RADIOLOGY OF SPINE DISEASES

KING KHALID UNIVERSITY HOSPITAL, RADIOLOGY DEPARTMENT

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- Normal Spine images
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  - Trauma
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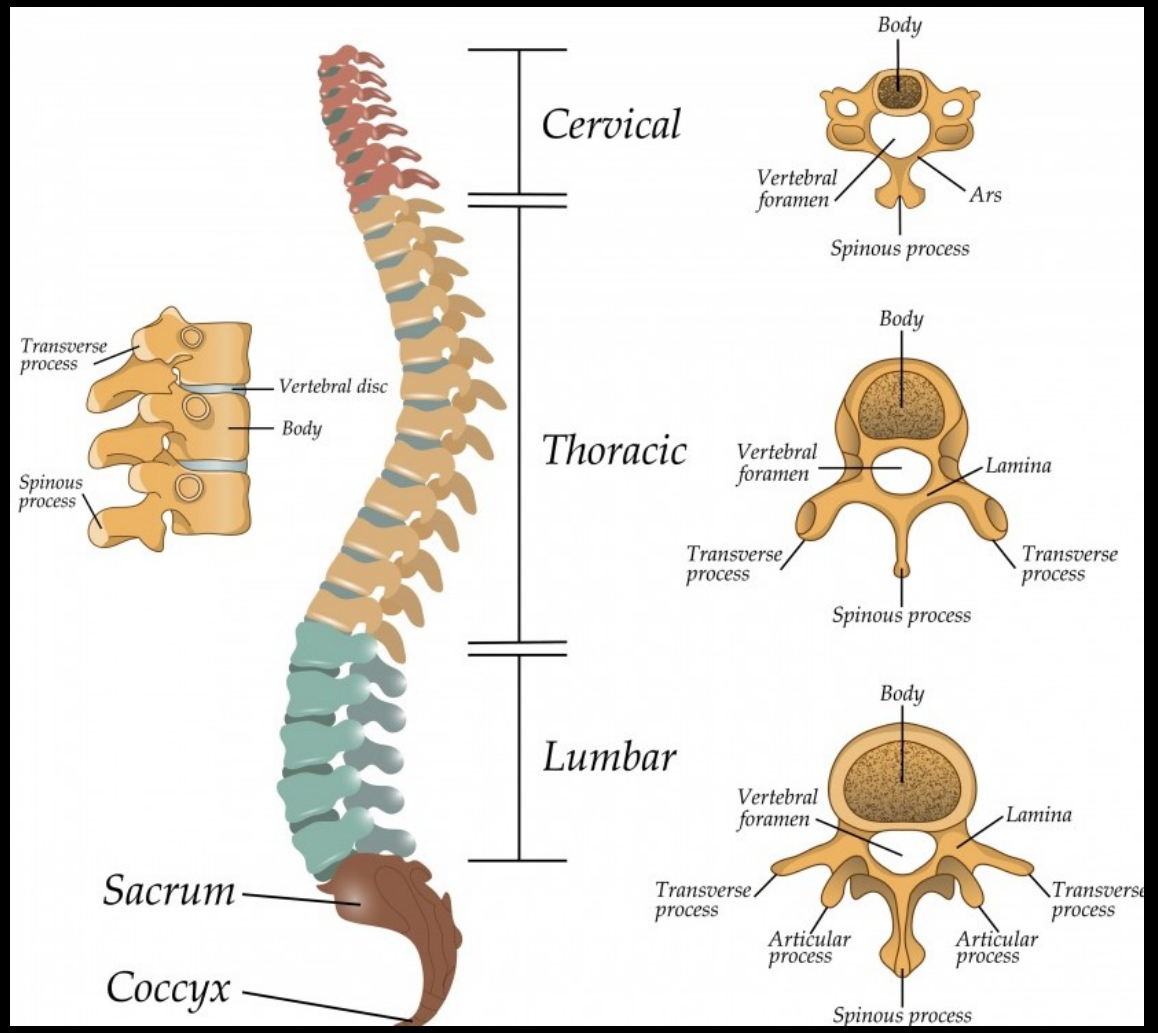
- Craniocervical Measurements

ANATOMY

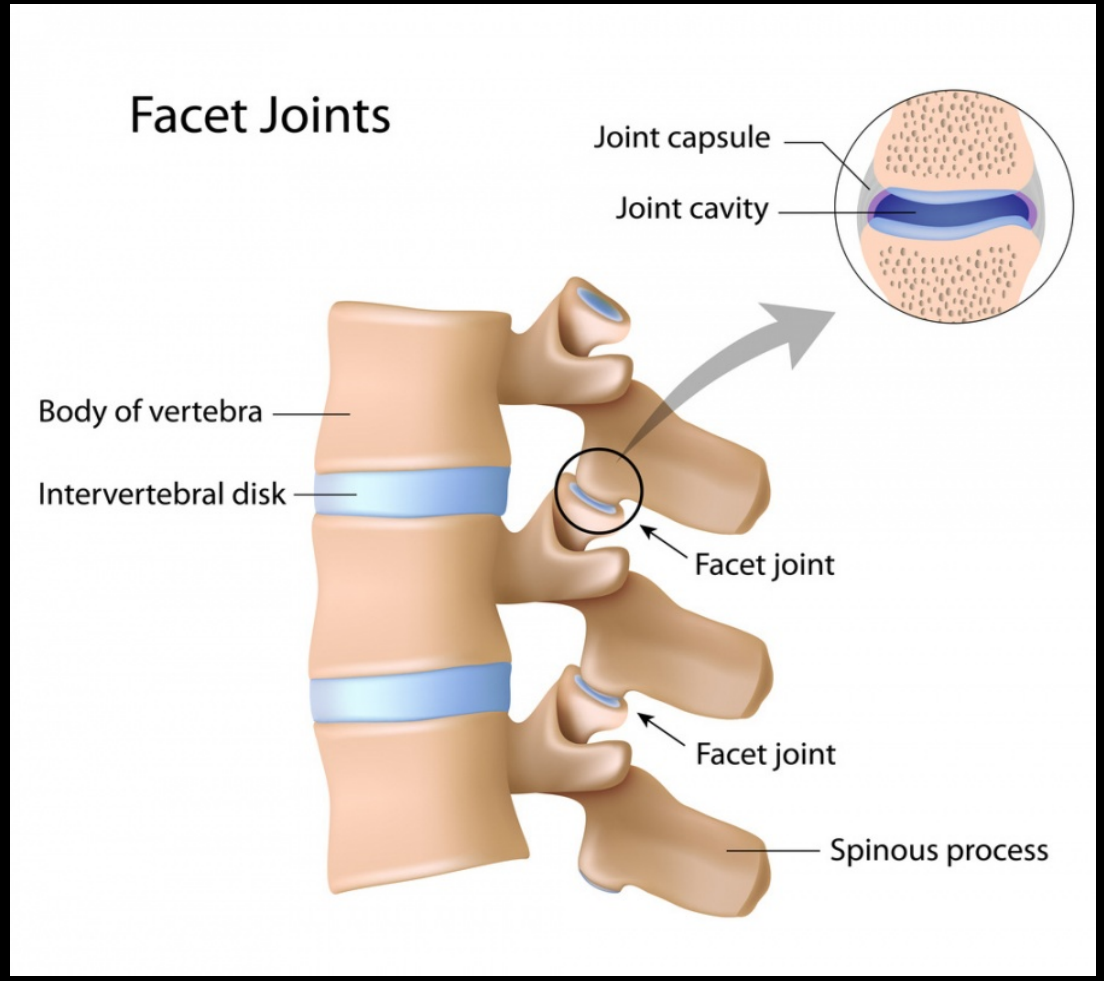
- The spinal / vertebral column provides both structural and nervous system support for your entire body.
- It holds the body upright, allows it to bend and twist with ease and provides a conduit for major nerves running from the brain to the tips of the toes—and everywhere in between.
- Double-S shaped
- Can be divided into:

- Cervical spine : C1-C7, C1 (Atlas) C2(Axis)
- Thoracic spine : T1-T12
- Lumbar spine : L1-L5
- Sacrum
- Coccyx



