Cervical Spine Trauma

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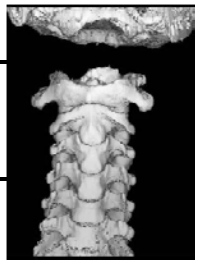


Trauma Cx Spine Protocols

- Issues
  - The clinically negative Cx-spine
  - Does everyone need a CT
  - Acute Flex/Ext in alert patients with a painful neck, negative x-rays
  - Supine Flex/Ext
  - Fluoro Flex/Ext in obtunded patients

Who to Image

- CCR and Nexus
  - CCR more sensitive and specific
  - CCR criteria more complicated

Canadian C spine rule - CCR
National Emergency X-Radiographic Utilization Study - NEXUS

Who to Image

- NEXUS
  - Fulfill all criteria
    - No tenderness at the posterior Cx spine midline
    - No focal neurological deficit
    - Normal level of alertness
    - No evidence of intoxication
    - No painful injury that might distract from CSI
  - No radiography

Canadian C spine rule - CCR
National Emergency X-Radiographic Utilization Study - NEXUS

Who to Image

- CCR
  - Different approach
  - Identifies those who should always be imaged
  - Those at low risk who can have ROM tested
  - 45 degrees rotation each way - no X-ray

Canadian C spine rule - CCR
National Emergency X-Radiographic Utilization Study - NEXUS

Who to Image

- CCR
  - High risk
    - >= 65years
    - Mechanism
      - Fall >1m
      - Axial load to head
      - MVA > 100Km/hr, rollover, ejection, ATV, Bike collision
    - Parasthesia in extremities

Canadian C spine rule - CCR
National Emergency X-Radiographic Utilization Study - NEXUS

Who to Image

- CCR
  - Can assess ROM
  - No high risk
    - Simple rear end MVA
    - Sitting in ED
    - Ambulatory since accident
    - Delayed onset of neck pain
    - Absence of midline Cx spine tenderness

Canadian C spine rule - CCR

National Emergency X-Radiographic Utilization Study - NEXUS

How to Image

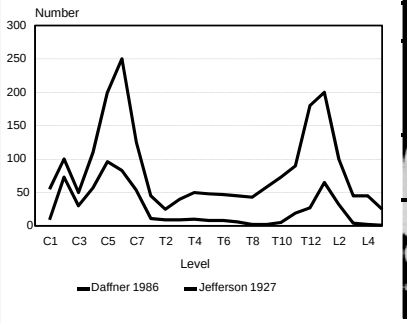
- Alert, but tender
  - 3 view Cx spine
    - +/- Swimmers, Fuchs, Trauma obliques
- 39% of Cx spine injuries not seen on plain films - NEXUS
- Head injury – having head CT
  - CT Cx
    - 1.25mm cuts (or less) base of skull to T1
    - Minimal reconstructions prior to reformats
    - Bone and ST algorithms
    - Reformats in sagittal and coronal planes

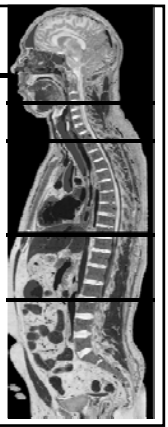
Top 10 Missed Fractures

- 1. Base of skull
- 2. Odontoid process
- 3. Zygomatic arch and orbit
- 4. C7 Fracture dislocation
- 5. Posterior dislocation of humerus
- 6. Scaphoid, lunate and perilunar dislocation
- 7. Sacroiliac fractures
- 8. Undisplaced neck of femur
- 9. Dislocated hip with ipsilateral femoral fracture
- 10. Tibial plateau fractures

Fulde GWO (1994) Emergency Medicine

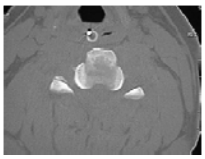
Spinal trauma





Technique - CT

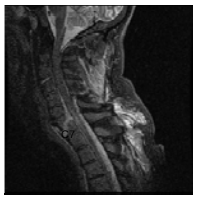
- Excellent visualization of fractures
- Must be optimized
  - Thin slices 1 - 1.25 - 2mm
  - Bone and soft tissue algorithm / window
  - Orthogonal planes
    - Thin recons
  - Use workstation
  - 3D for alignment



Bifacet Dislocation

Technique - MRI

- Poor visualization of fractures
- Good for soft tissue injury
- Good for spinal cord injury assessment
- Good for spinal cord injury prognosis
- Good for root avulsion



Ankylosing spondylitis fracture

Flexion Extension - Supine

- All radiographic texts describe obtaining F/E views with the patient standing or sitting.
- There are no articles on obtaining flexion extension views in a supine patient.

