

# Radiographic evaluation of the Spine

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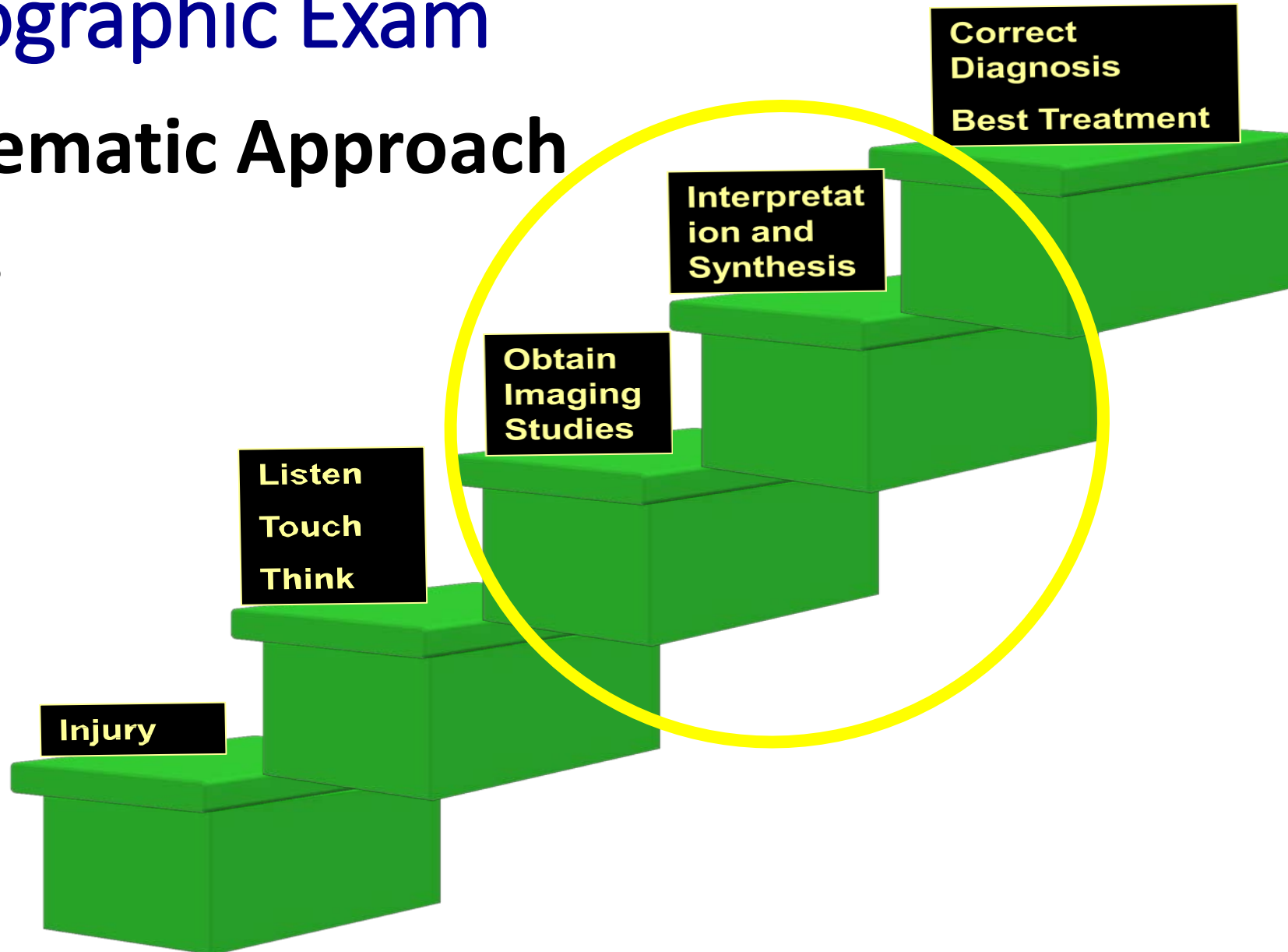
# Objectives of Radiographic Examinations

- **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

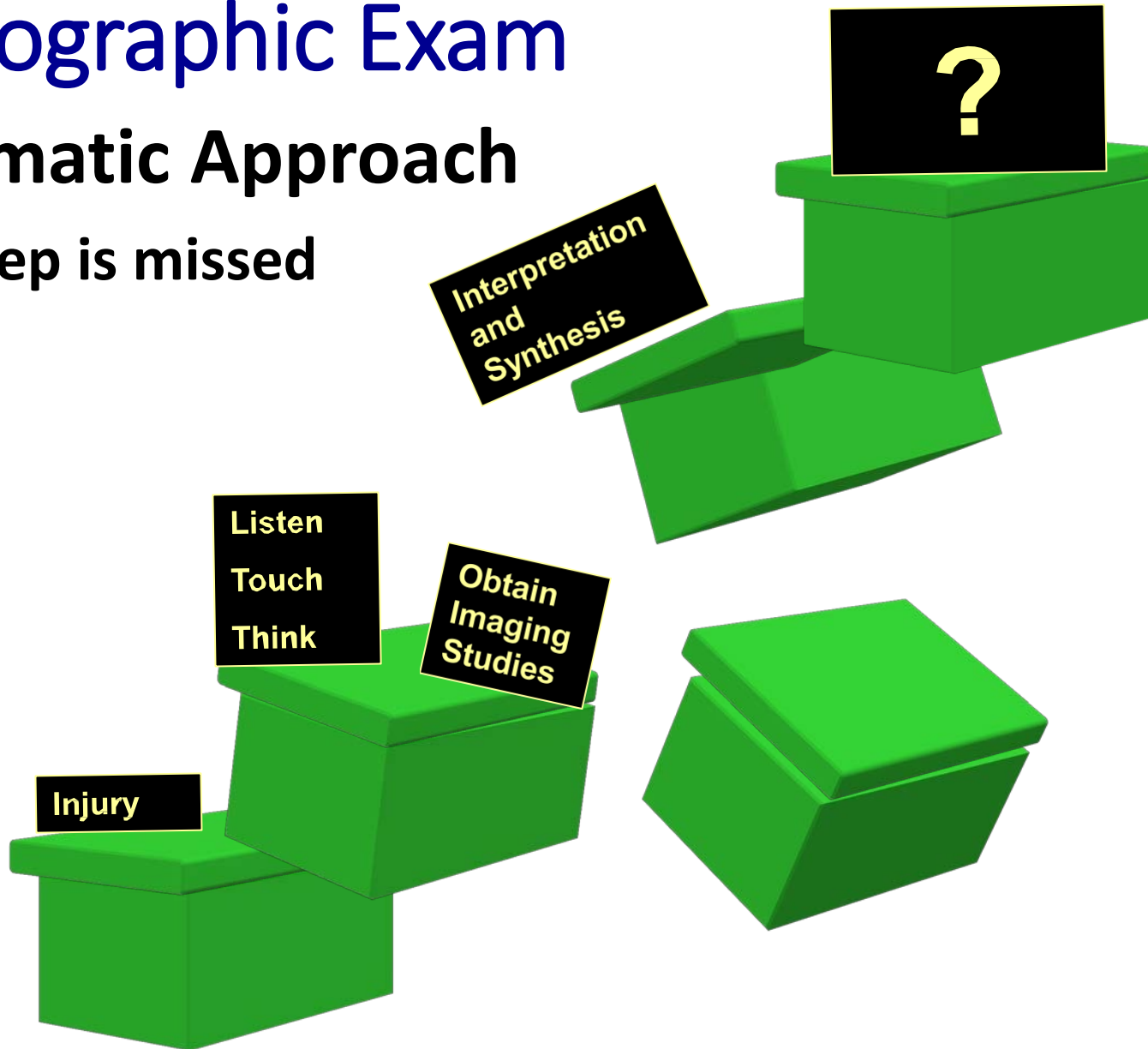
- **Systematic Approach**
- **Steps**



# 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)**



# Radiographic Examination

- **If 1 Spine injury is detected**
  
- **Do complete C, T, L and S of the Spine**

**10-20% non contiguous injury**

*Evaluation of risk of noncontiguous fractures of the spine in blunt trauma.  
Daniel William Nelson et al. J Trauma Acute Care Surg. 2013 Jul.*





# Radiographic examination

- Presence of facial trauma- **C-Spine radiographs**
- Presence of face or neck abrasions from sit 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

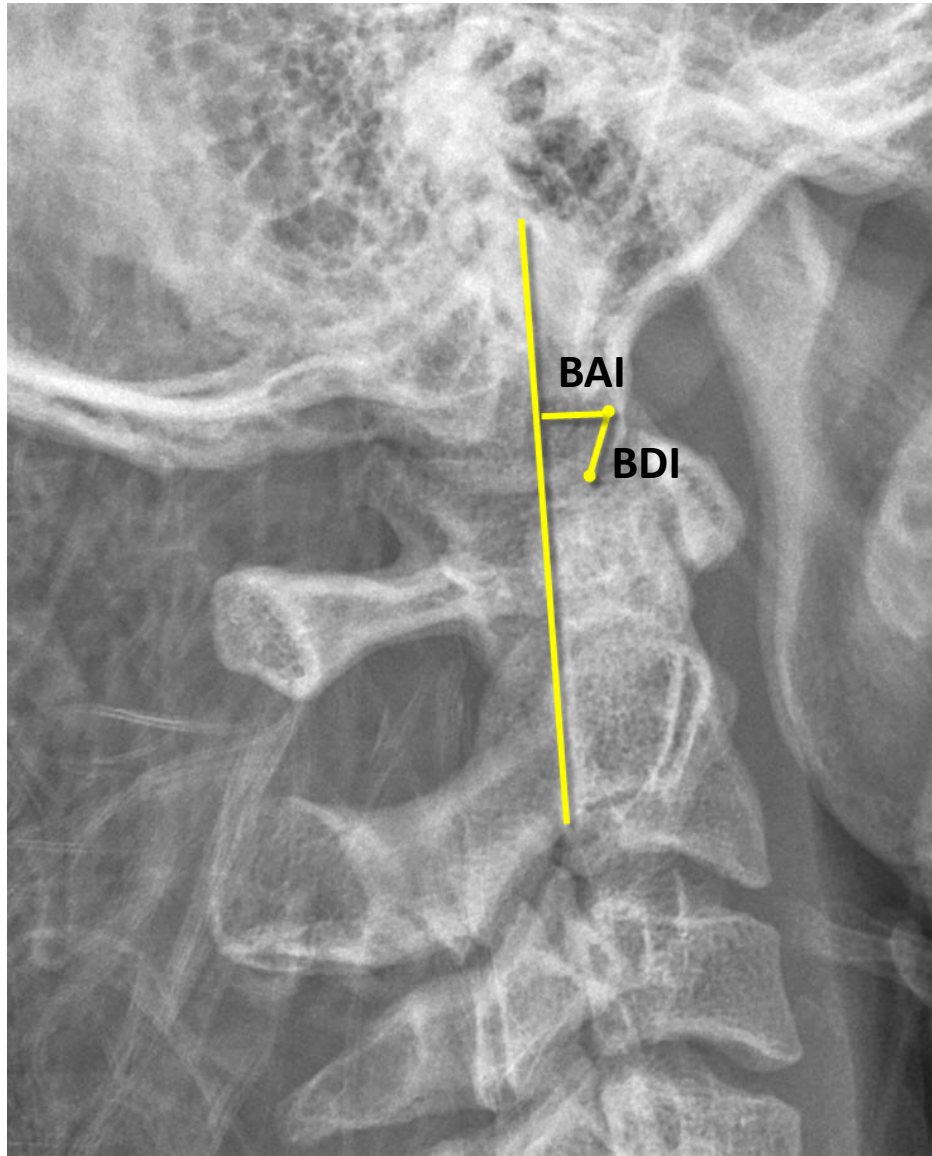
*85% of injuries*



# Occipital Cervical junction injuries

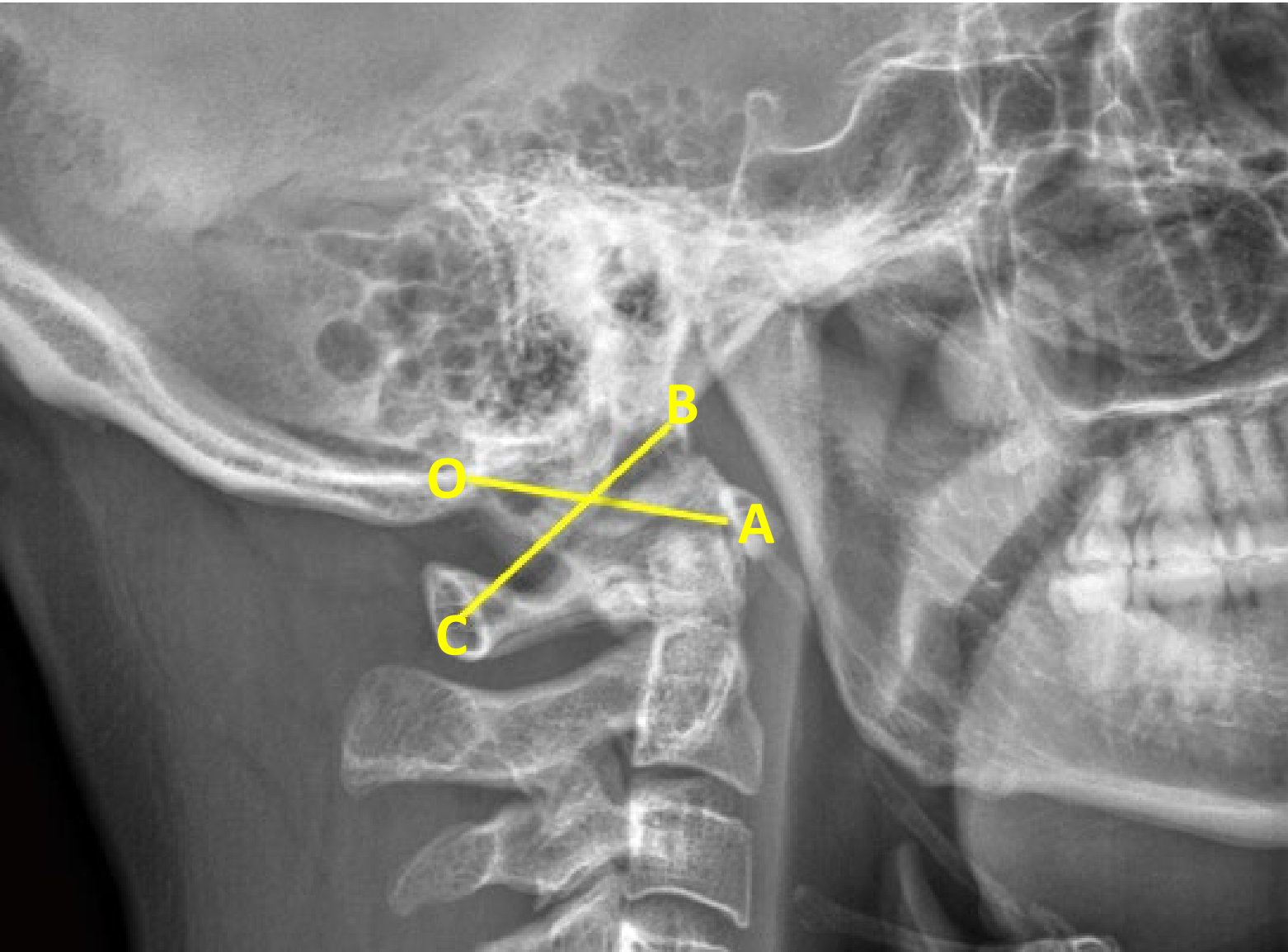
- **Dislocations and Dissociation**
- **Associated major trauma**
- **Injury Detection is a challenge leading to missed diagnosis**
- **CT scan is best option for these injuries.**

# 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

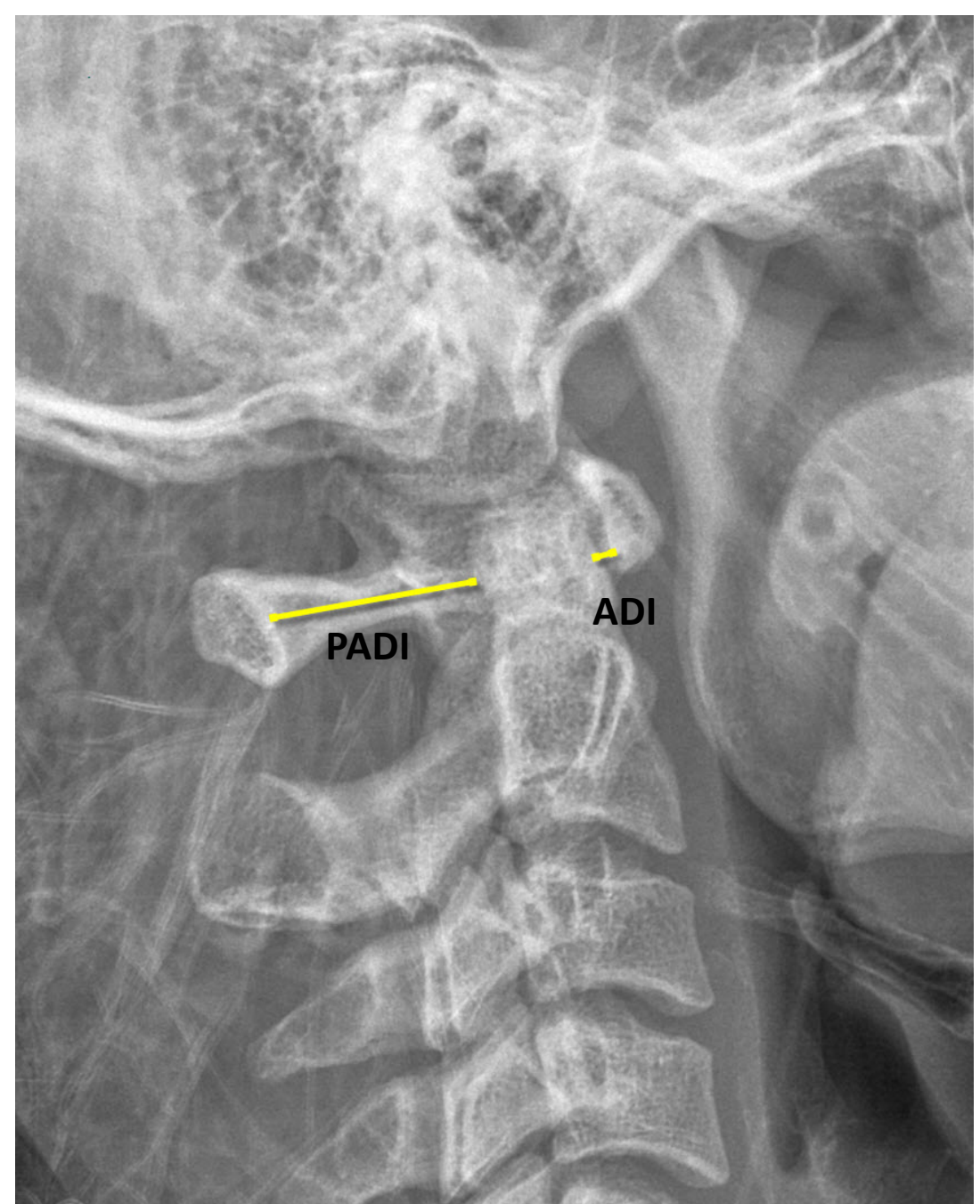
# Detecting O-C Junction injuries



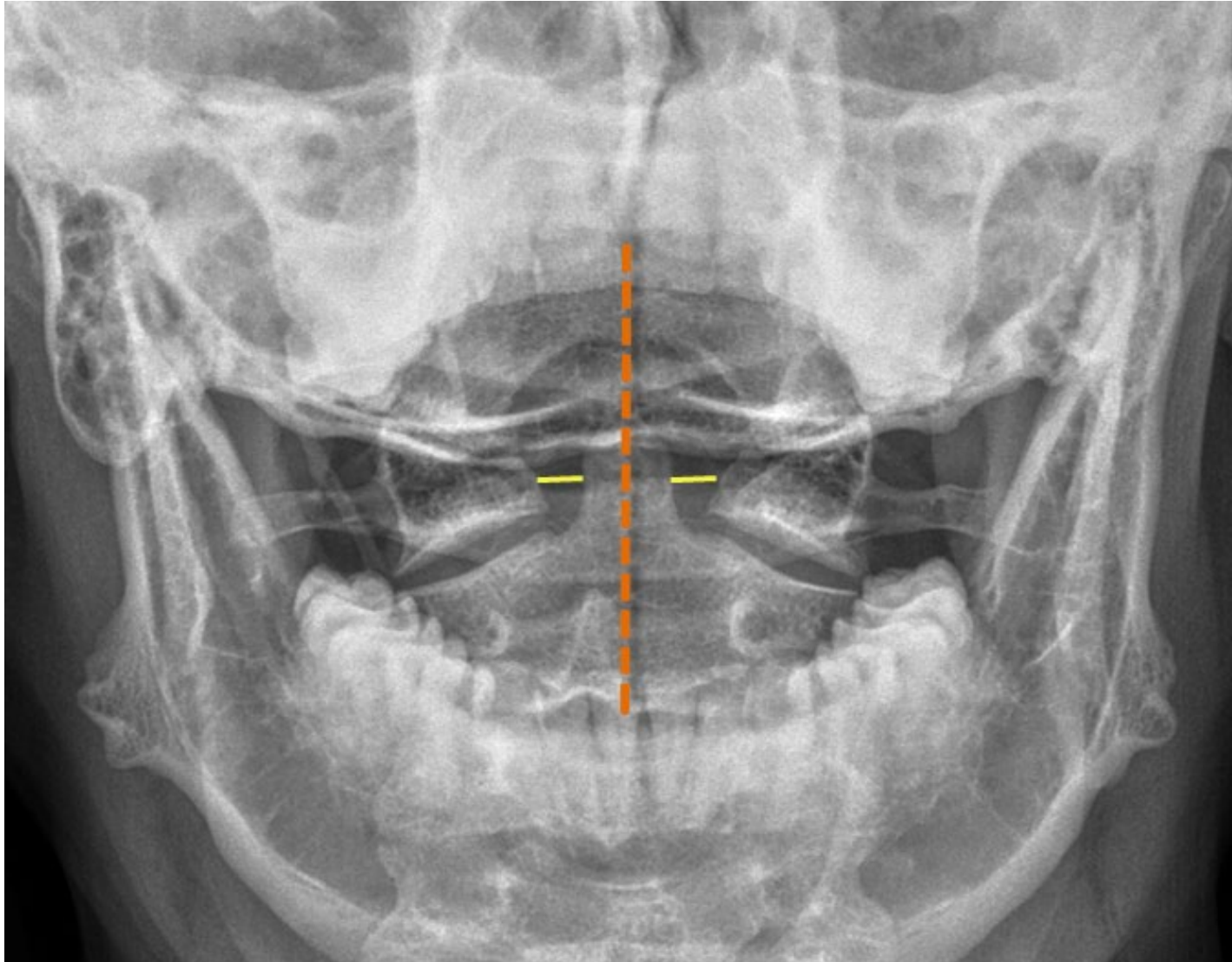
- Power's Ratio
  - Describes relationship between occiput and C1
  - Line drawn from
    - Basion to Posterior Aspects of the C1 Arch (BC)
    - Opisthion to Anterior Arch of C1 (OA)
  - Ratio of these lines should be less than 1 in normal patients
    - $BC/OA < 1$

# 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

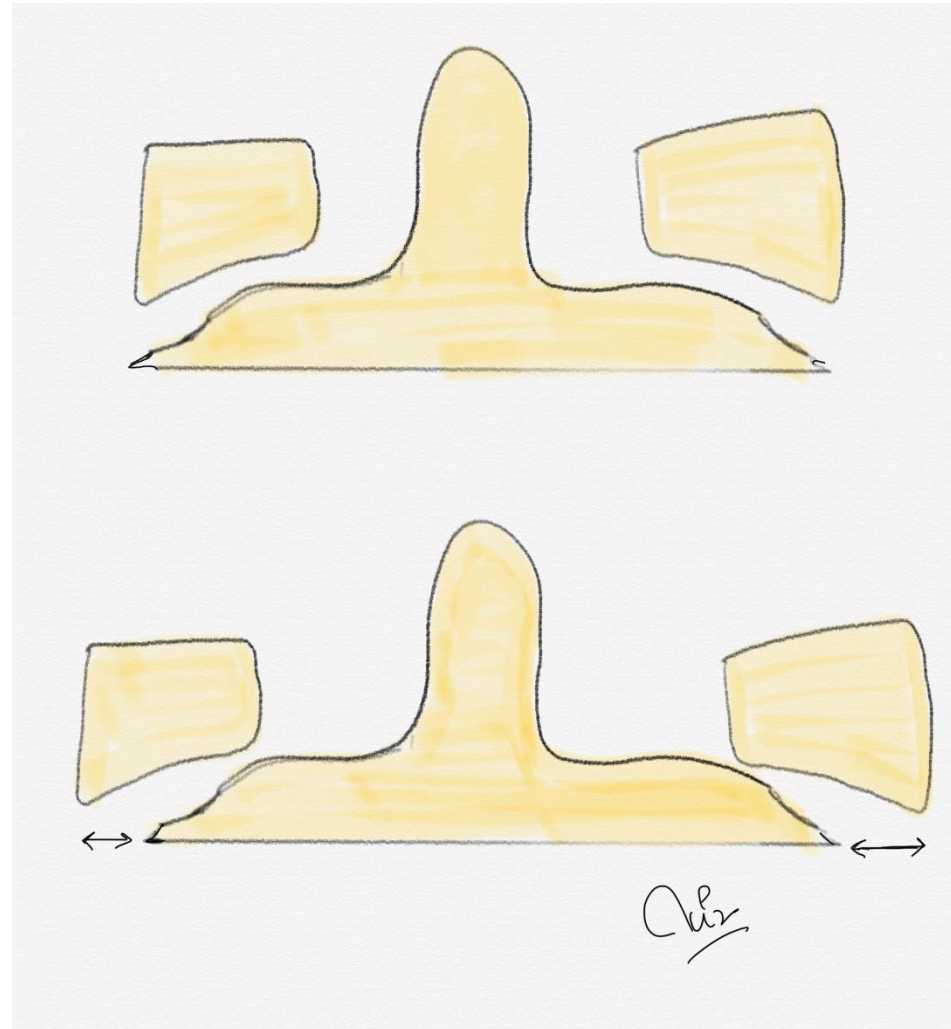


**Normal C1-C2**





# Measuring Lateral Mass Overhang



# CT scan- C- spine

# C1-C2 (Odontoid fracture)



**Defines the nature of spine injury better**

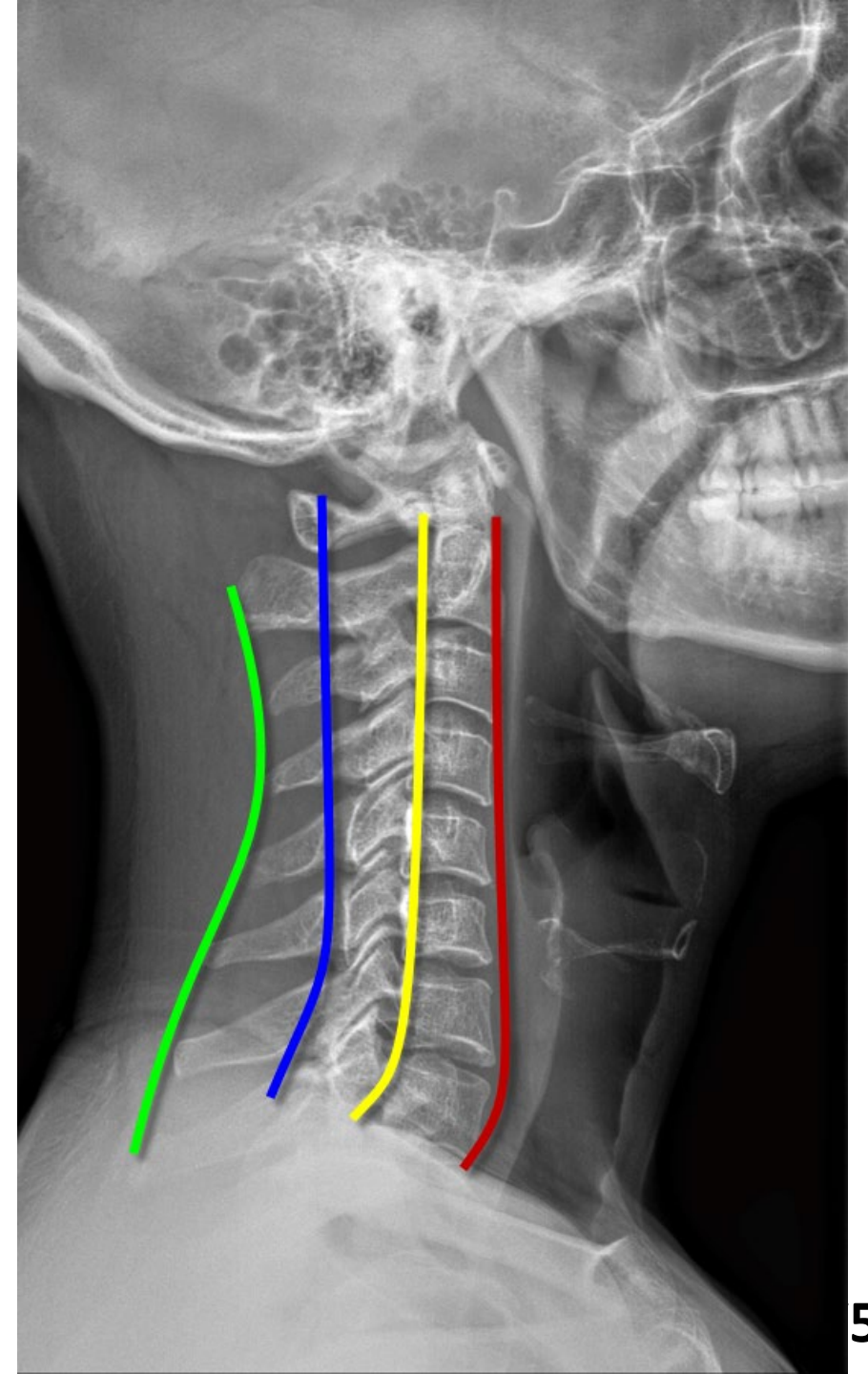
**Aids decision on management**

**C-arm Image post fixation**

# Cervical Spine: Lateral X-ray

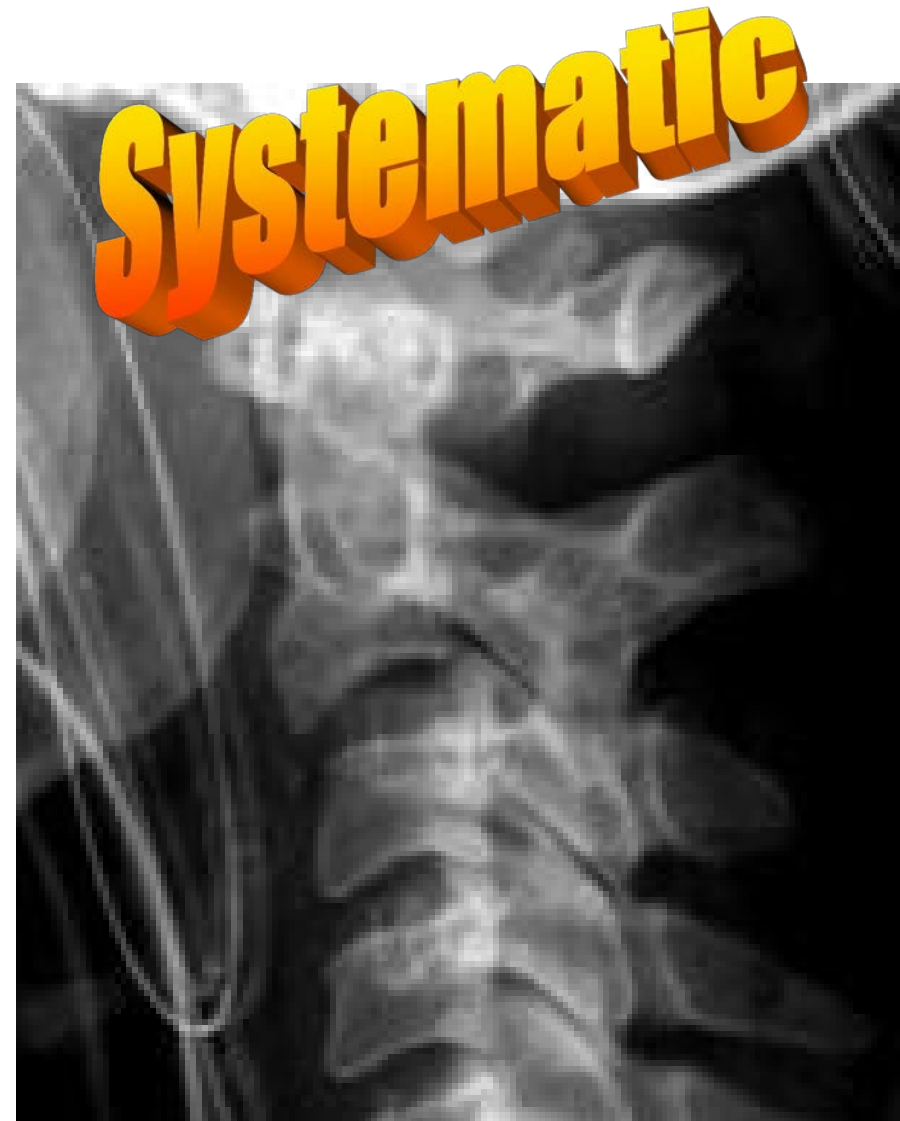
Check the lines and soft tissues

- Anterior VB line
- Posterior VB line
- Spinolaminar line
- Posterior spinous line