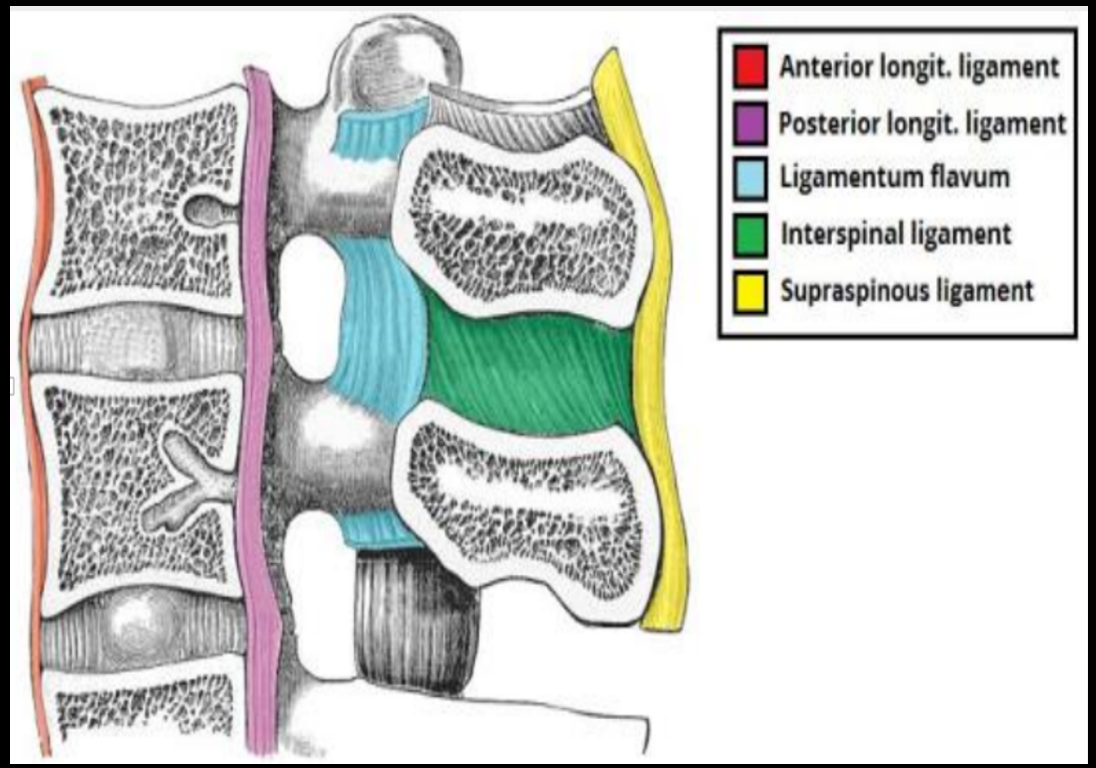
ANATOMY : SPINE MOVEMENT ENABLERS AND STABILIZERS

- Intervertebral Discs : Each disc is similar to a fibrous pad of tissue (called *fibrocartilage*) and anchored in place by vertebral endplates (called *cartilaginous endplates*) starting at C3 through L5-sacrum. These discs act as interbody spacers and shock absorbers.
- Facet Joints : paired (left, right sides) at the back of each vertebral body (C3-L5). Helps stabilize the spine while allowing flexion (bending forward), extension (bending backward) and twisting movement (*called articulation*).

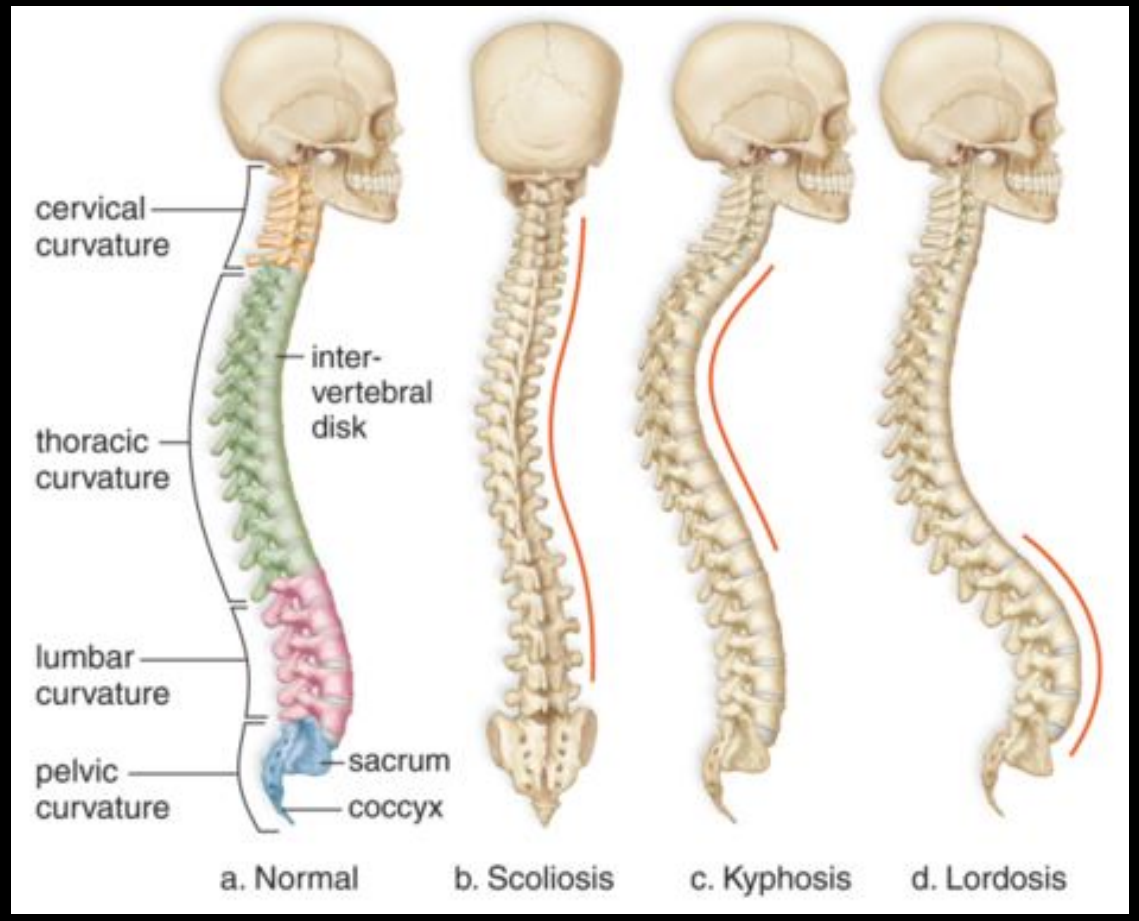


ANATOMY : SPINE MOVEMENT ENABLERS AND STABILIZERS

- Ligaments : Ligaments are fibrous bands or sheets of connective tissue linking two or more bones, cartilages, or structures together. One or more ligaments provide stability to a joint during rest and movement. Excessive movements such as hyper–extension or hyper–flexion, may be restricted by ligaments.
- Muscles :Varies according to different segments of the vertebral column. further categorized according function such as flexion, extension, or rotation. Muscles and ligaments work together to support the spine, hold it upright, and control movement during rest and activity.



ANATOMY : SPINAL CURVATURE



IMAGING METHODS

1. Plain X-RAY film

- Bones
- Often the first diagnostic imaging test, quick and cheap.
- Small dose of radiation to visualize the bony parts of the spine.
- Can detect :

- Spinal alignment and curvature
- Spinal instability – with flexion and extension views
- Congenital defects of spinal column
- Fractures caused by trauma
- Moderate osteoporosis (loss of calcium from the bone)
- Infections
- Tumors

IMAGING METHODS

2. Computed Tomography (CT)

- Uses radiation
- Obtain 2D images – can be processed to 3D images.
- Patients lies on a table that moves through a scanner.
- Much detailed information regarding bony structures.
- Limited information about spinal cord and soft tissues.
- Better in visualizing :

- Degenerative or aging changes, herniated disks
- Spinal alignment
- **Fractures and fracture patterns**
- Congenital / childhood anomalies
- Narrowing in spinal canal.

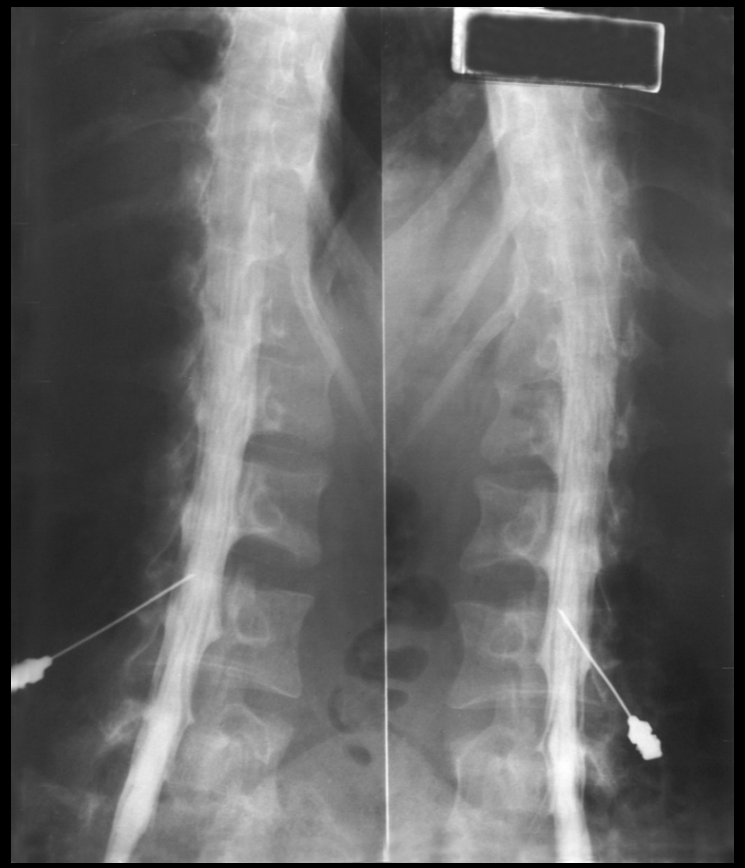
IMAGING METHODS

3. Magnetic Resonance Imaging (MRI)

- Gold standard of imaging for spinal disorders.
- Does not use ionizing radiation.
- Can identify abnormalities of bone, discs, muscles, ligaments, and spinal cord.
- Intravenous contrast is sometimes administered to better visualize certain structures or abnormalities.
- Patient lies still in a tunnel like structure for about 25 minutes.
- Images are multi planar and high resolution.
- Open / closed

