



# C-spine Imaging in ED

A point of care guide to interpreting CTs, plain films  
and rationalising their use in ED

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# ECI recommended neuroanatomy website

- <http://headneckbrainspine.com/Neuroanatomy-modules.php>

The screenshot displays the website's interface. At the top, the title "HeadNeckBrainSpine" is prominently featured in orange. Below it, a navigation bar includes links for "HNBS", "Neuroanatomy modules", "Cases", "Flashcards", "About", "Comments", "Contact", and "News". The "Neuroanatomy modules" dropdown menu is open, listing various anatomical topics. The main content area is a grid of nine modules, each with a representative image, title, file size, and a link to an optimal preset window.

Module Name	File Size	Link
Skull Base CT	12 Mb	<a href="#">optimal preset window</a>
Cranial Nerve MRI	12.4 Mb	<a href="#">optimal preset window</a>
Orbit CT	7.4 Mb	<a href="#">optimal preset window</a>
Temporal Bone CT	4.6 Mb	<a href="#">optimal preset window</a>
Head CTA	11 Mb	<a href="#">optimal preset window</a>
Sinus CT	4.7 Mb	<a href="#">optimal preset window</a>
Neck CT	15.7 Mb	<a href="#">optimal preset window</a>
Neck CT Lymph Node Levels	4.2 Mb	<a href="#">optimal preset window</a>
Teeth Panorex	341 Kb	<a href="#">optimal preset window</a>
Thoracolumbar spine Junction CT	10.6 Mb	<a href="#">optimal preset window</a>

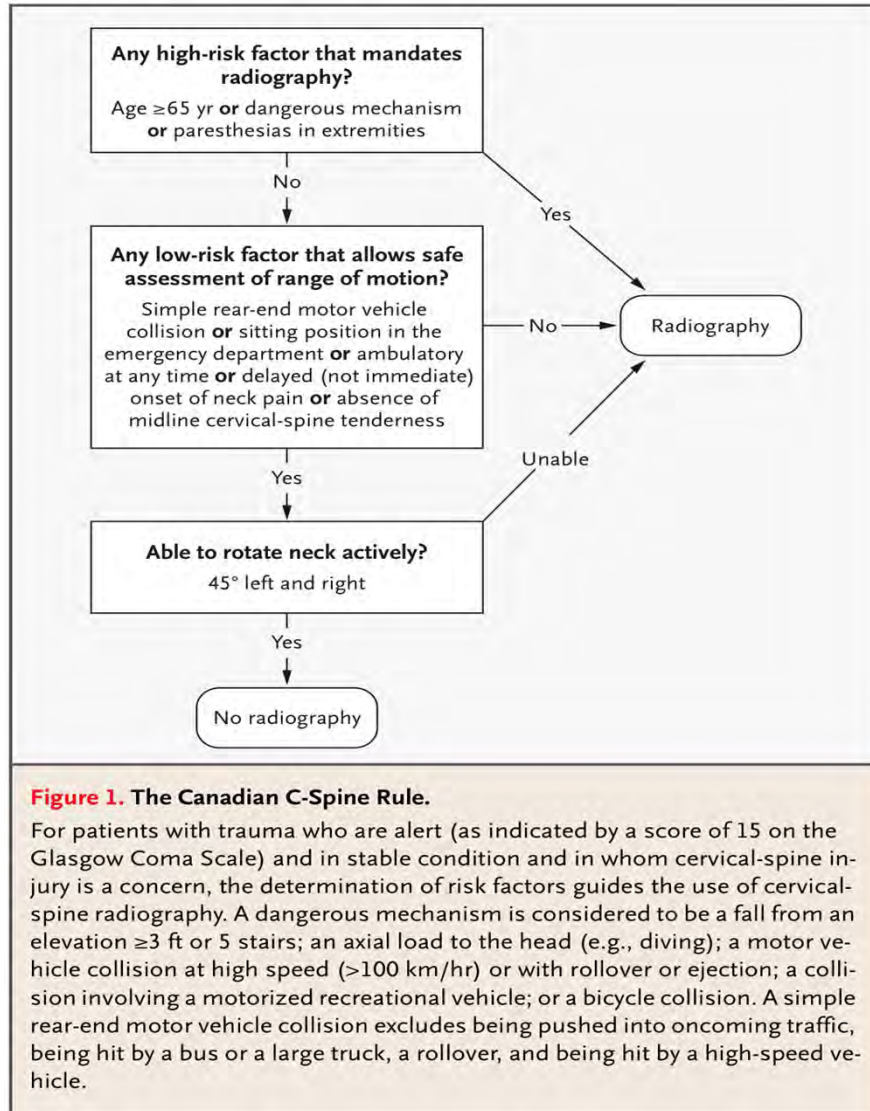
# Who needs C-spine imaging?

- According to **NEXUS** Criteria radiography indicated *unless* following criteria met:
  - No posterior midline C-spine tenderness
  - No evidence of intoxication
  - A normal level of alertness
  - No focal neurologic deficit
  - No painful distracting injuries

# Who needs C-spine imaging? (2)

## CANADIAN C-SPINE RULE

- High-risk:
  - MVA >100km/hr
  - Fall >3ft/>5 steps
  - Axial compression injury
  - Focal neurology
  - (Predisposing medical condition)

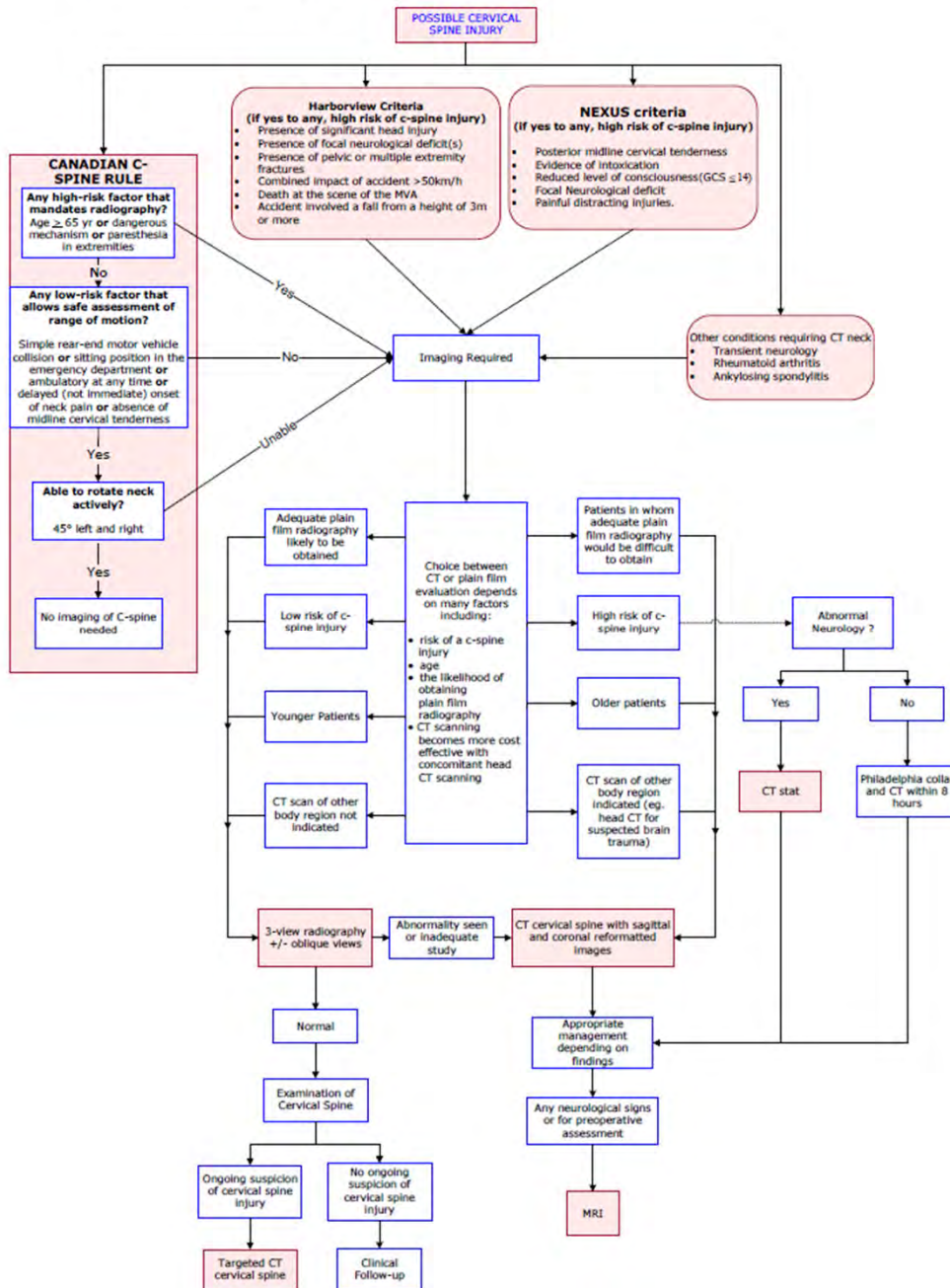


# CT or Plain Film?

- In reality CT commonly performed due to higher sensitivity, wide availability and speed of image acquisition
- CT recommended if:
  - High clinical suspicion of injury, even if normal X-ray
  - Inadequate plain film study
  - Suspicious plain film findings
  - Fracture seen on plain X-rays
- Lack of CT availability in rural NSW settings mean plain films often first line



2.4 Possible cervical spine injury

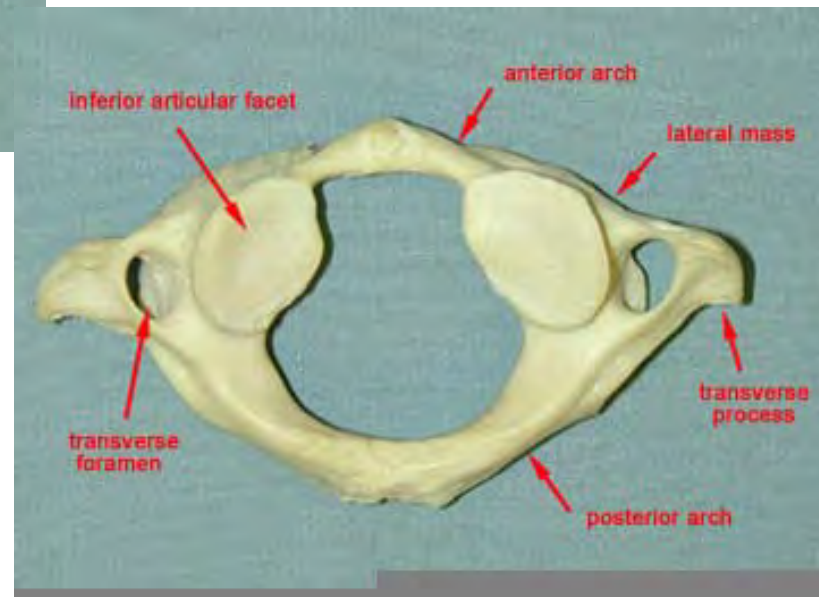
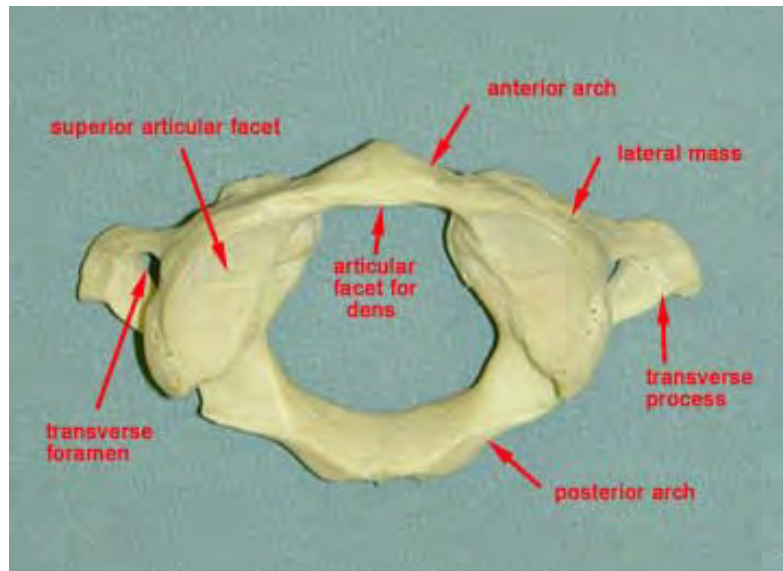


