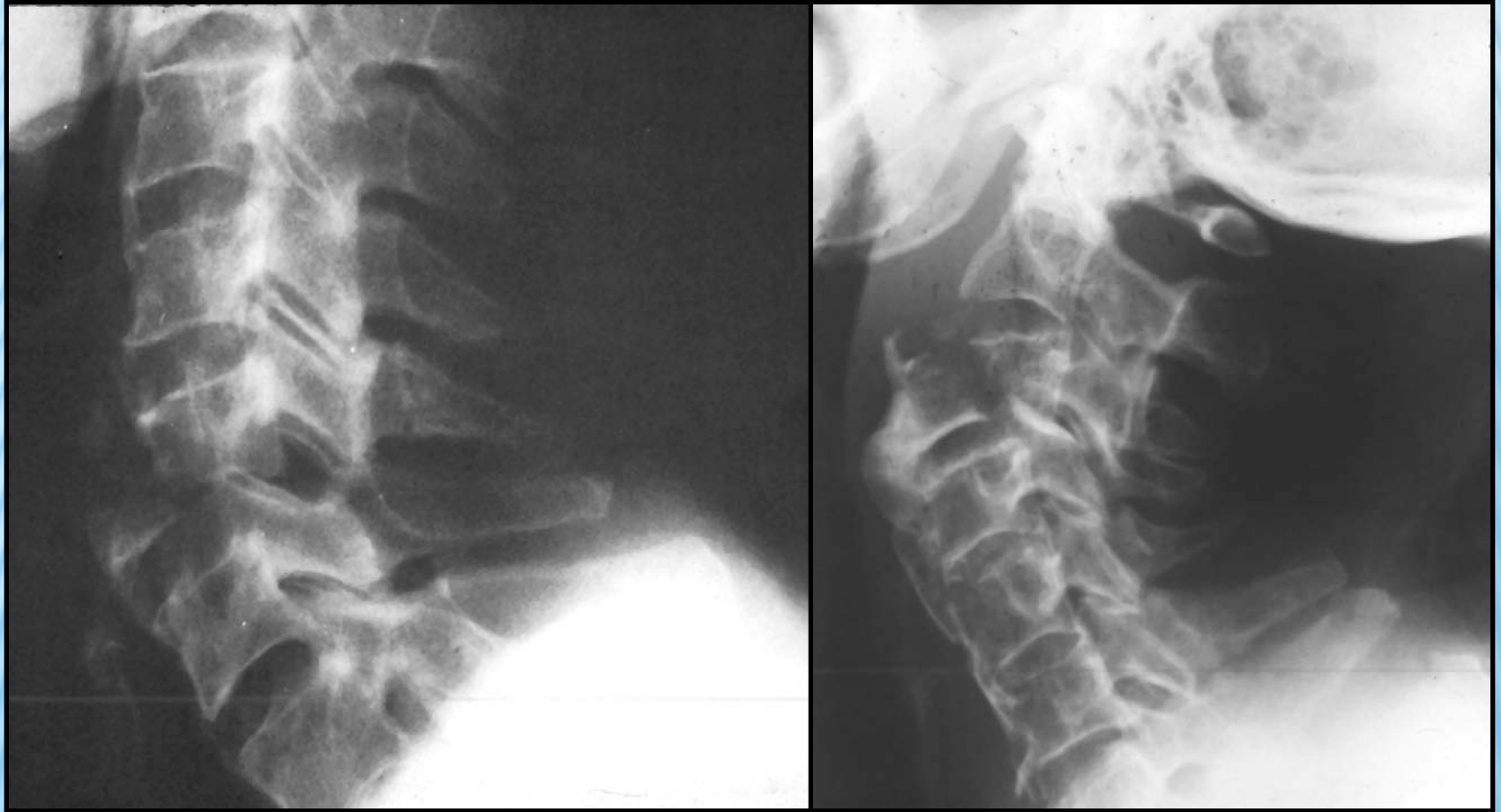
HYPEREXTENSION - COMPRESSION



Broken DISH

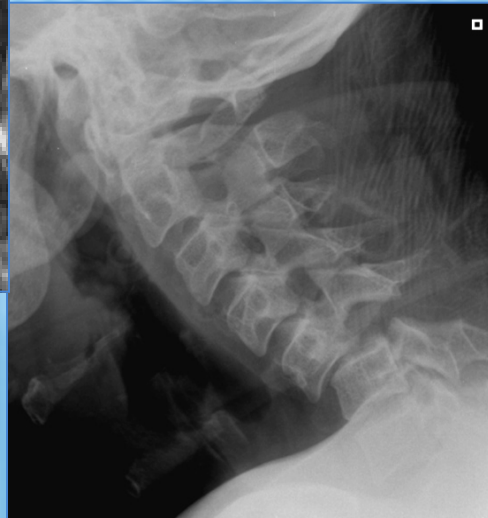






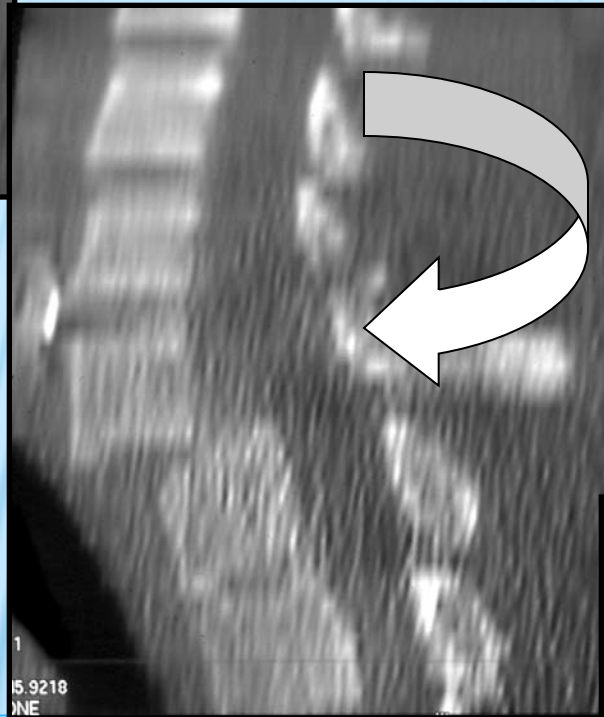
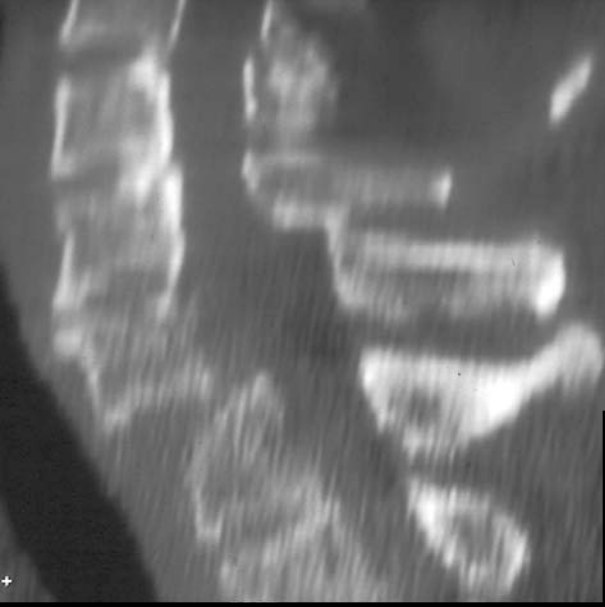
**Extension fracture-dislocation
(anterior to posterior failure)**

Unknown



Unstable Whiplash

Extension anterior dislocation



UNKNOWN