# Lower C-Spine detection

- Spinous process gapping
- Facet joint apposition
- Intervertebral gapping
- Angulation
- Translation

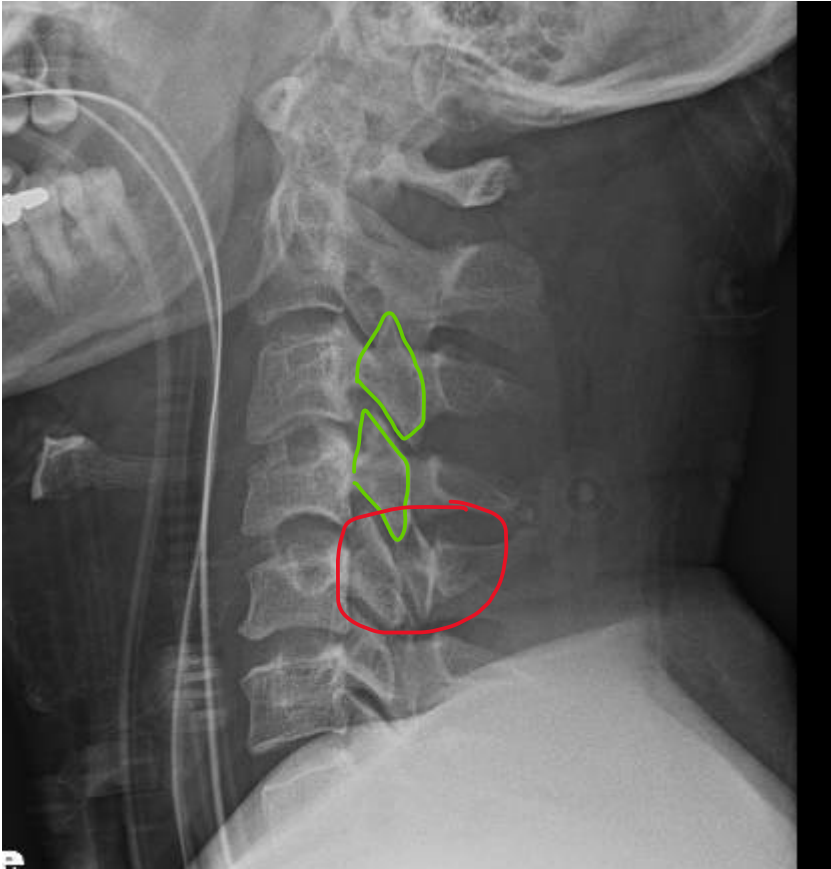


# Lower C-Spine detection

- **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

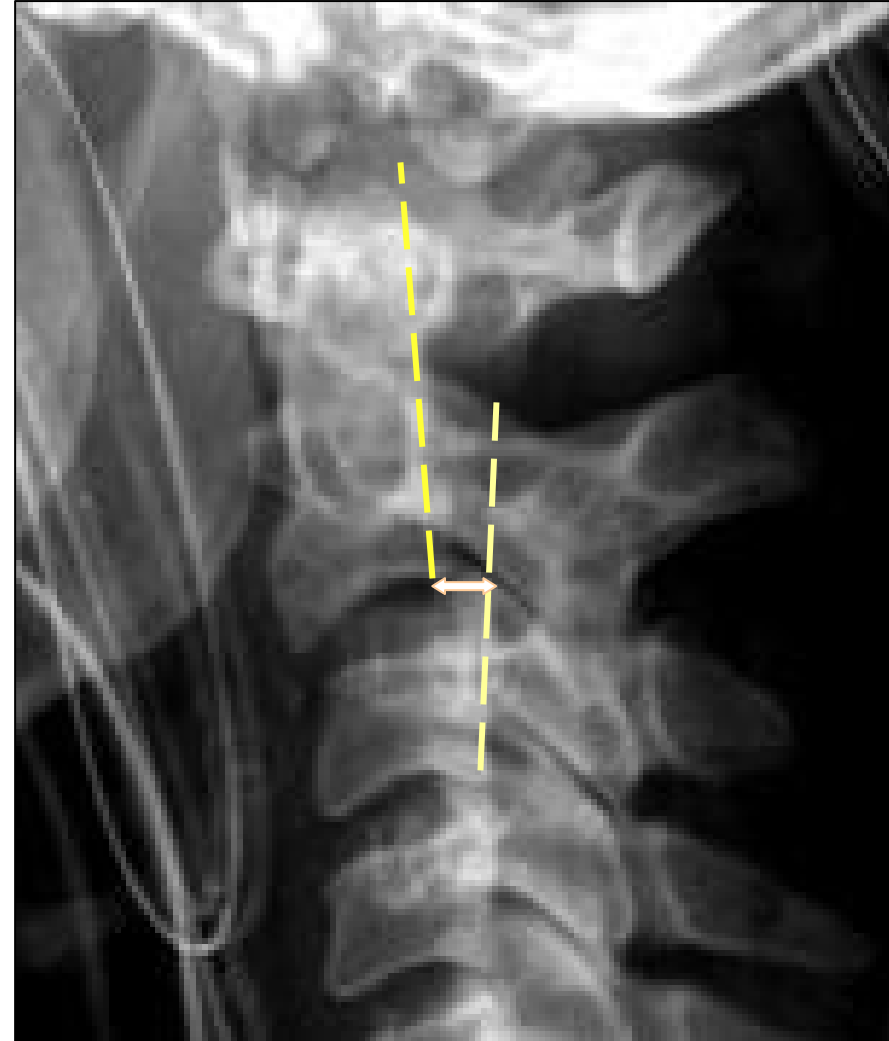
- **Vertebral Angulation**





# Lower C-Spine detection

- **Vertebral translation**

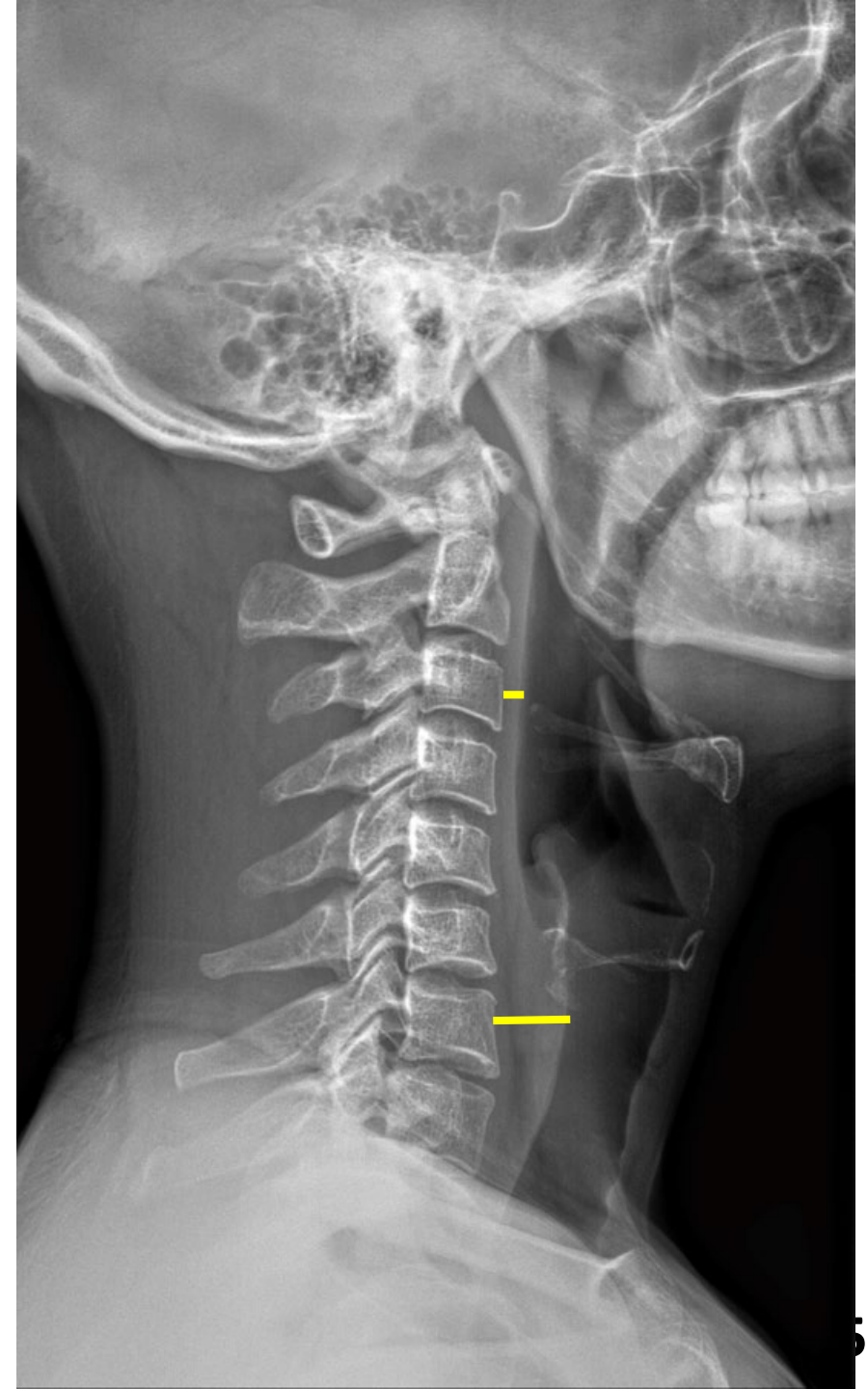


# Subtle signs of injury

- No obvious fracture/ dislocation