# ACEM Guideline



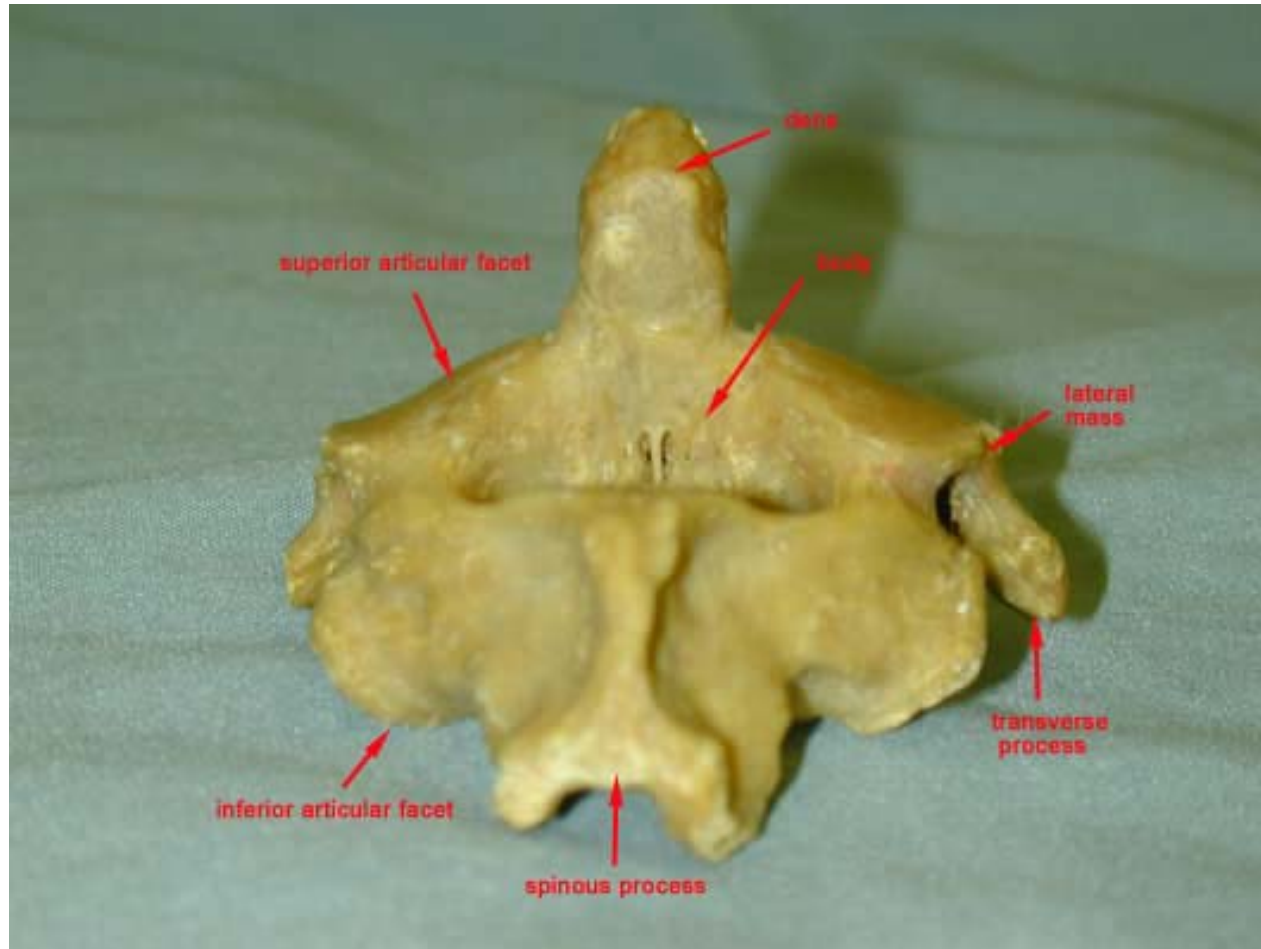
# **‘AABCDS’ of C spine Interpretation**