IMAGING METHODS

4. **Myelogram :** Contrast material injected into CSF to better identify areas where spinal cord or spinal nerves may be compressed.
5. **Spinal Angiography :** To evaluate arteries and veins.
6. **Ultrasound :** Pediatric
7. **Radionuclide Bone Scan :** Intravenous injection of radioactive material bound to phosphonates which deposit in bones, followed by images by gamma camera.
8. **DEXA :** Radionuclide scan for bone density (osteoporosis).



Myelography (Myelogram)

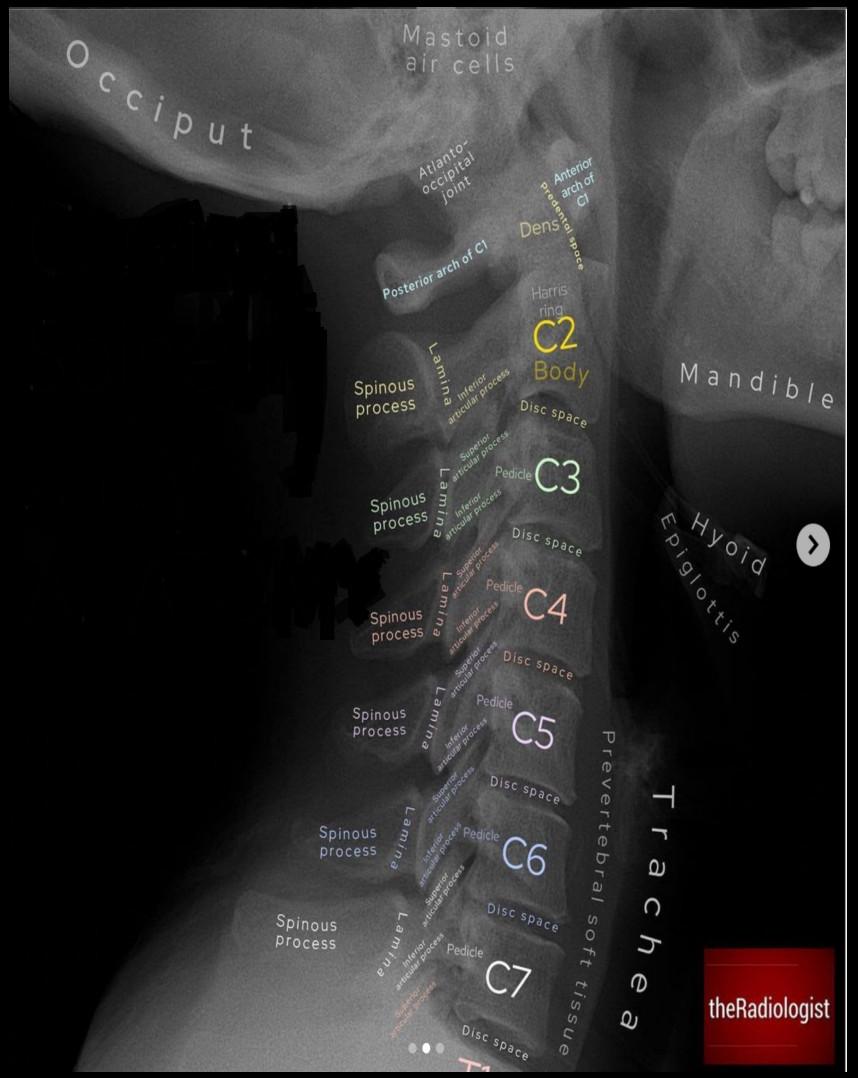
NORMAL SPINE IMAGES

X-RAY

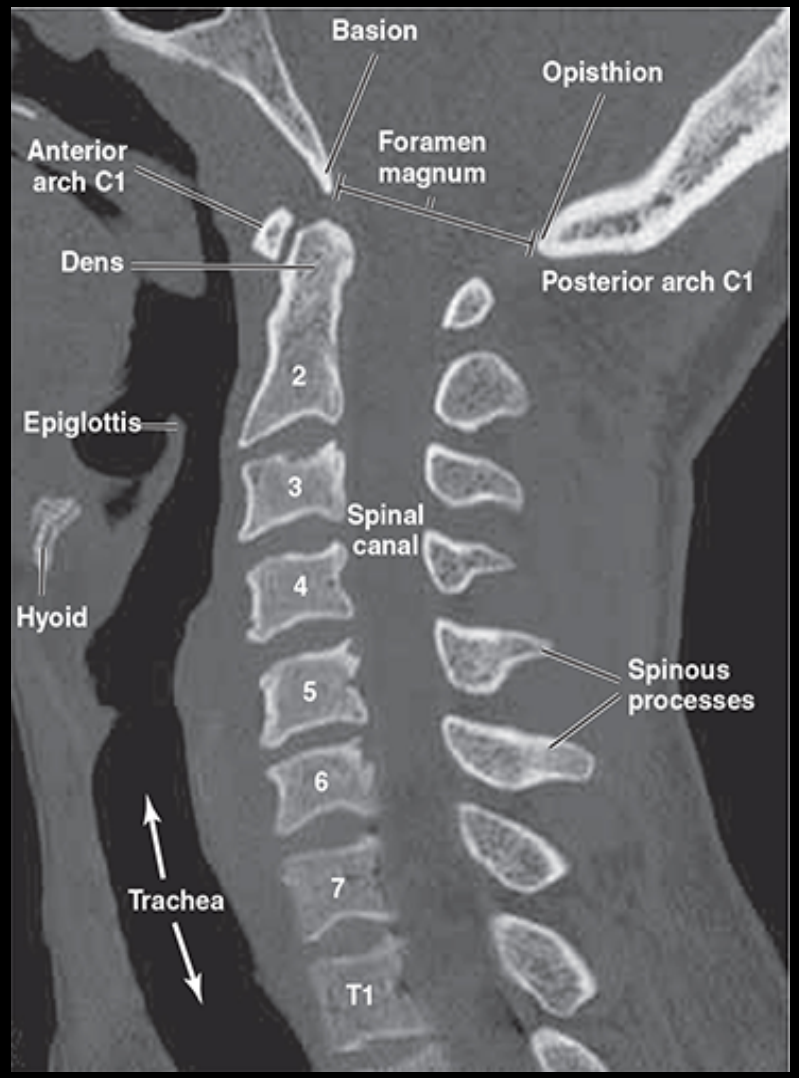
CT

MRI

CERVICAL SPINE



X-RAY LATERAL

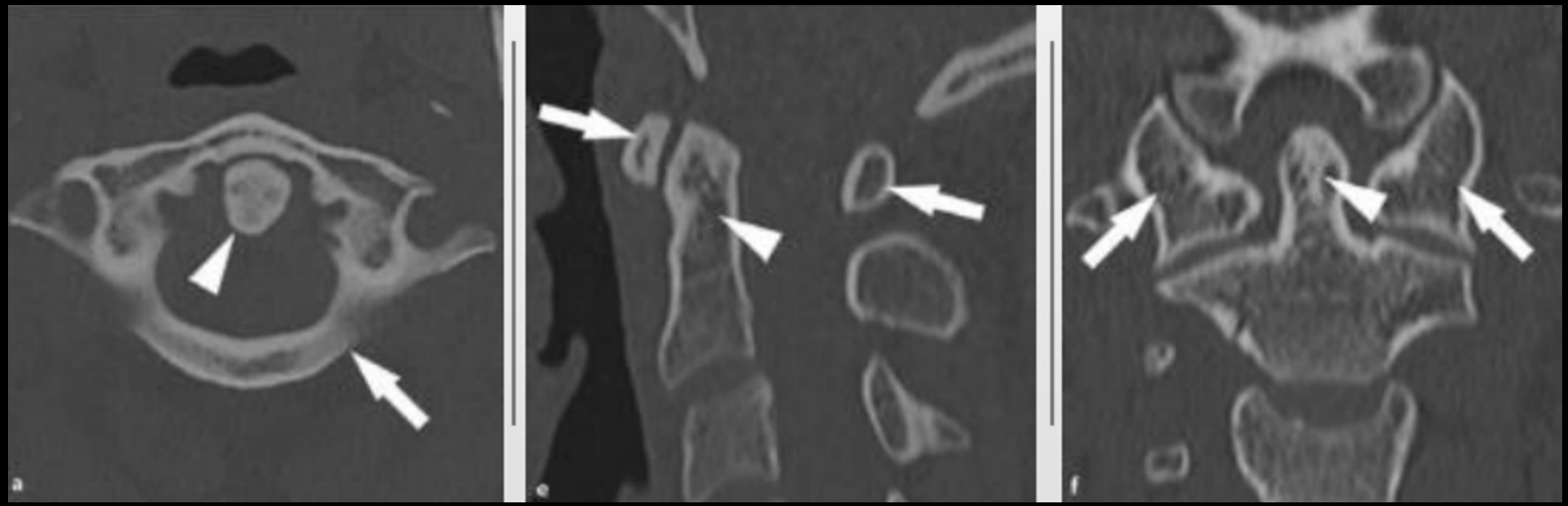


CT SAGITTAL

MRI SAGITTAL T2

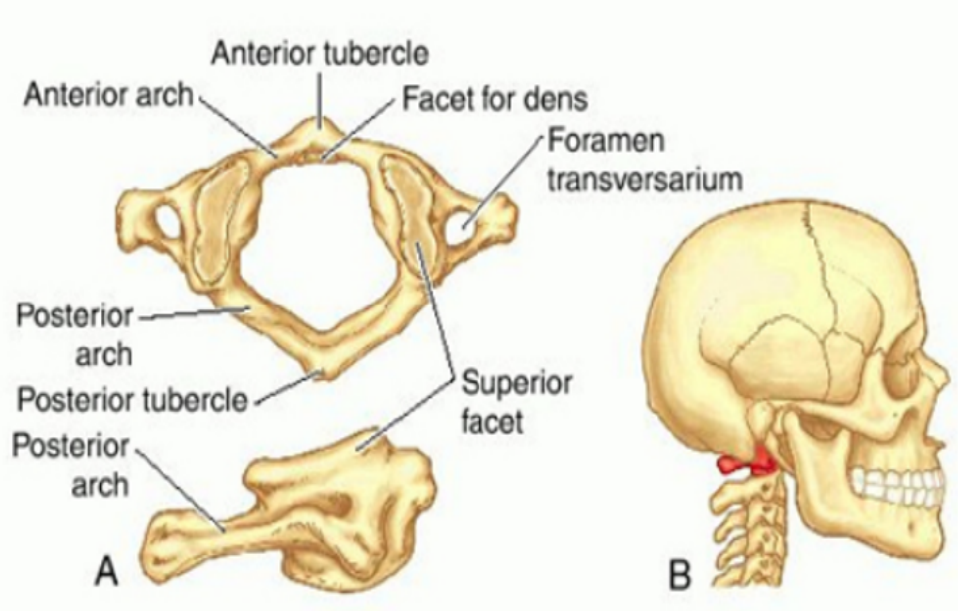
CRANIOCERVICAL JUNCTION