- Check retropharyngeal or Prevertebral soft tissue swelling

Presence:--> + injury

Absence: may not rule out injury



# Soft tissue swelling

Using:

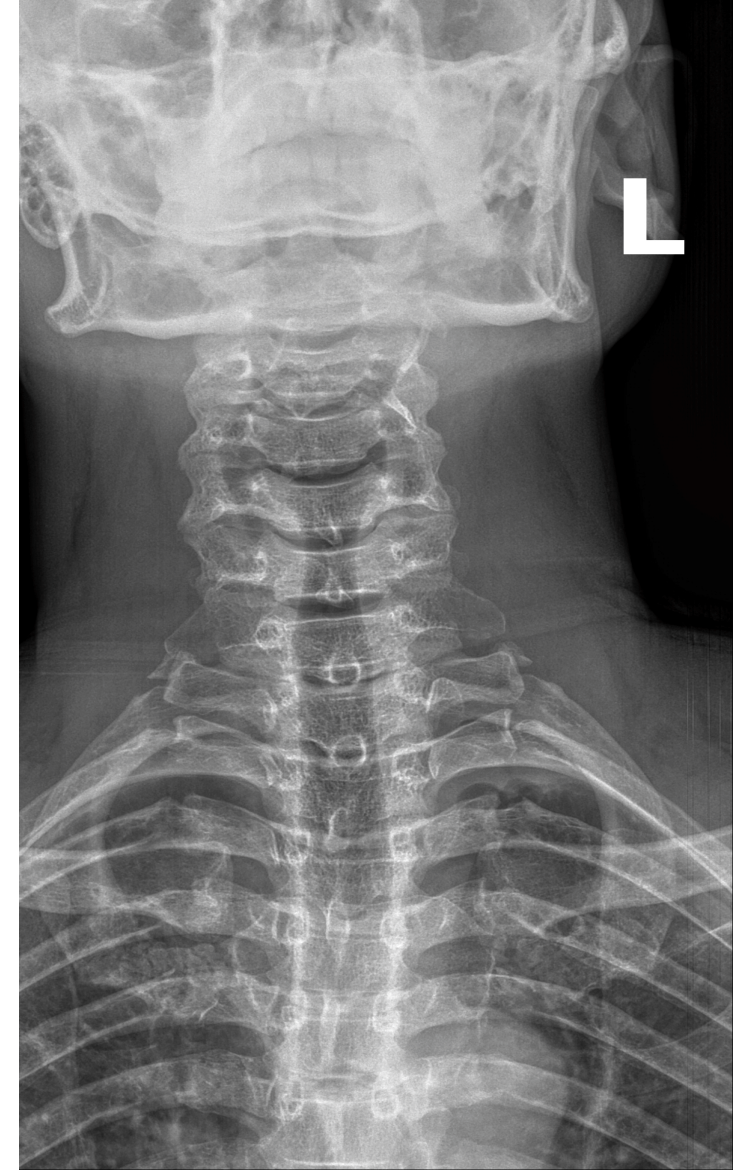
- **6mm at C3 ---> 59% Sensitivity**
- **22mm at C6 ---> 5% Sensitivity**

Doesn't mean much if not there

*DeBehn and Havel, 1994*

# C-Spine: Anteroposterior view

- **Spinous process deviation**
- **Lateral translation**
- **Coronal deformity**



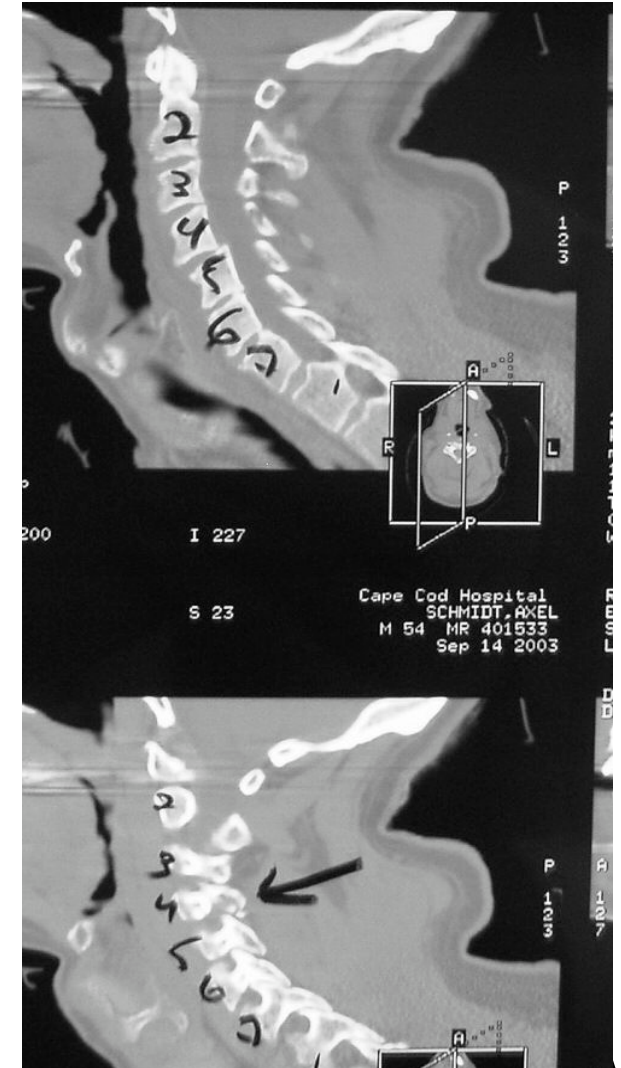
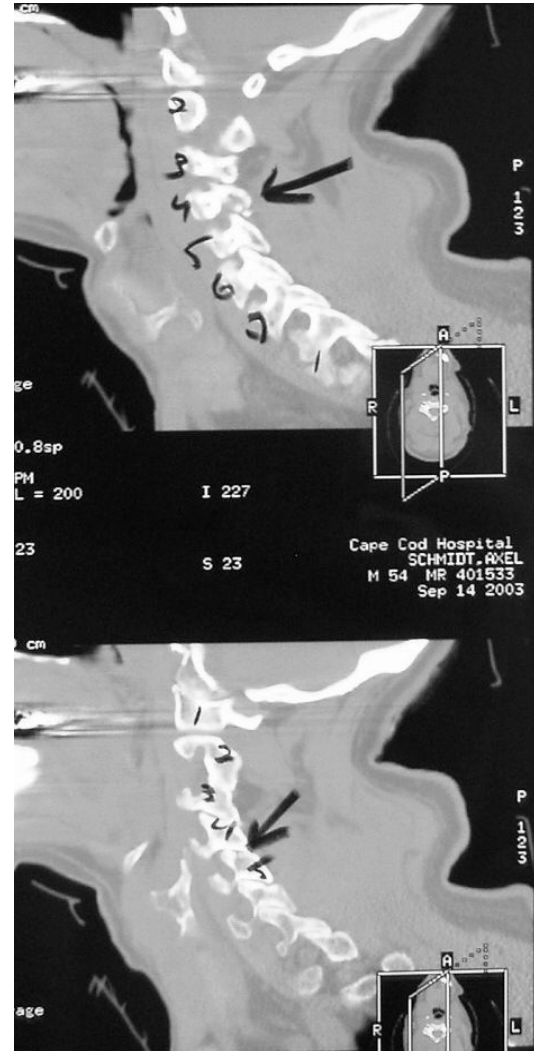
# Cervicothoracic junction

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



# CT Scan as- Screening Modality

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



# 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:**

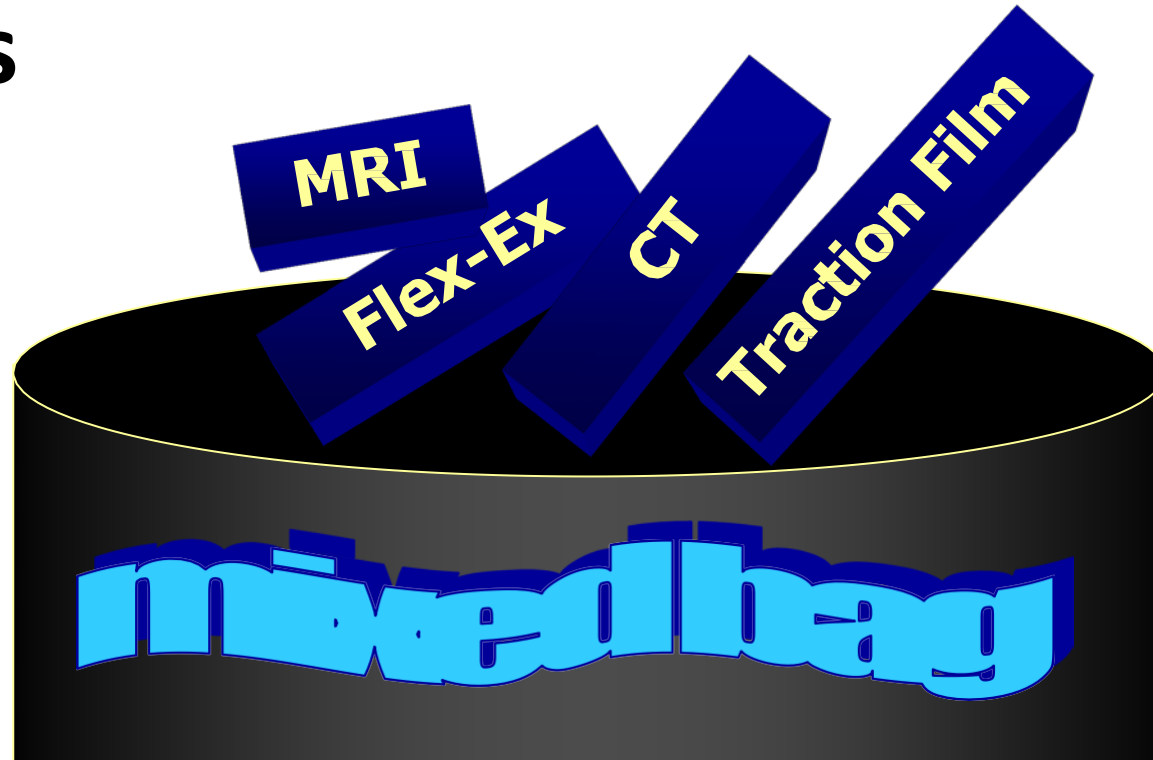
- **Excellent for surveying anatomy and caliber of spinal cord**

## **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

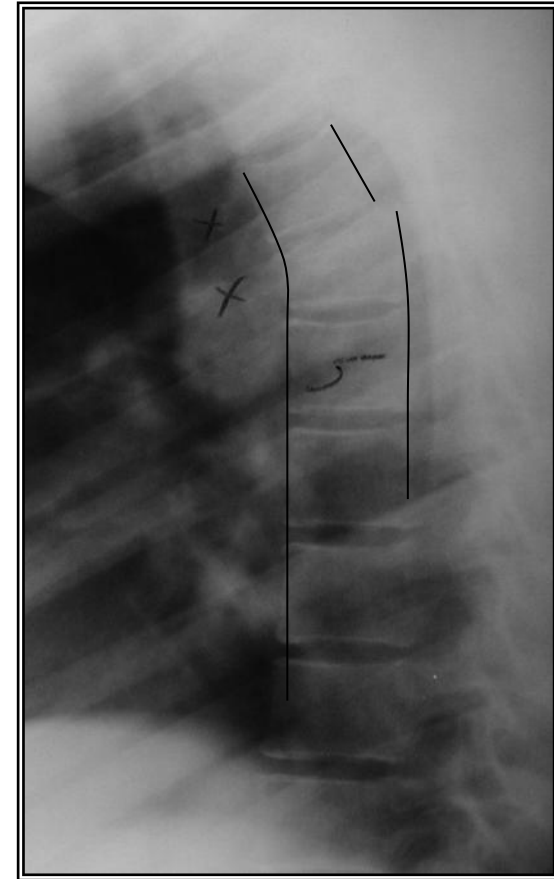
- **Avoid missed injuries**
- **Identify patients without significant injuries**
- **Delay in diagnosis associated with worse outcome**

Levi AD, Hubert RJ et al, Spine 2006



# Injury detection- Thoracic and Lumbar Spine

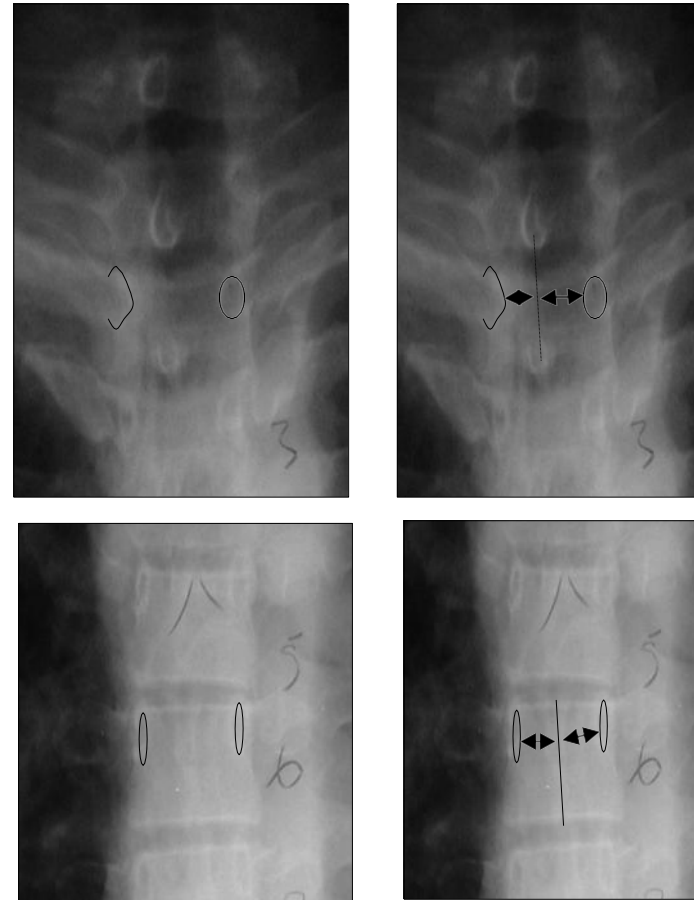
- **Same principles**
- **Landmarks and lines: Lateral View**
  - **Posterior vertebral body line**
  - **Anterior vertebral body line**
  - **Inter-spinous Distance**
  - **Translation**



# Injury detection- T and L Spine

## AP View:

- **Spinous process to pedicles**
  - Should be symmetric
- **Interpedicular distance**
  - May be widened in burst fractures
- **Translation**



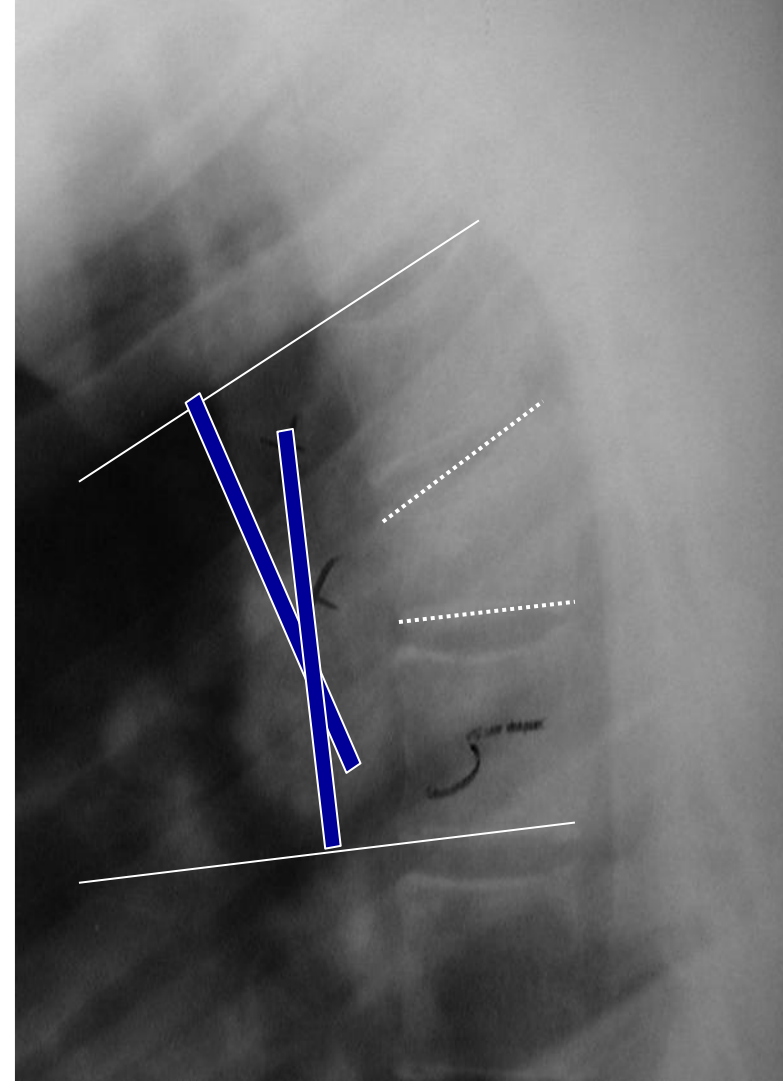
# CT Scan: T-L Spine

- 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?**

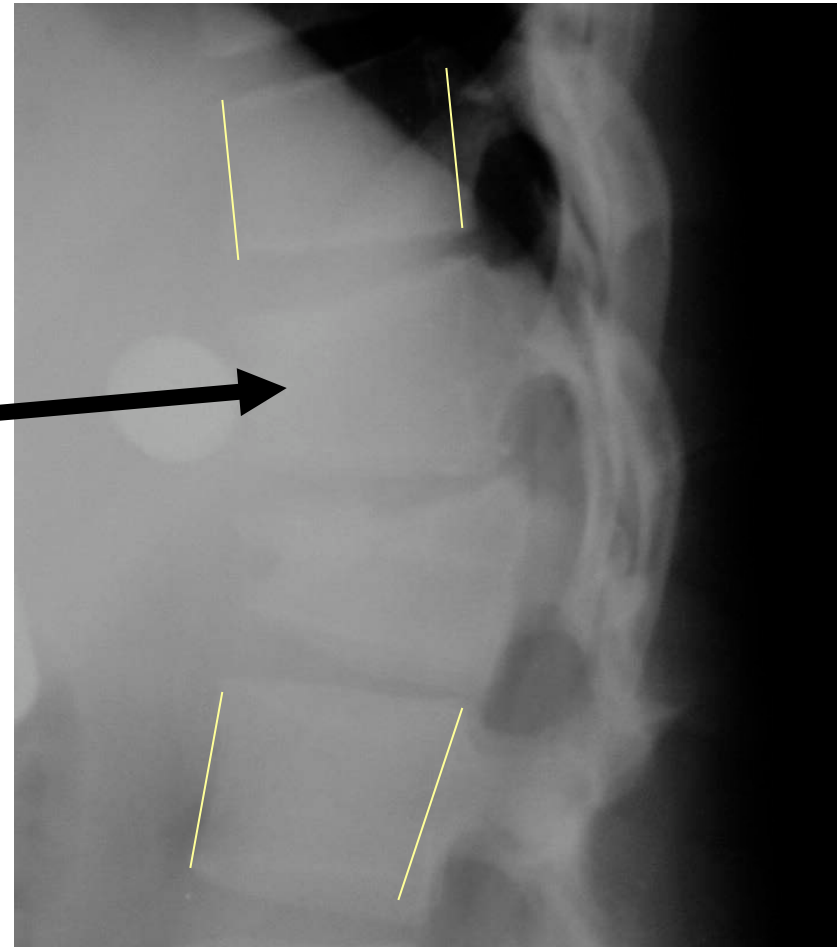




# T-L Spine injuries

- Height loss

Adjacent fracture



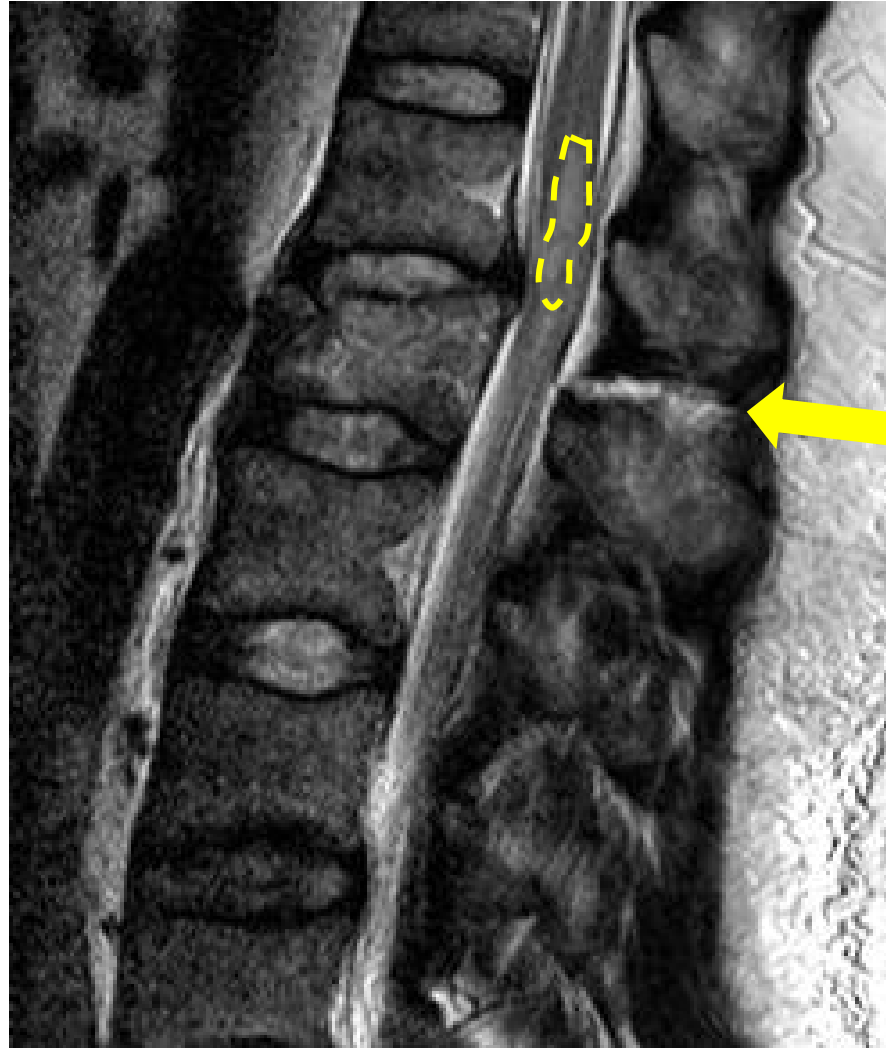
# MRI- Best at soft tissues

- 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**