# Atlas

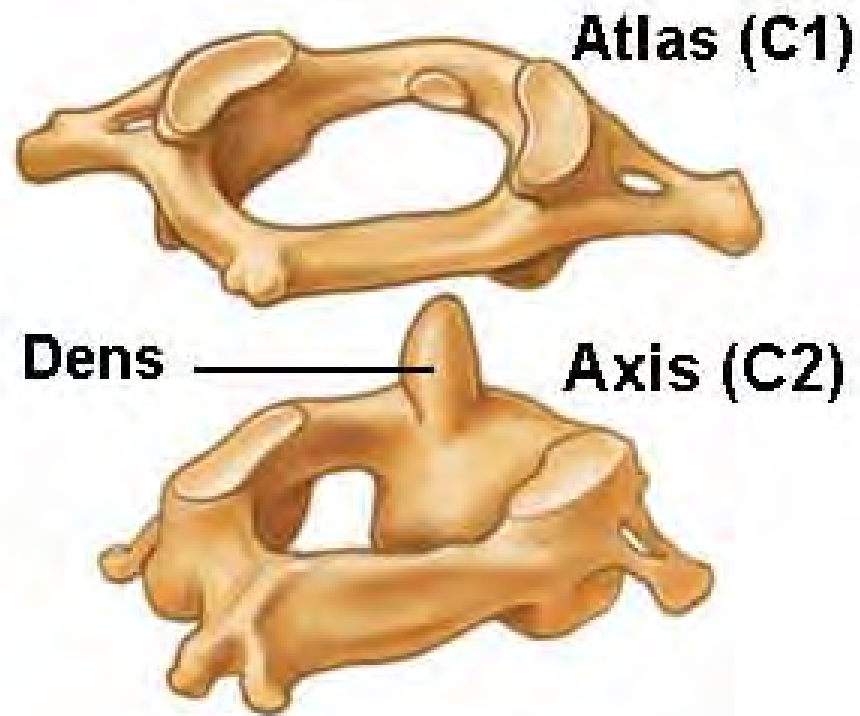




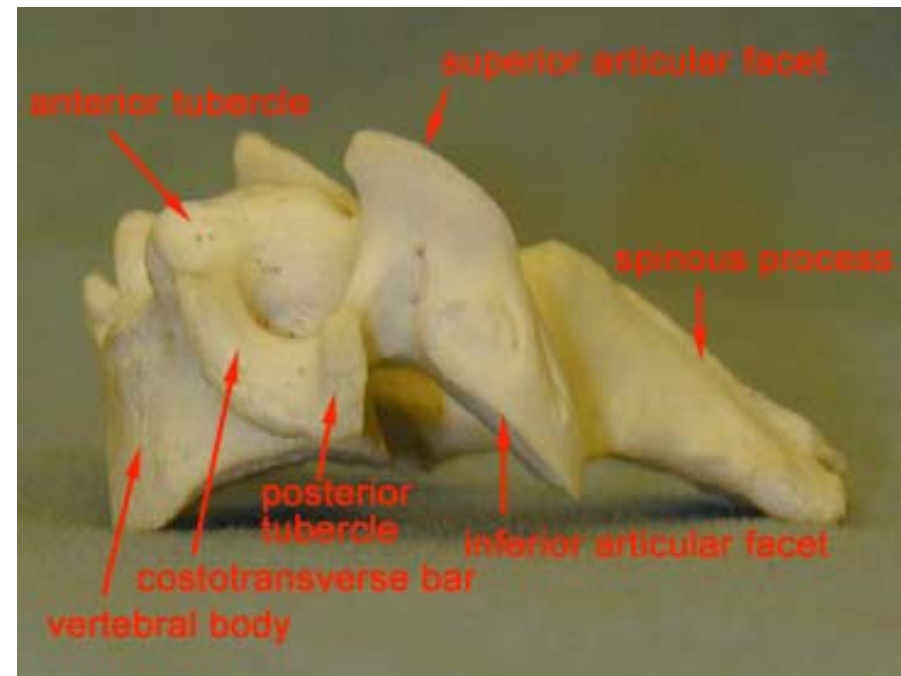
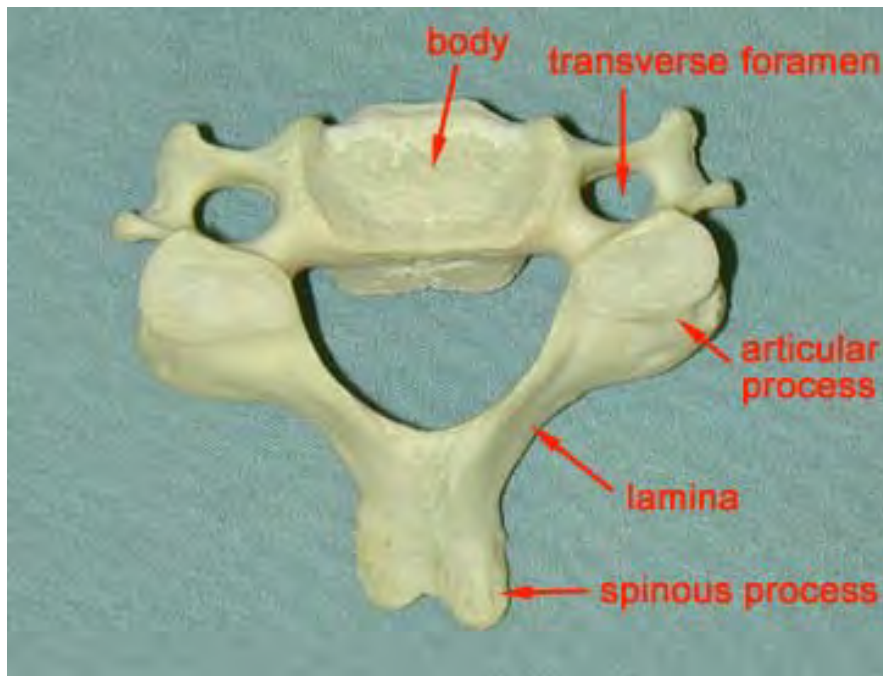
# Axis



# Articulation



# C4 – Typical vertebra



# AABCDs Mnemonic

- **A** = Adequacy
- **A** = Alignment
- **B** = Bone
- **C** = Cartilage
- **D** = Disc
- **S** = Soft tissue

Plain film: Lateral/AP/odontoid views

CT: Axial, sagittal, coronal slices

# Adequacy

All 7 vertebrae and C7-T1 junction





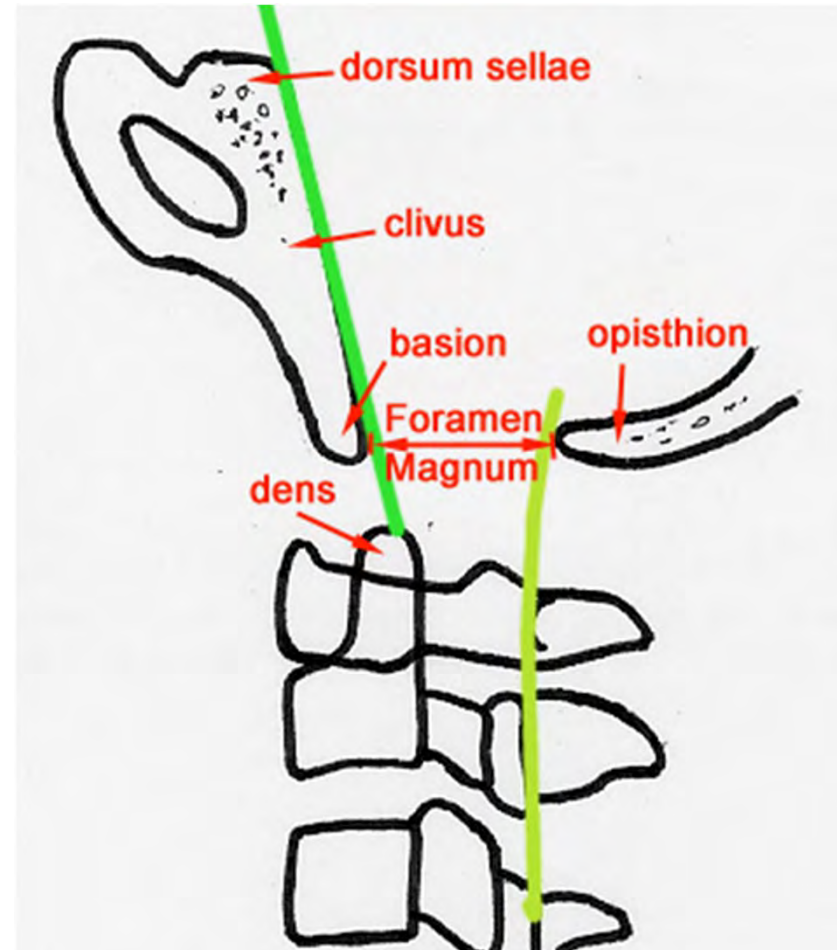
# Alignment

- **Anterior vertebral line (1)**
  - Anterior margin of vertebral bodies (VBs)
- **Posterior vertebral line (2)**
  - Posterior margin of VBs
- **Spinolaminar line (3)**
  - Posterior margin of spinal canal
- **Posterior spinous line (4)**
  - Tips of spinous processes



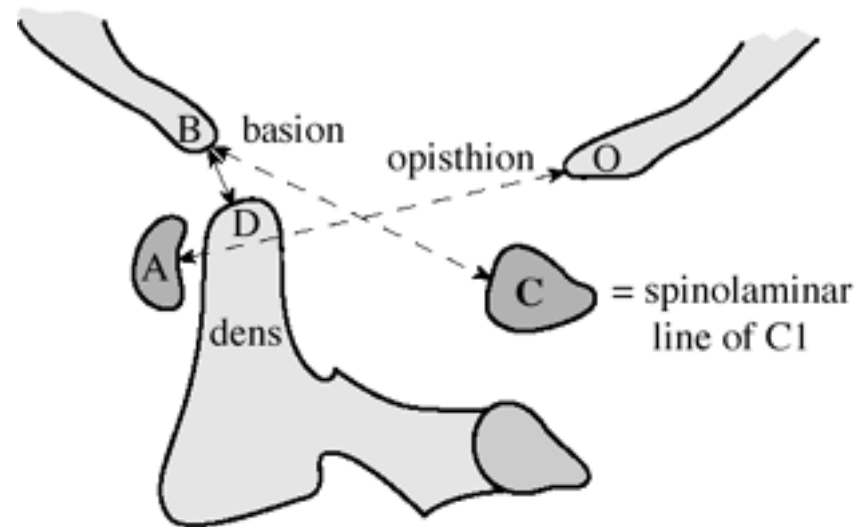
# Atlanto-occipital Alignment

- The anterior margin of the foramen magnum should line up with the dens
- The green line running downward from the dorsum sellae along the clivus and basion should point to the dens
- The posterior margin of



# Atlanto-occipital Dislocation

- $BC:AO = 0.6$  to  $1.0$
- Ratio  $>1.0$  = anterior cranio-cervical dislocation



# Bone: C1 & C2



# Bone: C3-C7

- Trace the outline of each vertebrae
- The VBs should line up with a gentle arch (cervical lordosis)
- Bodies rectangular in shape and roughly equal in size
  - Height of C4/C5 may be slightly less than C3/C6
  - Ant height = post height (up to 3mm post difference allowed)





# Bone

- **Pedicles**
- **Facet jts**
  - "Double cortical lines" due to slight obliquity from lateral projection
  - Joint space should be equal at all levels
- **Lamina**
- **Spinous processes**
  - Get progressively larger in the lower VBs



# Cartilage

- Pre-dentate space < 3mm (adults), <5mm (kids)

Dens to C1 body



# Disc Spaces

- Should be equal in height at A & P margins
- Symmetrical
- Approximately equal at all levels



# Soft Tissue Spaces

- High index of suspicion for underlying injury if enlarged
  - haemorrhage/occult fracture