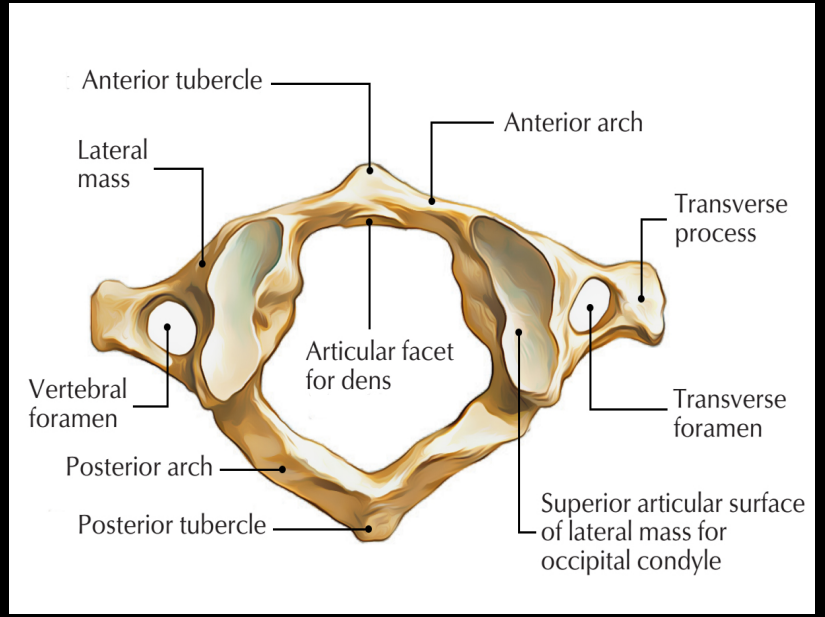
- The **Craniocervical junction** (CCJ) is comprised of the inferior surface of the skull, the atlas and axis, as well as muscles and connective tissues that attach the skull to the cervical spine.
- The CCJ encloses the central nervous system (CNS), encephalic vasculature and the cerebrospinal fluid (CSF) system.
- Two major joints: the atlanto-occipital joint and the atlanto-axial joint



C1 (ATLAS)

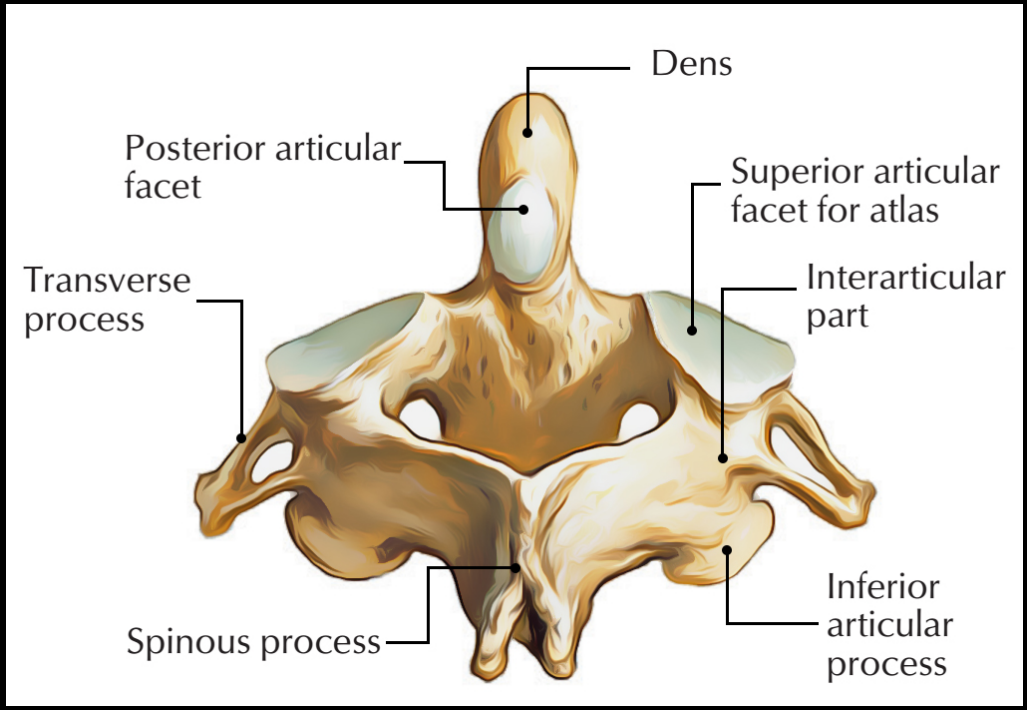
- Ring shaped
- Atlas was the primordial titan who supported the heavens.
- Anterior arch, posterior arch, and 2 bulky lateral masses.
- It plays vital roles in the support of the skull, spinal cord, and vertebral arteries and provides attachment points for several muscles of the neck.

