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How can spine fractures be classified?

Spine fractures can be classified by location, mechanism, and stability.

How is the spine divided structurally?

The spine is divided into three columns:

- **Anterior column** – anterior two-thirds of the vertebral body and the anterior longitudinal ligament.
- **Middle column** – posterior one-third of the vertebral body and the posterior longitudinal ligament.
- **Posterior column** – posterior elements and ligaments.

What makes a spine fracture unstable?

A fracture involving two or more columns is considered unstable.

Cervical Spine Fractures

What are important intervals to evaluate on a lateral cervical spine radiograph?

- The **basion-dental interval** should be less than 12 mm.
- The **atlanto-dental interval** should be less than 2.5 mm in adults and 5 mm in children.

The **Atlanto-Dental Interval (ADI)** is the space between the **anterior arch of the atlas (C1)** and the **odontoid process (dens) of the axis (C2)** on a lateral cervical spine radiograph.

Normal ADI Values:

- **Adults: <2.5 mm**
- **Children: <5 mm**

The **basion-dental interval (BDI)** is the distance between the **basion** (the midline inferior portion of the clivus) and the **dens** (odontoid process of C2).

- It is used to assess **atlanto-occipital dissociation (AOD)**, which is a severe and often fatal injury where the skull separates from the cervical spine. A BDI **>12 mm** suggests **craniovertebral instability or dislocation**.
- An **increased ADI** suggests **atlantoaxial instability**, which can be caused by:
 - **Trauma** (e.g., transverse ligament rupture)
 - **Rheumatoid arthritis** (due to ligamentous laxity)
 - **Down syndrome** (congenital ligamentous laxity)
 - **Ankylosing spondylitis** (leading to instability)

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What is a Jefferson fracture, and what causes it?

A Jefferson fracture is a fracture of the atlas (C1) caused by axial force, leading to symmetrical fractures of the anterior and posterior arches.

What are the types of odontoid fractures?

Odontoid fractures (C2) are classified into:

- **Type 1** – Distal dens, usually stable.
- **Type 2** – Base of the dens, usually unstable.
- **Type 3** – Extends into C2 vertebral body, may be stable or unstable.

What is a Hangman's fracture?

A Hangman's fracture results from hyperextension and involves fractures of the C2 pedicles.

What is a flexion teardrop fracture, and why is it significant?

A flexion teardrop fracture is an unstable fracture caused by hyperflexion, resulting in an avulsion fracture of the anteroinferior vertebral body. It is associated with **anterior cord syndrome**.

Anterior Cord Syndrome

Anterior cord syndrome is an incomplete spinal cord injury that results from **damage to the anterior two-thirds of the spinal cord**, typically affecting the **anterior spinal artery**.

Causes:

- **Hyperflexion injuries** (e.g., severe cervical flexion, as seen in flexion teardrop fractures)
- **Anterior spinal artery occlusion** (e.g., aortic pathology, embolism)
- **Direct compression** (e.g., herniated disc, fracture, or tumor)

Clinical Features:

- **Loss of motor function** below the level of injury (due to corticospinal tract involvement)
- **Loss of pain and temperature sensation** (due to spinothalamic tract involvement)
- **Preserved proprioception and vibratory sense** (posterior columns are spared)

Prognosis:

- **Worst prognosis** among incomplete spinal cord syndromes
- **Poor motor recovery**, as motor pathways are primarily affected

How does an extension teardrop fracture differ from a flexion teardrop fracture?

An extension teardrop fracture is stable and results in an avulsion fracture of the anteroinferior vertebral body but without subluxation or spinolaminar line disruption.

What is a Clay-shoveler's fracture?

A Clay-shoveler's fracture is an avulsion fracture of the spinous process caused by forced flexion, typically occurring in the lower cervical or upper thoracic spine.

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What is bilateral interfacetal dislocation, and why is it concerning?

It is a **highly unstable** hyperflexion injury where the affected vertebra is anteriorly displaced by more than 50%.

How does unilateral interfacetal dislocation differ from bilateral interfacetal dislocation?

Unilateral interfacetal dislocation is a **stable** injury caused by hyperflexion with rotation, resulting in a single dislocated facet joint.

Thoracolumbar Spine Fractures

What is a Chance fracture?

A Chance fracture is a **flexion-distraction injury** from acute forward flexion, leading to horizontal splitting of the vertebra through the posterior elements (spinous process, pedicles, lamina) and extending into the vertebral body.

Common Causes:

1. **High-energy trauma**
 - **Motor vehicle accidents (MVAs):** Most common cause, especially when **lap seatbelts** (without shoulder restraints) cause **jackknifing** of the upper body while the pelvis remains fixed.
 - **Falls from height** with hyperflexion forces.
 - **Sports injuries** with sudden forward bending.
2. **Improperly worn seatbelts**
 - **Lap belts alone** create a fulcrum at the lumbar spine, increasing the risk of distraction forces.
 - **Three-point seatbelts (lap + shoulder restraint)** reduce the risk of Chance fractures.

Most Common Location:

- **Thoracolumbar junction (T12–L2)**
- This area is biomechanically vulnerable due to the transition between the rigid thoracic spine and the more mobile lumbar spine.

What is spondylolysis, and how can it progress?

Spondylolysis is a fracture of the **pars interarticularis**, often due to chronic stress or an acute injury. It can lead to **spondylolisthesis**, which is anterior-posterior subluxation.

What is the most common cause of compression fractures?

Osteoporosis is the most common cause. These fractures appear on bone scans as **multilevel linear areas of varying uptake intensity although single level involvement is also seen**.

What radiographic sign is associated with ankylosing spondylitis?

A **“bamboo spine” appearance** is characteristic of ankylosing spondylitis.

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What are Romanus lesions and shiny corners?

- **Romanus lesions** are erosions of the anterior vertebral body endplates.
- **Shiny corners** are areas of sclerosis from prior Romanus lesions, often seen in inflammatory spondyloarthropathies.

What is the "Scotty dog" sign?

The "Scotty dog" sign is associated with **spondylolysis**. A "collar on the Scotty dog" indicates a **pars interarticularis defect**.

When is MRI preferred over CT for evaluation of the spine?

MRI is useful for assessing **soft tissues, ligaments, and spinal cord pathology**.

What is a "crescent sign" on MRI?

The **crescent sign** on MRI refers to a **T1 hyperintense (bright) signal** seen within the vertebral body, typically indicating the presence of **intravertebral hemorrhage** or **osteonecrosis**.

Clinical Significance:

1. **Vertebral Compression Fractures (Osteoporotic or Pathologic)**
 - The **crescent sign** represents an **intravertebral vacuum cleft** due to **avascular necrosis** of the vertebral body.
 - Seen in **Kümmell's disease** (delayed collapse of a vertebra due to ischemic necrosis).
2. **Avascular Necrosis (AVN) of the Vertebral Body**
 - Can result from steroid use, radiation therapy, or underlying ischemic conditions.
3. **Pathologic Fractures (e.g., Metastasis, Multiple Myeloma)**
 - The crescent sign may be seen in **lytic lesions** with associated necrosis or collapse.

What are characteristic imaging features of Modic changes on MRI?

Modic changes describe **signal alterations in the vertebral endplates**:

- **Type 1** – T2 bright (edema).
- **Type 2** – T1 bright (fatty change).
- **Type 3** – T1 and T2 dark (fibrotic changes/sclerosis).

Bone Scans

When is a bone scan useful in spine fracture evaluation?

Bone scans help detect fractures **not clearly visible on radiographs**.

What is the "Honda sign," and what does it indicate?

The **Honda sign** is an H-shaped uptake pattern on a bone scan, indicative of a **sacral insufficiency fracture**.

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How does osteoid osteoma appear on a bone scan?

It appears as a **focal three-phase hot lesion**, often showing a **double density sign** with a central hot nidus.

What distinguishes bisphosphonate-related proximal femoral fractures?

They show **focal uptake in the lateral femoral cortex**, typically presenting on radiography as a **simple horizontal fracture**.

What is the classic imaging finding of Paget's disease in the spine?

Paget's disease can show an **enlarged "ivory vertebra"** or **"picture frame vertebrae"**.

Other Conditions Mimicking Fractures

What is Scheuermann's disease?

It is a condition in teenagers with multiple **Schmorl's nodes** and **kyphotic deformity**.

How can a limbus vertebra mimic a fracture?

A **limbus vertebra** is caused by **herniated disc material between a non-fused apophysis and adjacent vertebral body**, mimicking a fracture.