Retropharyngeal space (C2-C4) - 5-7 mm

Retrotracheal space (C5-C7) - 22 mm

C1-C4 <  $\frac{1}{2}$  VB width, C4 onwards < 1 VB width



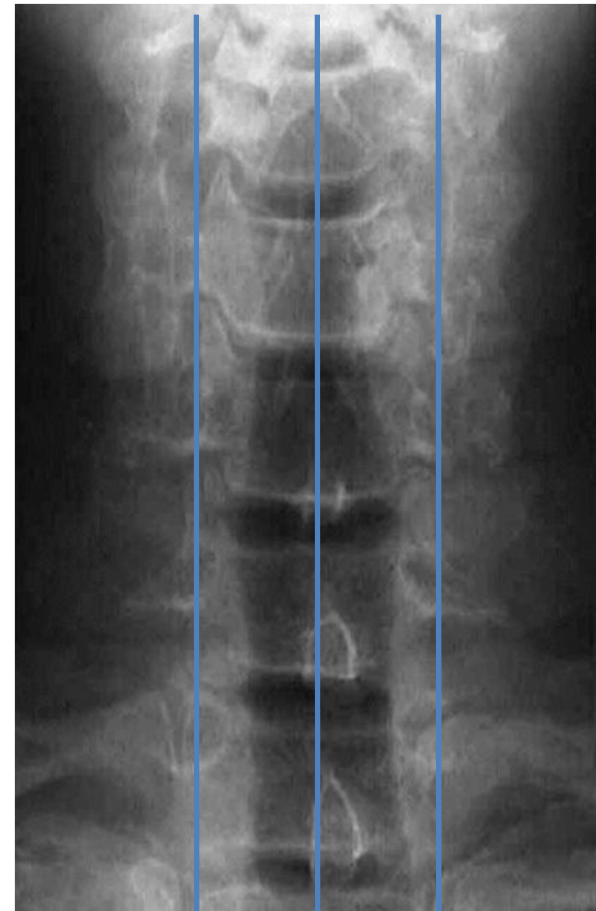
# Type III Dens # on CT



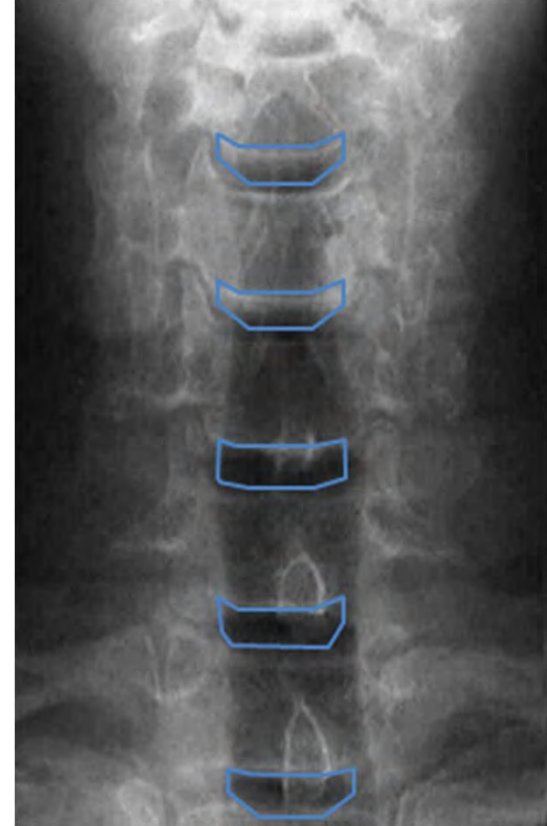
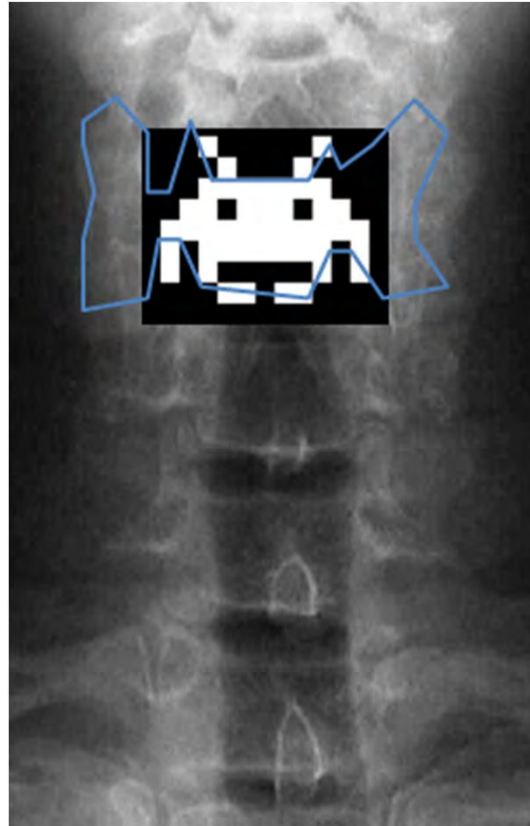


# The AP view

- Assess alignment of edges of the VBs and articular pillars
- Equal height of VBs and jt spaces
- Spinous processes midline
  - Suspect a facet dislocation if displaced to one side

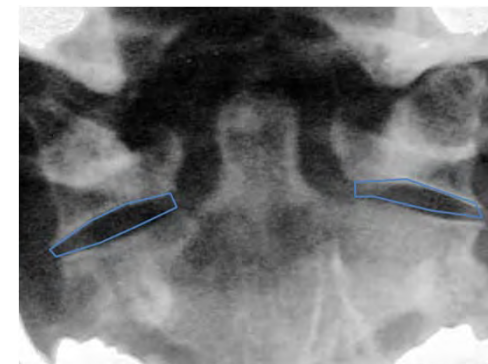
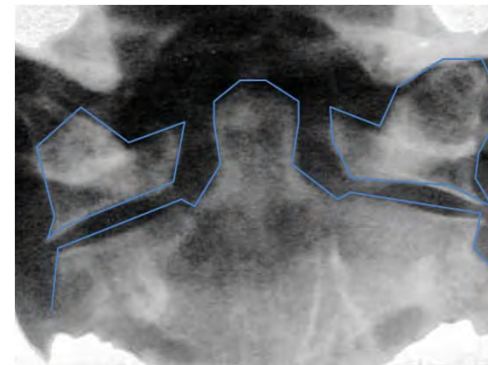
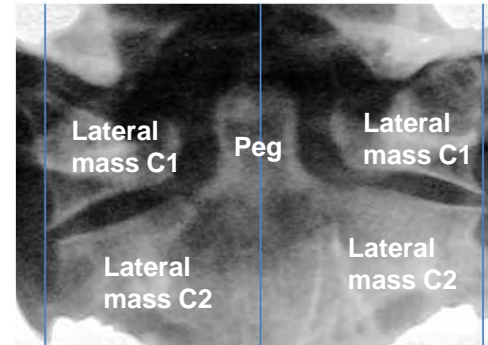


# AP View



# Odontoid View

- **Adequacy:**
  - Entire odontoid and the lateral borders of C1-C2 visible
- **Alignment:**
  - The tips of lateral mass of C1 should line up with the lateral margins of C2
  - The distance from the dens to the medial border of the lateral masses of C1 should be equal bilaterally
- **Bone:**
  - Look for any interrupted cortical margins



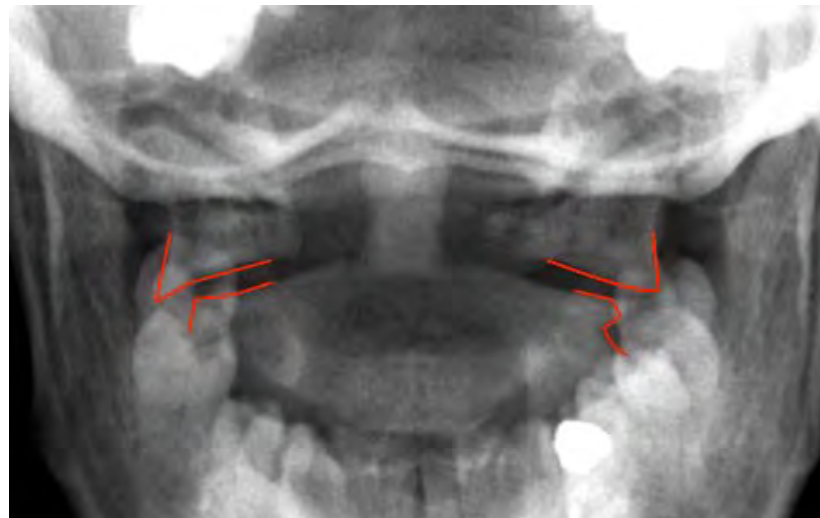
# CT Basics

- Radiation considerations
- Orientation
- Views
- Windows
- Hounsfield Units

# **C-spine Fractures**

# Jefferson # (unstable)

- Compression # of C1 bony ring, characterized by lateral masses splitting and transverse ligament tear
- **Mechanism:** Axial blow to the head (eg. diving)
- **Radiographic features:** displacement of the lateral masses of C1 beyond margins of body of C2 (CT required)