Obtunded Flexion – Extension Dangers

- Causing paraplegia/quadraplegia
  - Can only see part of Cx spine
  - Could be causing a disc herniation
- Rise in ICP
  - I have seen rise to over 80 mmHg
- Rise in BP
  - I have seen rise to over 200 systolic

Obtunded Flexion - Extension

- I cannot find any reference to dynamic passive flexion/extension studies finding an unstable ligamentous injury, without fracture, that needed to be surgically fixed.

Unconscious Patient

- In persons with decreased mental status, flexion/extension views in experienced hands can probably exclude instability in adults. This can be done at the bedside even in ITU. However, this method does not exclude significant soft tissue or spinal cord injuries, and manipulation and mobilization can cause secondary spinal cord trauma. On this basis the practice is not recommended.

Imaging of acute cervical spine injuries: review and outlook
B.J. Tins and V.N. Cassar-Pullicino, Clinical Radiology Volume 59, Issue 10 , October 2004, 865-880

Cx-Spine - Stability

- Instability is a function of ligamentous injury, or fracture pattern
- Can be inferred from radiographs for certain fracture patterns
- Not 100% accurate
  - Eg. Delayed flexion subluxation

Cx-Spine Stability

An unstable injury, is one which can progress and cause cord injury.

Flexion	Anterior Subluxation	Stable
	Unilateral facet dislocation	Stable
	Bilateral facet dislocation	Unstable
	Wedge compression fracture	Stable
	Flexion teardrop fracture	Unstable
	Clay-shoveler's fracture	Stable
Extension	Posterior arch C1 fracture	Stable
	Hangman's fracture	Unstable
	Laminar fracture	Stable
	Pillar fracture	Stable
	Extension teardrop fracture	Stable
	Hyperextension dislocation fracture	Unstable
Compression	Jefferson fracture	Unstable
	Burst fracture	Stable
Complex	Odontoid fractures	Unstable
	Atlantooccipital disassociation	Unstable

Cx-Spine - Stability

- MRI
  - Shows
    - Edema of soft tissues
    - Paravertebral hematoma
    - Ligamentous disruption
  - Still does not indicate instability
  - Negative study does not indicate stability

Cx-Spine - Stability

- Flexion Extension views
  - Patient should be erect
  - Should wait 2w for spasm to resolve
  - Must see to T1
  - Must move > 30 degrees

Cx-Spine
Signs of Instability F/E

- Subluxation greater than 3.5mm
- Angular deformity of more than 11 deg.
- Compression fx more than 25% loss of height
- Narrowing of the disk space.
- Widening of the interspinous distance 1.5X
- Facet joint widening

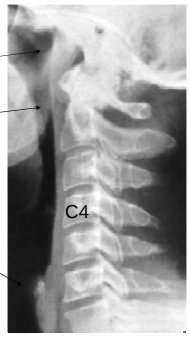
Reading Algorithm

- Soft tissues first, so you don't forget
- Bony alignment
- Facet joint alignment
- Look at common sites of fractures
- Find the second fracture
- Fluid levels
- Ribs, skull, clavicles etc
- Lines and tubes

Reading Algorithm
Soft Tissues

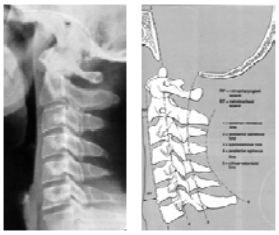
Maximum Allowable Thickness

- Nasopharyngeal space (C1) - 10 mm (adult)
- Retropharyngeal space (C2 - C4) - 5-7 mm
- Retrotracheal space (C5 - C7)
  - 14 mm (children)
  - 22 mm (adults)



Reading Algorithm – Bony alignment
Life Lines

1. Anterior vertebral body line
2. Posterior vertebral body line
3. Spinolamina line
4. Posterior spinous process line



Evaluate C1-C2 Area
Adults: <3mm
Child: <5mm

Greenspan

Reading Algorithm – Bony alignment

Pseudo (physiologic) Subluxation

- In children
- Ligament laxity
- Check Posterior Spinal (cervical) Line
- More than 2-3mm offset (C2 SLL anterior to PSL) must be considered traumatic.

Normal spine C2-3 13F

Reading Algorithm – Bony alignment

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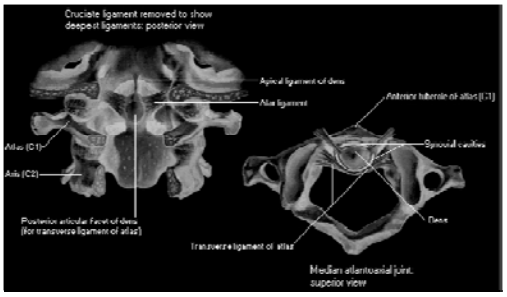
Normal spine C2-3 13F

CranioAtlas Assimilation

- Occipitalization of the atlas
- 0.75% of population
- Usually asymptomatic
- Usually anterior arch fusion
- 50% have C2-3 fusion
- Associated anterior atlantoaxial subluxation
- Associated middle ear anomalies
- Associated Chiari 1

Craniocervical Ligaments



Netter

Atlanto Occipital Dislocation

- 40% missed dx at presentation
- STS +/- Retropharyngeal air
- Avulsion fractures occipital condyle or lower tip of clivus
- Classification:

Normal I II III

Atlanto Occipital Dislocation

Causes:

- Traumatic
- Nontraumatic
  - RA
  - Congenital Skeletal Abnormalities
  - Down's
  - Infection
  - CPPD
- Prognosis not good
  - (but 20% may have no deficit!)

Atlantooccipital subluxation

- Powers ratio:
  - Basion to C1 Posterior lamina line / Opisthion to posterior cortex of the anterior C1 tubercle <1
- X method of Lee
- Clival line
- BAI (Basion Axial Interval)
  - Anterior distance of basion from PSL -4 – +12 mm
- BDI (Basion Dental Interval)
  - Vertical distance of basion above dens <12 mm

Jefferson Fracture (Burst Fracture of C1)

- Compression to vertex
- Diving injury
- Rx. Halo for 3m

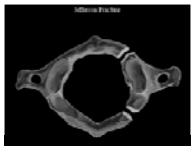
Jefferson Fracture (Burst Fracture of C1)

- Radiographic findings
  - AP open mouth is key
  - C1 lateral masses laterally displaced
  - >2mm bilaterally always abnormal
  - 1-2mm unilaterally may be head tilt

Jefferson Fracture (Burst Fracture of C1)

Vertical Compression – Unstable

1. Unilateral or Bilat FX's of both ant and post arches of C1
2. Displacement of lateral masses.
3. CT required for defining full extent of fracture and detecting fragments in spinal cord/canal
4. Treatment: Halo placement for 3 months



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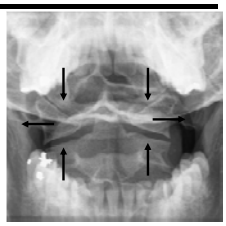


Normal

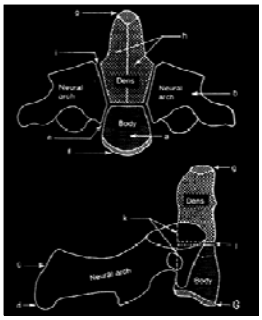
Direction of forces

Isolated Fracture posterior ring of C1

- Hyperextension injury
- Stable

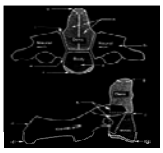
Embryology (C2)

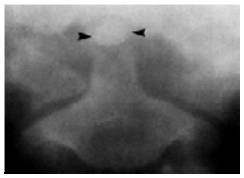
- C2 multiple ossification centers
- Body ossified at birth
- Fuse posteriorly by 2nd/3rd yr
- Unite with body by 7yr.



Embryology (Dens)

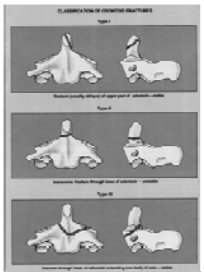
- Dens:
- 2 vertical ossification centers
- Fuse by 7th fetal month
- Os terminale unites by age 11-12
- Cleft dens tip





9M

Dens Fractures



TYPE 1 - Avulsion fx of the tip.
Considered Stable

TYPE II - Fx at Base of Dens.
Most Common
Poor blood supply
Unstable

TYPE III - Fx into body of axis
Best Prognosis
Unstable

Greenspan

Anderson and D'Alonzo

Hangee Fracture - Unstable

- Traumatic Spondylolisthesis of the Axis
- Bilateral C2 pars (common) or Pedicle (less common)
- Hyperextension and traction injury of C2
  - MVA (chin to dashboard)
  - Hanging
- The odontoid and its attachments are intact.
- Nerve damage is uncommon owing to the width of the canal at this level.

Hangman's Fracture

Effendi classification

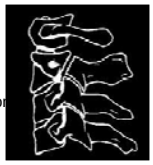
Grade 1:
Extension injury, displacement < 2mm. Rx flexion.

Grade 2:
Extension injury, displacement >2mm and angulation. Rx flexion.

Grade 3:
Flexion injury, C2-3 facet joint subluxation/ dislocation. Rx extension.