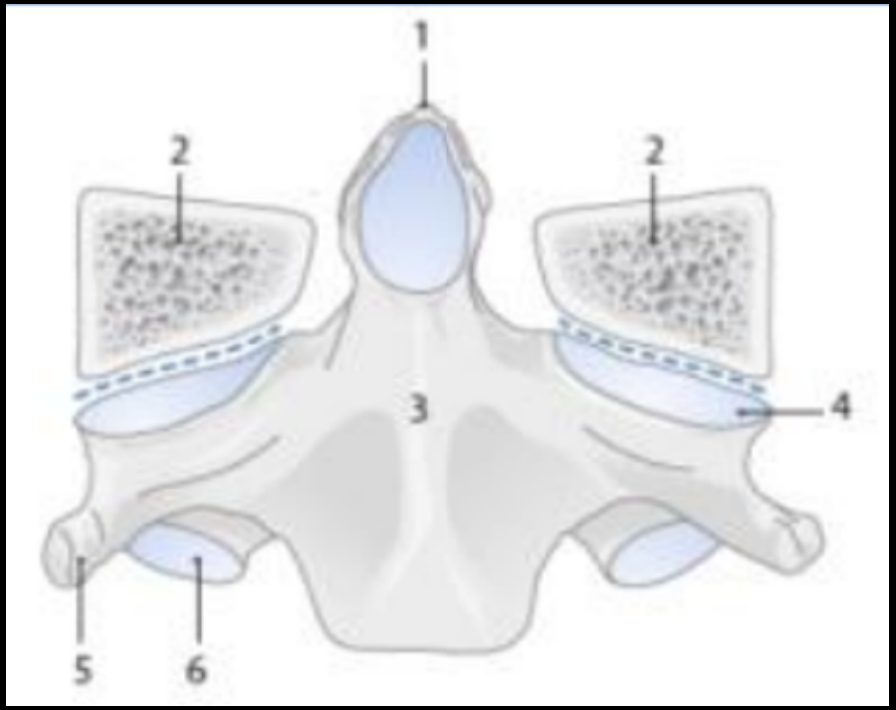




C2 (AXIS)

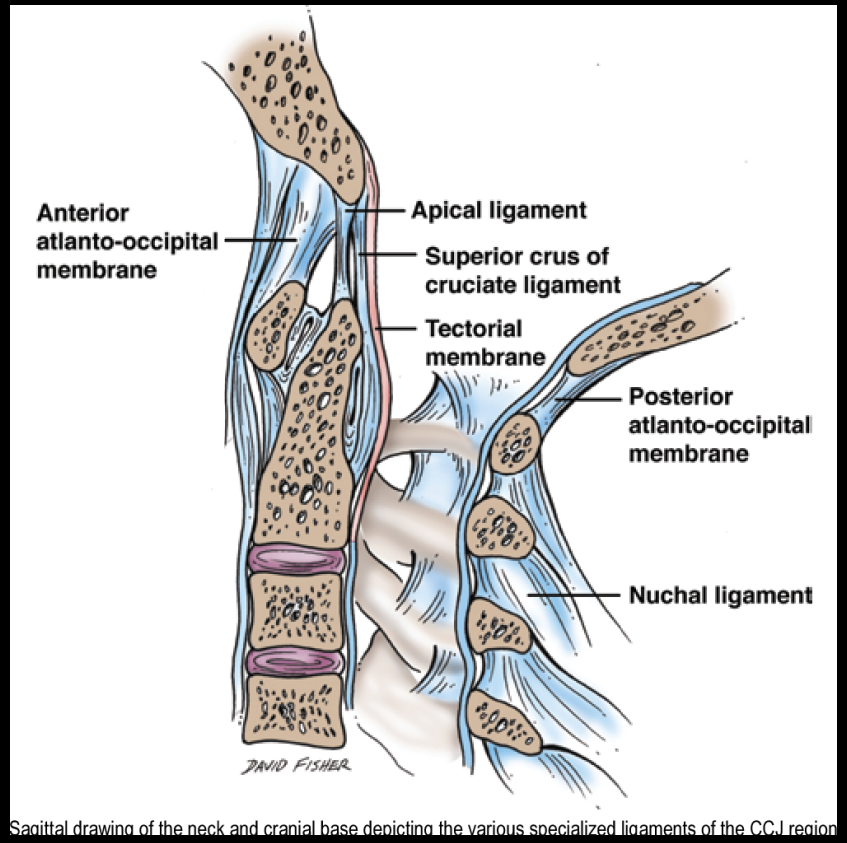
- It is unique in that it contains the odontoid process(also known as odentoid peg and dens) - odontoid means "tooth" and that is what this bone looks like.
- It forms a pivot point on which C1 atlas can rotate.
- Injuries to the odontoid are common in motor vehicle accidents and falls.



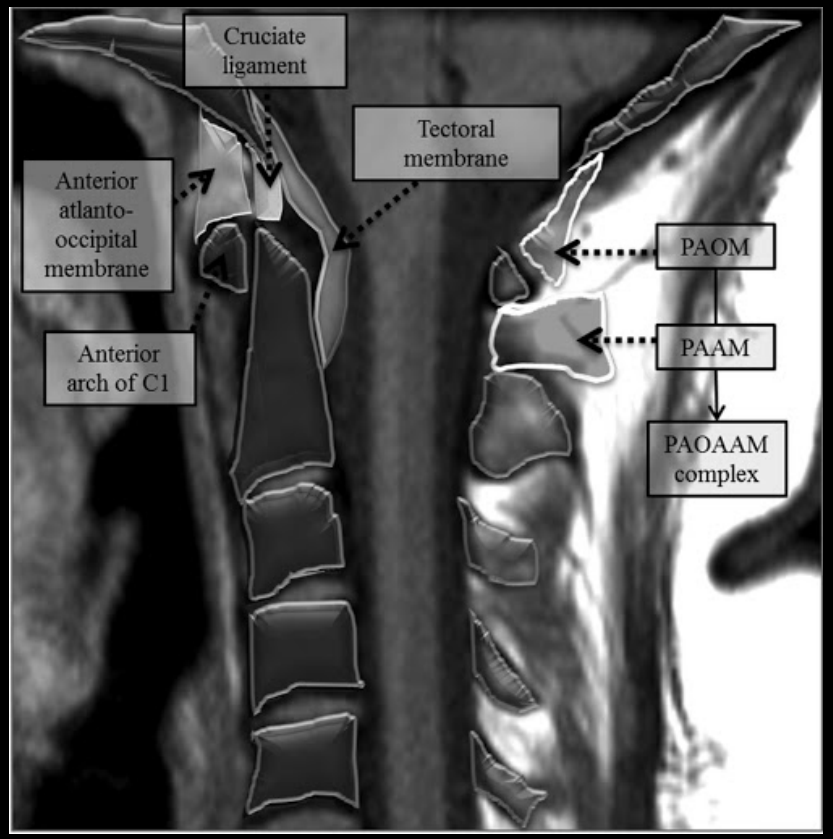


CRANIOCERVICAL JUNCTION LIGAMENTS

- Anterior atlanto-occipital membrane
- Posterior atlanto-occipital membrane
- Apical ligament
- Tectorial ligament
- Nuchal ligament (ligamentum nuchae)
- Cruciform ligament (cruciate)
- Alar ligaments
- Transverse ligament



Sagittal drawing of the neck and cranial base depicting the various specialized ligaments of the CCJ region



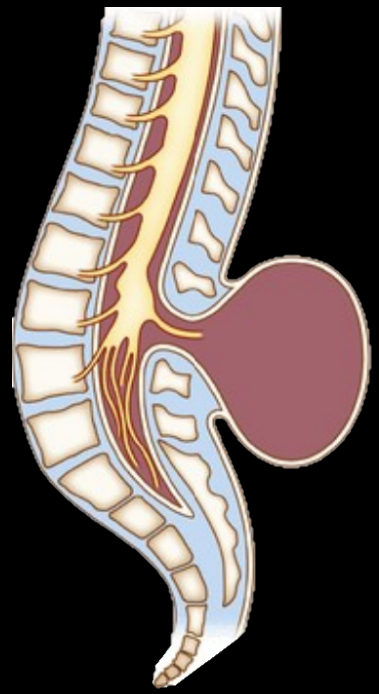
ABNORMALITIES

CONGENITAL ANOMALIES

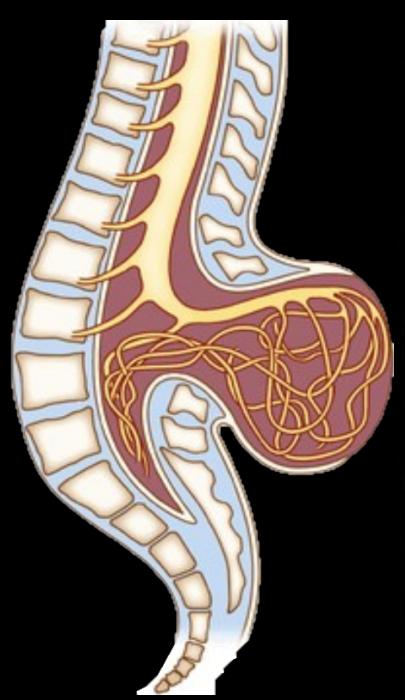
- MRI is the best to assess the contents of the cavity, extent of abnormalities, and spinal cord.
- CT shows bony structures the best and is often used before surgery