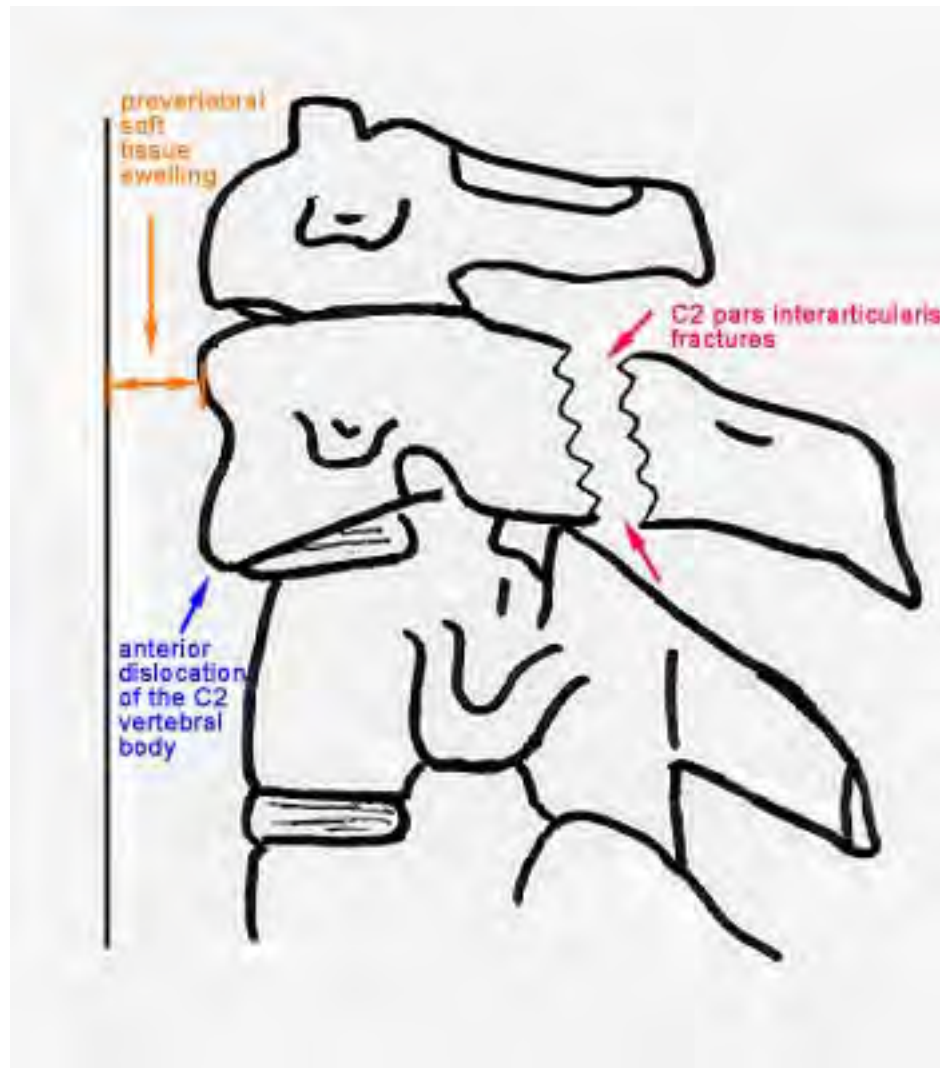


# Hangman's # (unstable)

- Fracture through the pars interarticularis of C2 resulting from hyperextension and distraction
- **Mechanism:** hyperextension
- **Radiographic features:** (best seen on lateral view)
  - 1. Prevertebral soft tissue swelling
  - 2. Avulsion of anterior inferior corner of C2 (+ rupture of the anterior longitudinal ligament)
  - 3. Anterior dislocation of the C2 vertebral body
  - 4. Bilateral C2 pars interarticularis fractures



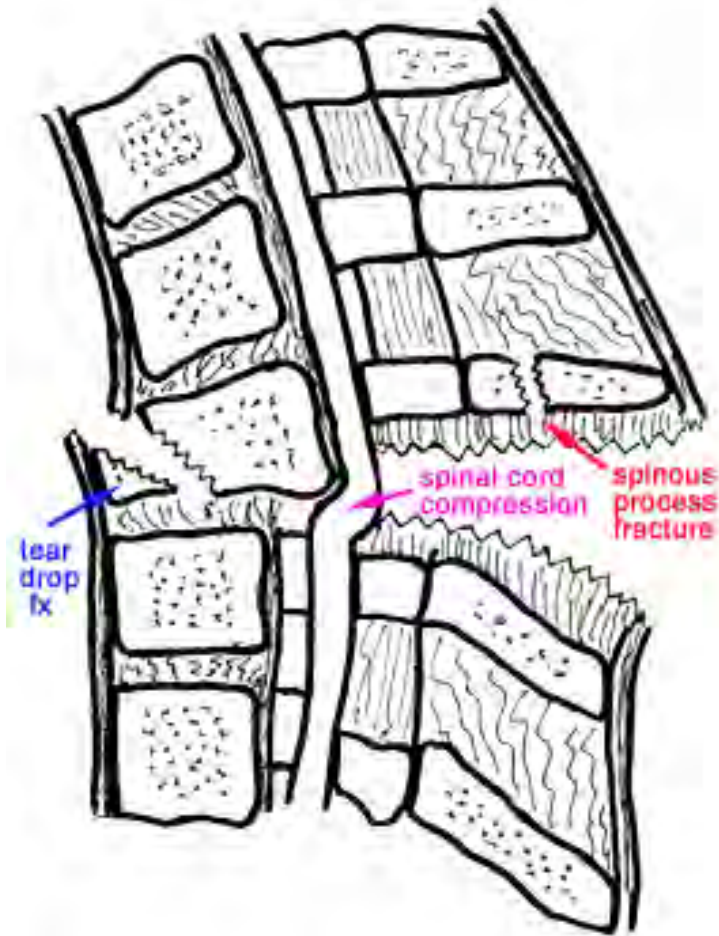
# Hangman's # (2)



# Teardrop # (unstable)

- Post ligament disruption and ant compression # of VB from a severe flexion injury
- **Mechanism:** hyperflexion and compression (eg. diving into shallow water)
- **Radiographic features:** (best seen on lateral view)
  - 1. Prevertebral swelling (+ ant. longitudinal ligament disruption)
  - 2. Teardrop fragment (avulsion fracture) from anterior VB
  - 3. Posterior portion of VB displaced into the spinal canal
  - 4. Spinal cord compression
  - 5. Spinous process #

# Teardrop # (2)



# Facet Joint Dislocation

## Unilateral (stable)

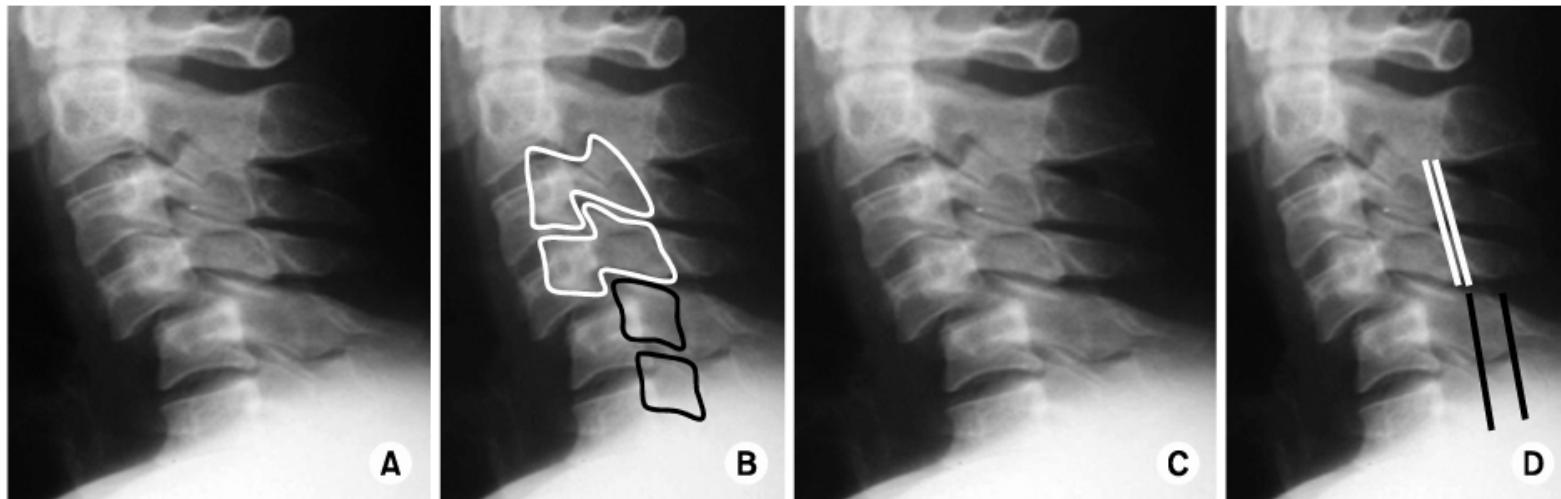
- **Mechanism:** simultaneous flexion and rotation
- **Radiographic features:**
  - 1. Anterior dislocation of affected VB by  $< \frac{1}{2}$  *of the vertebral body AP diameter*
  - 2. Facet within intervertebral foramen on oblique view
  - 3. Widened 'laminar' space
  - 4. "Bow tie" appearance of the overriding locked facets

## Bilateral (unstable)

- Complete anterior dislocation of the VB secondary to extreme hyperflexion
- **High risk** of cord damage
- **Mechanism:** extreme flexion of head and neck
- **Radiographic features:**
  - 1. Complete anterior dislocation of affected VB by  $\frac{1}{2}$  *or more of the vertebral body AP diameter*
  - 2. Disruption of the posterior and anterior ligaments
  - 3. Widened 'laminar' space
  - 4. "Bow tie" appearance of the locked facets

# Unilateral Facet Joint Dislocation

- Bowtie appearance (white outline in image B)
- Widened laminar space



# Bilateral Facet Joint Dislocation

- Anterior displacement of C5 >  $\frac{1}{2}$  width of the VB



# Clay Shoveler's # (stable)

- Spinous process # C6-T1
- **Mechanism:** powerful hyperflexion combined with contraction of paraspinal muscles pulling on spinous processes (e.g. shoveling)
- **Radiographic features:**
  - 1. Spinous process # on lateral view





# Wedge # (stable)

- Compression # resulting from flexion
- **Mechanism:** hyperflexion and compression
- **Radiographic features:**
  - 1. Buckled anterior cortex
  - 2. Loss of height of anterior VB
  - 3. Anterosuperior fracture of VB



# Burst # (stable)

- C3-C7 # from axial loading
- Retropulsion of posterior fragments causing spinal cord compression
- Seen as double cortical line on lateral Xray with loss of posterior VB height
- CT all of these!



# C-Spine Clearance in Comatose Patient

- CT C-spine
- CT not enough to exclude significant injury
- Options include:
  - Clinical assessment if likely to wake within 48 hours
  - MRI scan
  - Flexion-extension views under dynamic fluoroscopy
- Early consult with neurosurgery

# Internet Images

- <http://synapse.koreamed.org/DOIx.php?id=10.12671/jkfs.2011.24.1.100&vmode=PUBREADER>
- <http://radiopaedia.org/articles/clay-shoveler-fracture-2>
- <http://www.msdlatinamerica.com/ebooks/RadiologyReviewManual/sid401030.html>
- <http://www.med-ed.virginia.edu/courses/rad/cspine/index.html>

# Additional References

## ***ACEM Diagnostic Imaging Guideline, Dec 2013***

*Available from:*

<https://www.acem.org.au/Standards-Publications/Policies-Guidelines.aspx>

Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker MI. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. National Emergency X-Radiography Utilization Study Group. N Engl J Med. 2000 Jul 13;343(2):94-9.

Stiell IG, Clement CM, McKnight RD, Brison R, Schull MJ, Rowe BH, Worthington JR et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. N Engl J Med. 2003 Dec 25;349(26):2510-8.