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

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)

*Figure 1. The Canadian C-Spine Rule.*
For patients with trauma who are alert (as indicated by a score of 15 on the Glasgow Coma Scale) and in stable condition and in whom cervical-spine injury is a concern, the determination of risk factors guides the use of cervical-spine radiography. A dangerous mechanism is considered to be a fall from an elevation ≥3 ft or 5 stairs; an axial load to the head (e.g., diving); a motor vehicle collision at high speed (≥100 km/hr) or with rollover or ejection; a collision involving a motorized recreational vehicle; or a bicycle collision. A simple rear-end motor vehicle collision excludes being pushed into oncoming traffic, being hit by a bus or a large truck, a rollover, and being hit by a high-speed vehicle.
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
‘AABCDS’ of C spine Interpretation
Atlas
Axis
Articulation

Atlas (C1)

Dens

Axis (C2)
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)
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 < ½ 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 > ½ width of the VB
Clay Shoveler’s # (stable)

- Spinous process # C6-T1

- **Mechanism:** powerful hyperflexion combined with contraction of paraspinous 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

Additional References

ACEM Diagnostic Imaging Guideline, Dec 2013

Available from:
