Radiographic evaluation of the Spine

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Objectives of Radiographic Examinations

• Adjunct to history and physical examination in process of establishing diagnosis of spine injury.

• Ascertain as definitively as possible whether there is a Spine injury

• Define fully the nature of the Spine injury
Radiographic Examination
Radiographic Exam

• Systematic Approach

- Steps

1. Injury
2. Listen
3. Touch
4. Think
5. Obtain Imaging Studies
6. Interpretation and Synthesis
7. Correct Diagnosis
8. Best Treatment
Radiographic Exam

Systematic Approach

• If a Step is missed
Challenges of Radiographic Examination

• Extremely sensitive but relatively non specific

• Reveal abnormalities in 1/3 of asymptomatic patients

• Differentiating between abnormalities with clinical implications and effects of ageing or healing
Radiographic Examination

• Studies that are routine- Lateral C-Spine (Part of Trauma Series)

• Or Equivalent (CT Scan with Sagittal recon)

Cervical spine imaging in patients with blunt trauma
Blackmore CC, Emerson SS et al, 1999
Radiographic Examination

• If 1 Spine injury is detected

• Do complete C, T, L and S of the Spine

10-20% non contiguous injury

Radiographic examination

• Presence of facial trauma - C-Spine radiographs
• Presence of face or neck abrasions from seat belts - C-Spine radiographs
• Presence of lap belt contusion - T-L Spine radiographs
• Presence of calcaneal fractures - T-L/ L-Spine radiographs
Cervical Spine

Spine Examination
Injury Detection: Cervical Spine

• Systematic

• Upper Cervical

• Lower Cervical

• Start with PLAIN LATERAL FILM

  85% of injuries

Initial radiographic evaluation of the spine after trauma, France John CM, Bono Christopher et al, 2005
Occipital Cervical junction injuries

• Dislocations and Dissociation

• Associated major trauma

• Injury Detection is a challenge leading to missed diagnosis

• CT scan is best option for these injuries.
Detecting O-C Junction injuries

• Harris Lines
  • Basiondental Interval (BDI)
    • Distance from basion to the tip of the dens
  • Basionposterior Axial Line Interval (BAI)
    • Distance from the basion to a line drawn on the posterior aspect of C2

• Harris Rule of 12
  • Both of these lines should be less than 12 mm
Detecting O-C Junction injuries

• Power’s Ratio
  • Describes relationship between occiput and C1
  • Line drawn from
    • Basion to Posterior Aspects of the C1 Arch (BC)
    • Opisthion to Anterior Arch of C1 (OA)
  • Ratio of these lines should be less than 1 in normal patients
    • BC/OA < 1
Upper Cervical Instability

- Widened ADI
- Atlanto-dens Interval (ADI)
  - Horizontal distance between posterior border of anterior arch of C1 and the anterior border of the Dens
  - > 3.5 mm indicative of instability
- Posterior atlanto-dens interval (PADI)
  - Horizontal distance between posterior border of dens and the anterior border of the posterior arch of C1
  - Commonly evaluated as Space Available for the Cord
    - The AP diameter of the canal at this level
Upper Cervical: Open Mouth View: C1-C2

Normal C1-C2
Measuring Lateral Mass Overhang
CT scan - C- spine

C1-C2 (Odontoid fracture)

Defines the nature of spine injury better

Aids decision on management

C-arm Image post fixation
Cervical Spine: Lateral X-ray

Check the lines and soft tissues

- Anterior VB line
- Posterior VB line
- Spinolaminar line
- Posterior spinous line
Lower C-Spine detection

- Spinous process gapping
- Facet joint apposition
- Intervertebral gaping
- Angulation
- Translation
Lower C-Spine detection

• Spinous process gapping
Lower C-Spine detection

• Facet Joint Apposition
  • Normal facets should have overlap (green)
  • Subluxed or Dislocated facets no longer show this overlap (red)
Lower C-Spine detection

• Inter-vertebral gapping
Lower C-spine detection

• Vertebral Angulation
Lower C-Spine detection

- Vertebral translation
Subtle signs of injury

• No obvious fracture/dislocation
• Check retrophangeal or prevertebral soft tissue swelling

Presence: --> + injury
Absence: may not rule out injury
Soft tissue swelling

Using:

• 6mm at C3 ---> 59% Sensitivity

• 22mm at C6 ---> 5% Sensitivity

Doesn’t mean much if not there

DeBehn and Havel, 1994
C-Spine: Anteroposterior view

• Spinous process deviation
• Lateral translation
• Coronal deformity
Cervicothoracic junction

- Complete lateral (Upper part of T1)
- Swimmers view
- CT Scan is better for transition zones
CT Scan as Screening Modality

- CT with sagittal recon
- Most sensitive for fracture detection
- Especially transition zones (C0-C1 and C7-T1)
- Difficult with X-rays
- Vascular injury

Michael Utz, Shadab Khan et al, Insights Imaging, 2014
MRI- best soft tissue definition

- Negative plain Films
- Negative CT Scan
- But Clinically Suspicious
- Check for:
  - Continuity of ligaments
  - Edema in soft tissues
  - Cord injury?
Safety: Contra-indications for MRI

Implanted devices that:

• Subject to magnetically induced malfunction

• Potentially harmful movement
MRI- best soft tissues definition

- Clinical suspicion
- Has neural deficit
  - Herniated disc
  - Cord injury
MRI - soft tissue definition

**T1 sequences:**
- Excellent for surveying anatomy and caliber of spinal cord

**T2 images with or without fat saturation:**
- Epidural fluid collection, ligamentous disruption, edema and herniated discs
‘Clearing’ the C-Spine

• Standardized Protocol
• No consensus
Clearing C-Spine

• Avoid missed injuries
• Identify patients without significant injuries
• Delay in diagnosis associated with worse outcome

Levi AD, Hubert RJ et al, Spine 2006
Injury detection- Thoracic and Lumbar Spine

• Same principles

• Landmarks and lines: Lateral View
  ▪ Posterior vertebral body line
  ▪ Anterior vertebral body line
  ▪ Inter-spinous Distance
  ▪ Translation
Injury detection - T and L Spine

AP View:

- Spinous process to pedicles
  - Should be symmetric
- Interpedicular distance
  - May be widened in burst fractures
- Translation
CT Scan: T-L Spine

• More Common as initial study
• Indicated if plain x-ray is suspicious
• Best bony detail
• Request multiple planes and recon
• Axial alone can miss translation
Thoracic and lumbar injuries

• What is normal angulation?
T-L Spine injuries

• Height loss

Adjacent fracture
MRI- Best at soft tissues

- MRI Can be useful to detect injuries to soft tissues, such as the posterior ligamentous complex (PLC)
- Consists of
  - Supraspinous Ligament
  - Interspinous Ligament
  - Ligamentum Flavum
  - Facet Capsule
MRI - best for soft tissues

Assessing PLC using MRI

Continuity of the ligamentum flavum
Summary

• Radiographic imaging serves as an adjunct to history and physical examination in process of diagnosing traumatic spinal injuries
• Radiographic evaluation should be approached in a systematic manner
• The advent of advanced imaging systems has led to improved detection, understanding, and diagnosis of spine trauma ...
• But understanding the principles of these injuries on plain films remains critically important