Hangman's Fracture

Levin and Edward's



Type 1:
Neural arch fracture,
< 3mm displacement, no angulation

Type 2: A;
+ angulation

Type 2: B;
+ >3mm displacement

Type 3:
+ bilateral facet dislocation C2-3

C3-7

- Fractures
  - Tear drop
    - Flexion
    - Extension
    - Posterior
  - Burst
  - Posterior arch
  - Clayshoveller's Fracture
- Dislocations
  - Unifacet
  - Bifacet
- Fracture Dislocations
  - Unilateral
  - Bilateral
- Floating lateral mass

Wedge Compression Fracture

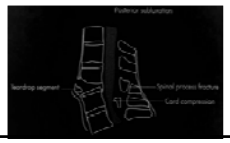
- Usually stable
- Loss of height anterior vertebral body
- Buckled anterior cortex
- Anterosuperior fracture of body
- Differentiate from Burst
  - Lack of vertical fracture component
  - Posterior cortex intact

Flexion Teardrop

- Flexion Fracture Dislocation
- Unstable
- Most severe Cervical spine injury
- Anterior cord syndrome
  - Quadriplegia
  - Loss of anterior column senses
  - Retention of posterior column senses
- Associated with Tx or Lx spine Fx in 10%

Flexion Teardrop

- Teardrop fracture – anteroinferior
- All ligaments and disc disrupted
- Posterior subluxation of vertebral body
- Bilateral subluxated or dislocated facets
- Spinal canal compromise



Extension Teardrop Fracture

- Avulsion fracture of anteroinferior corner of C2>C3>C4

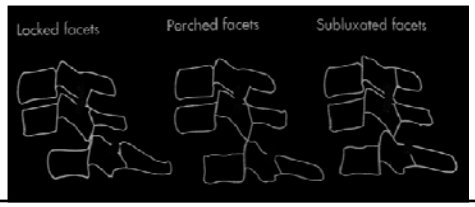
- Radiographic findings
  - Teardrop pulled off by ALL
  - Vertical height of fragment >= width

Burst Fractures

- Same mechanism as Jefferson Fx but located at C3-C7.
- Injury to spinal cord (due to displacement of posterior fragments) is common.
- Requires CT to evaluate.
- Stable

Facet Dislocation - Subluxations

- Anterior subluxation (hyperflexion strain)
  - The Posterior Ligament complex is disrupted. (30-50% can show delayed instability)
- Unilateral facet dislocation (stable)
  - Results from simultaneous flexion and rotation
- Bilateral Facet Dislocation (unstable)
  - Results from extreme flexion of head and neck without axial compression



Unilateral Facet Dislocation

- Simultaneous flexion and rotation
- Best seen on lateral and oblique views
- Vertebral body subluxation < ½ of AP width
- Disrupted "shingles on a roof" on oblique view
- Facet within foramen on oblique view
- Disrupted posterior ligaments
- Disrupted SP line on AP
- Butterfly appears

Bifacet Dislocation

- Extreme flexion without compression
- Unstable
- Vertebral body anterolisthesis > ½ AP body
- Batwing or bowtie appearance of adjacent facets
- Wide SP on AP view
- Disrupted ALL, disc and posterior ligaments

Unifacet Fracture Dislocation

- More common than pure dislocation
- Signs as before + fracture
- Fracture of facet often not seen on radiographs

Bifacet Fracture Dislocation

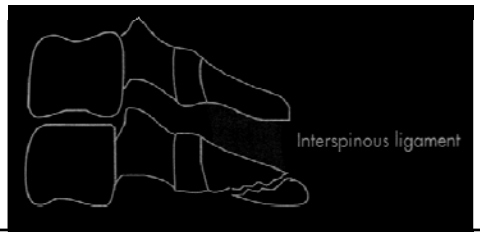
- Higher energy than bifacet dislocation
- MVA

Clay Shoveler's Fracture

- Oblique avulsion fx of spinous process
- C7 > C6 > T1 levels
- Due to powerful hyperflexion

Clay Shoveler's Fracture

- Best seen on lateral view
- Double spinous process on AP

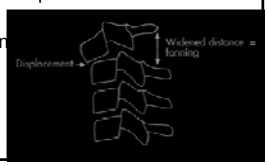


Anterior Subluxation

- Hyperflexion sprain
- Posterior ligament complex disrupted
- 20-50% show delayed instability

Anterior Subluxation

- Radiographic findings
  - Localized kyphotic angle
  - Fanning
    - Widened interspinous/interlaminar distance
  - Posterior widening of disc space
  - Subluxation of facet join
  - Anterior subluxation



Follow up studies

- Look for occult fractures
- Check fixation
- Check for progressive flexion subluxation

PEARLS

- One view is no view.
- 20% of spinal fractures are multiple
- 5% of spinal fractures are at discontinuous levels
- Most spinal fractures occur in upper (C1-C2) or lower (C5-C7) regions

PEARLS (Cont)

- Spinal cord injury occurs
  - –At time of trauma 84%
  - –As a late complication 15%
- Any signs/symptoms of cord injury require MRI.
- Get CT in patients with unexplained prevertebral soft tissue swelling.