Spina bifida occulta

Meningocele

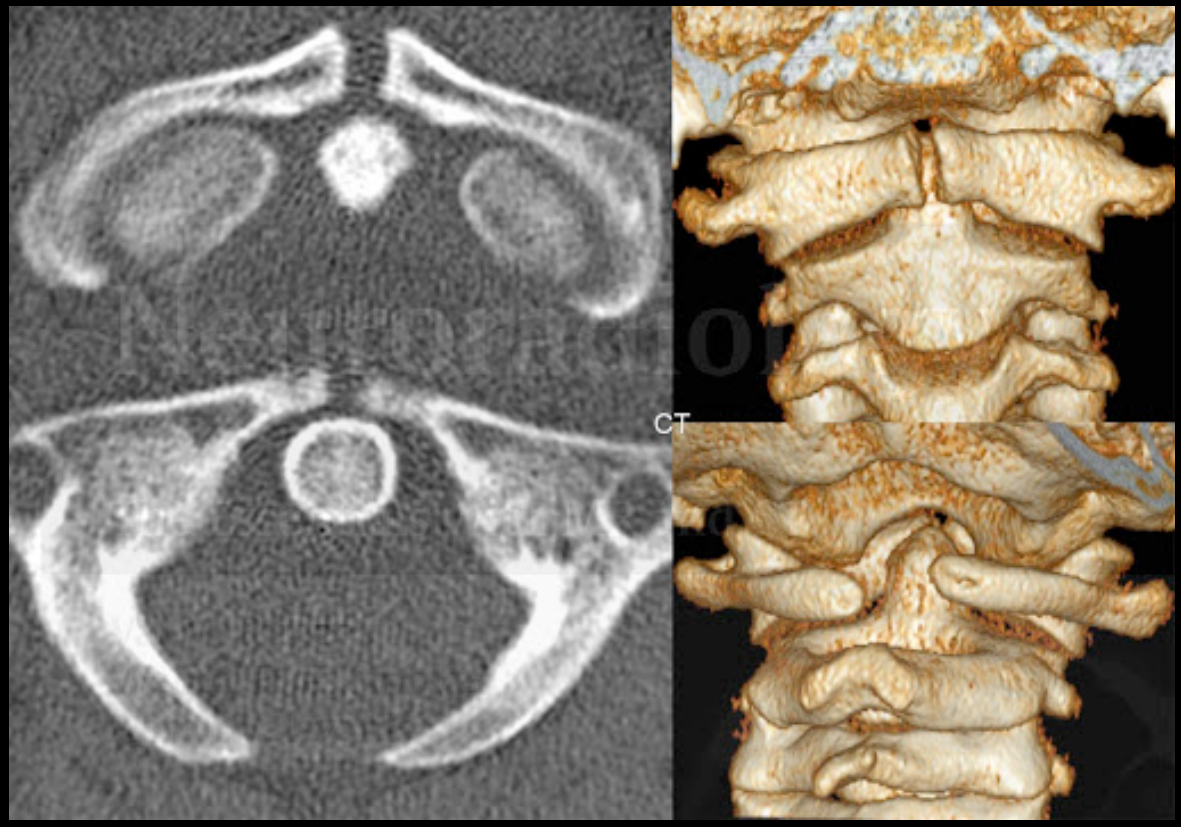


Myelomeningocele

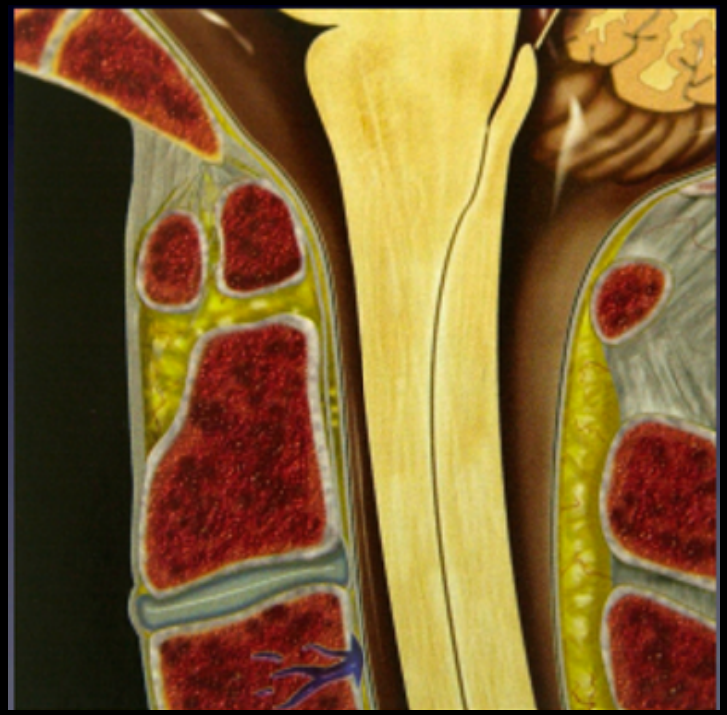


Spina bifida occulta at C1

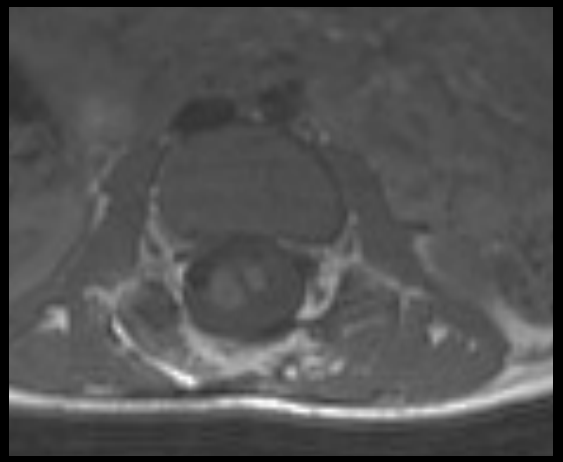
Anterior and posterior fusion defects of C1



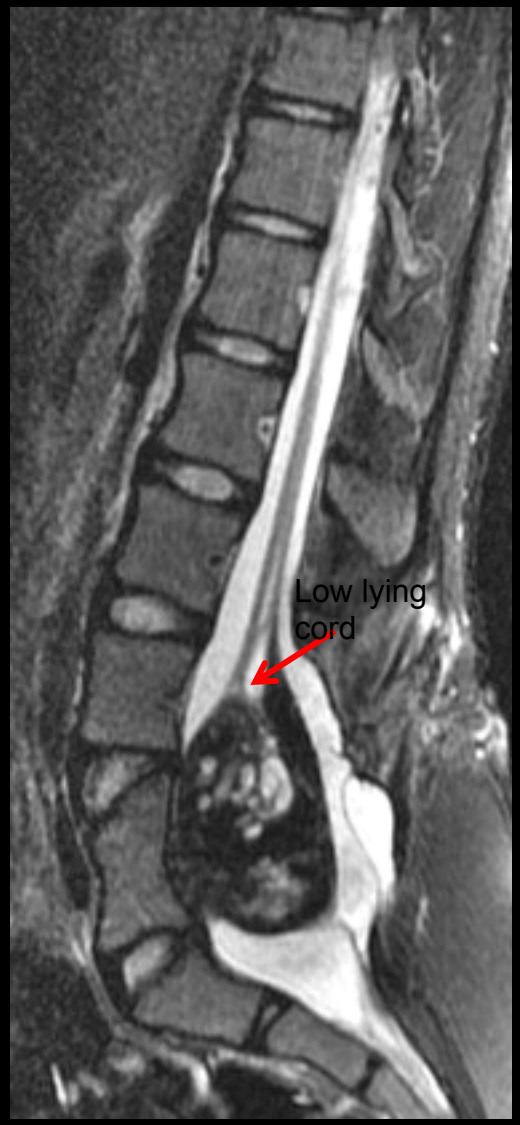
Os odontoideum



Split low lying cord (Diastematomyelia)

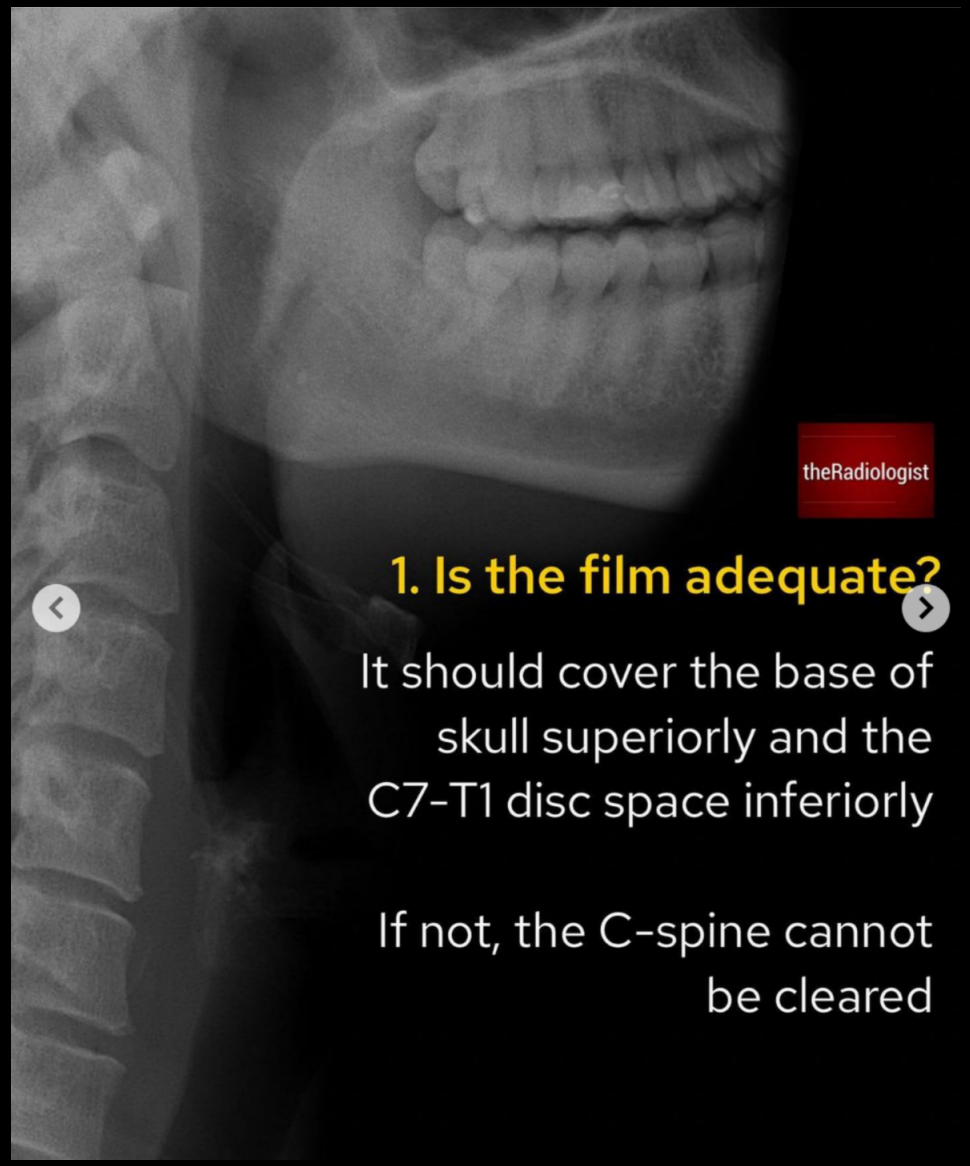


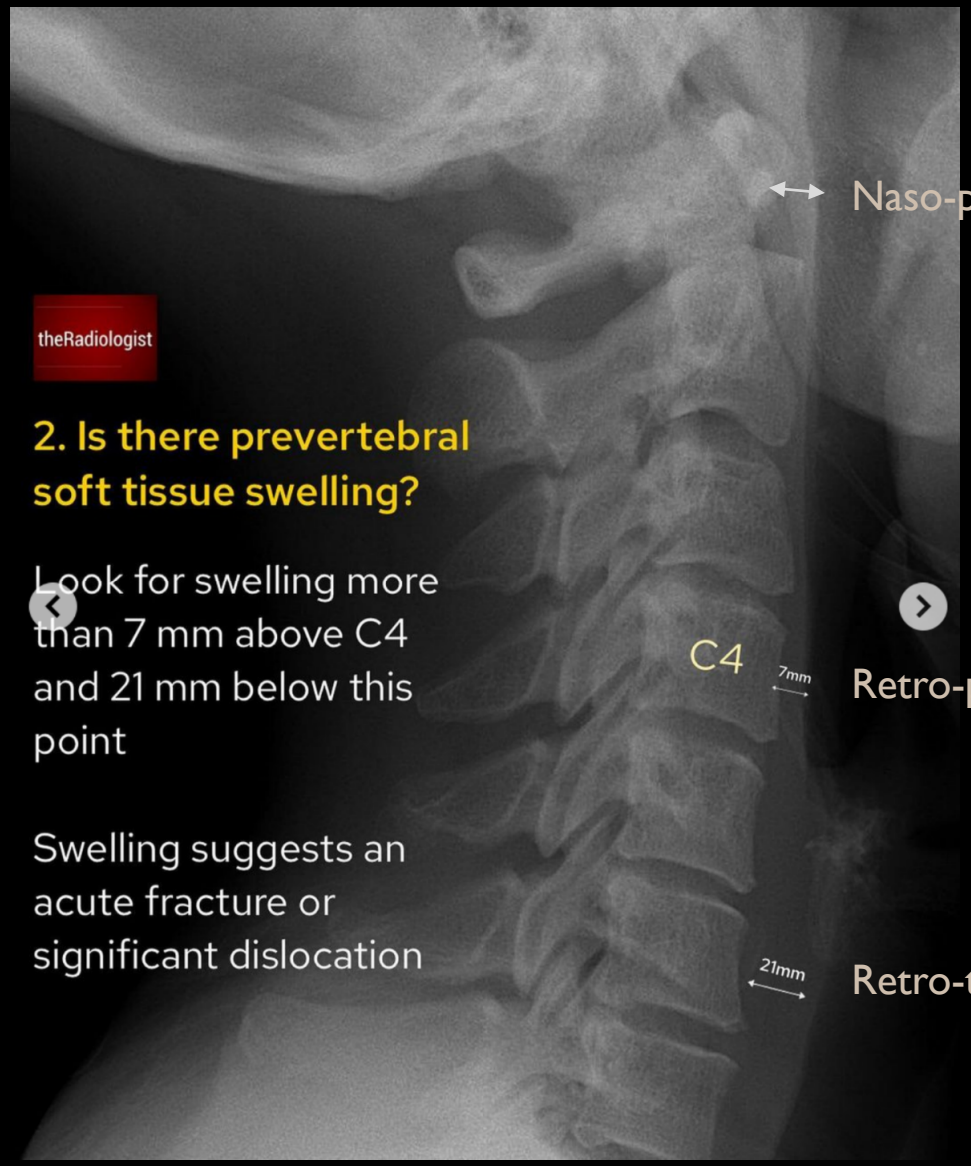
Low lying cord tethered to large lipoma



TRAUMA

TRAUMA :ASSESSMENT OF LATERAL C-SPINE XRAY



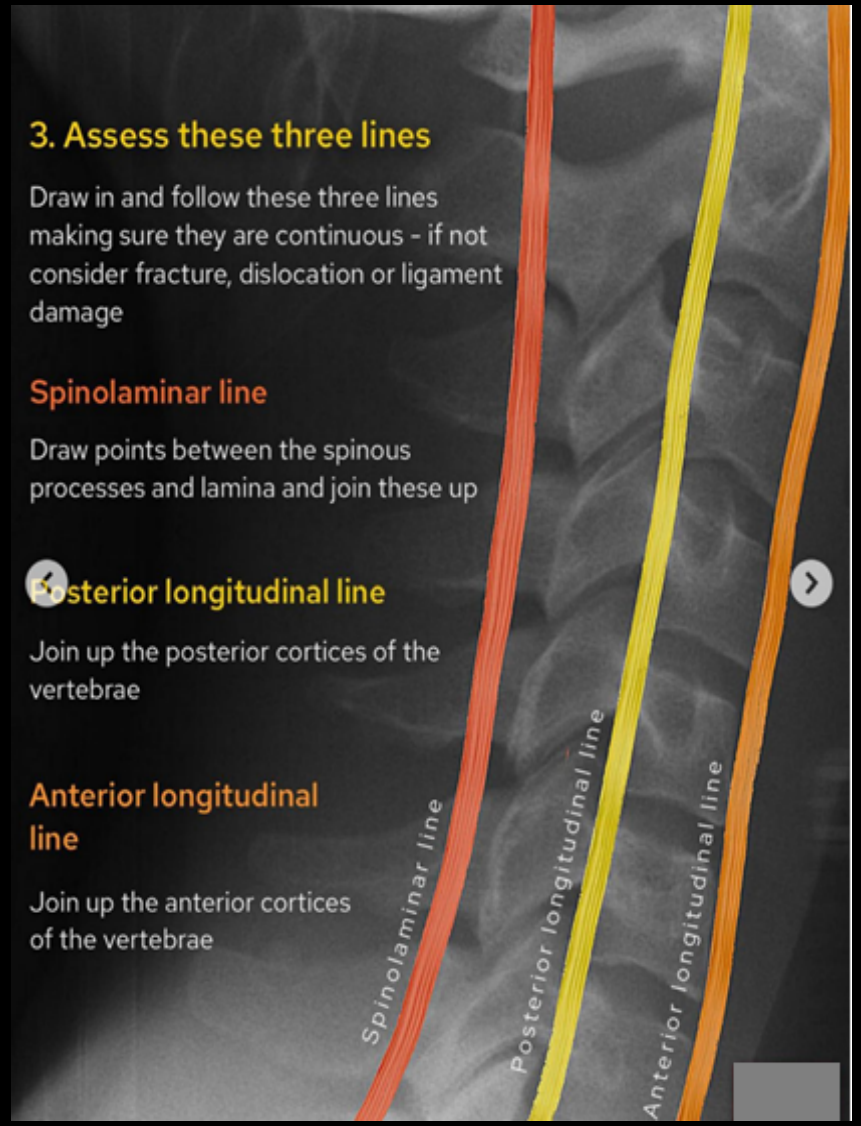


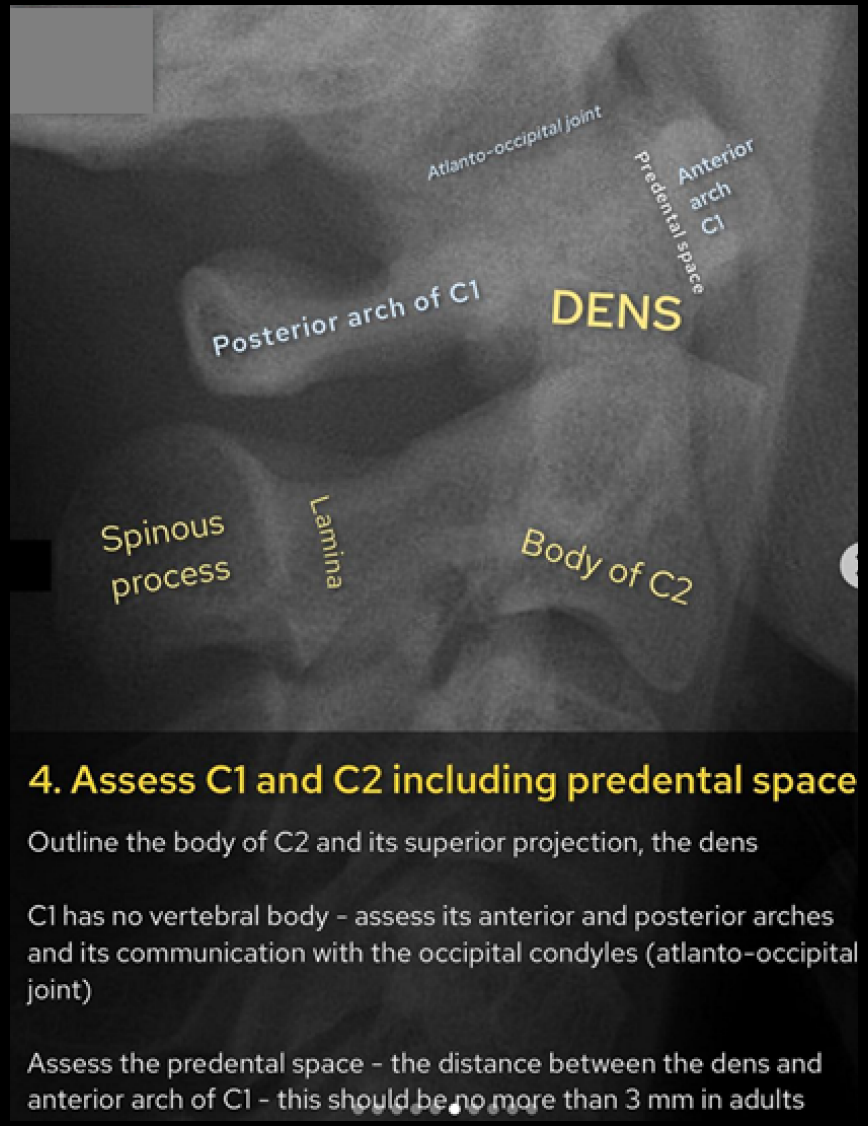
Naso-pharyngeal space

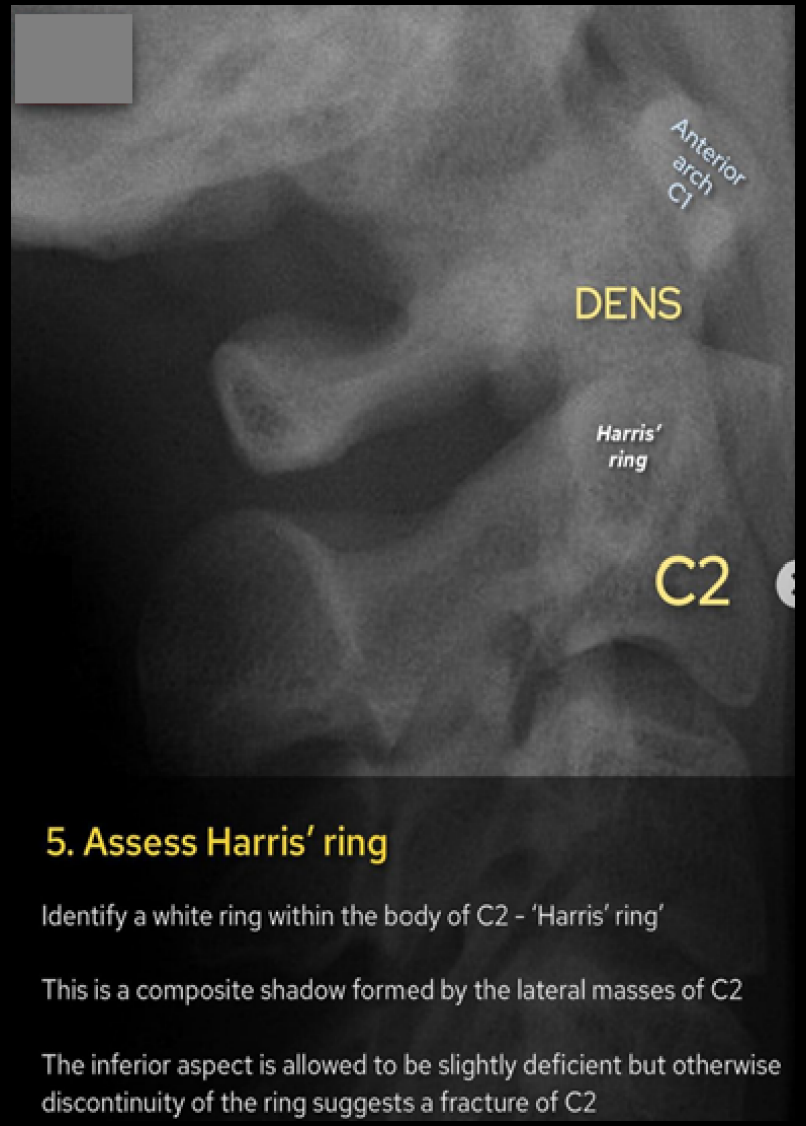
Retro-pharyngeal space

Retro-tracheal space

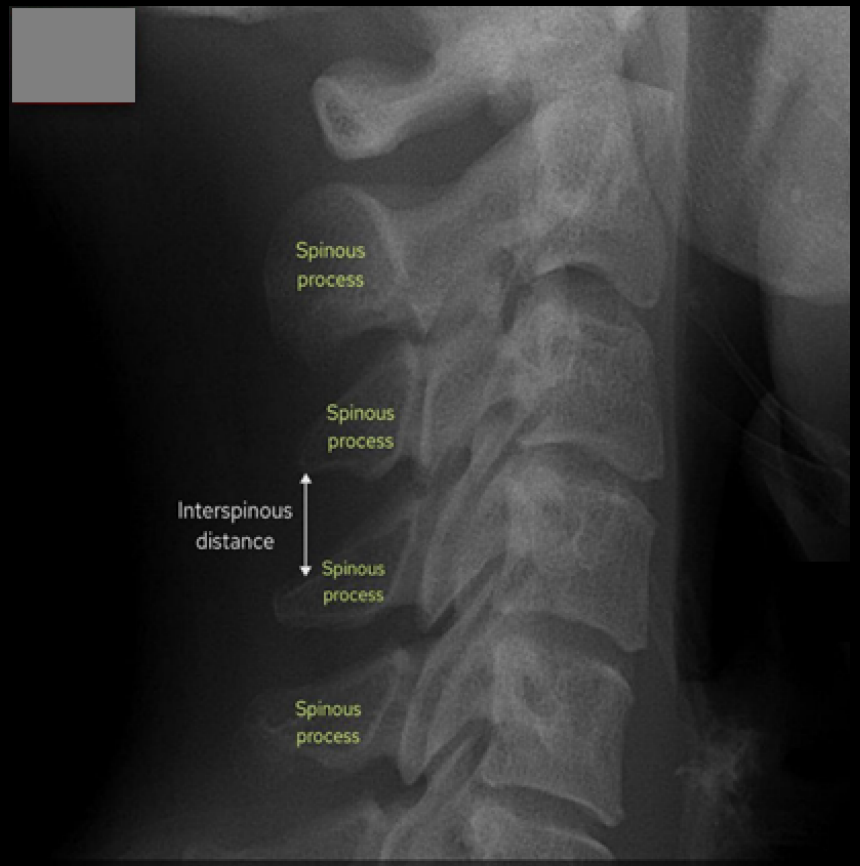
TRAUMA :ASSESSMENT OF LATERAL C-SPINE XRAY







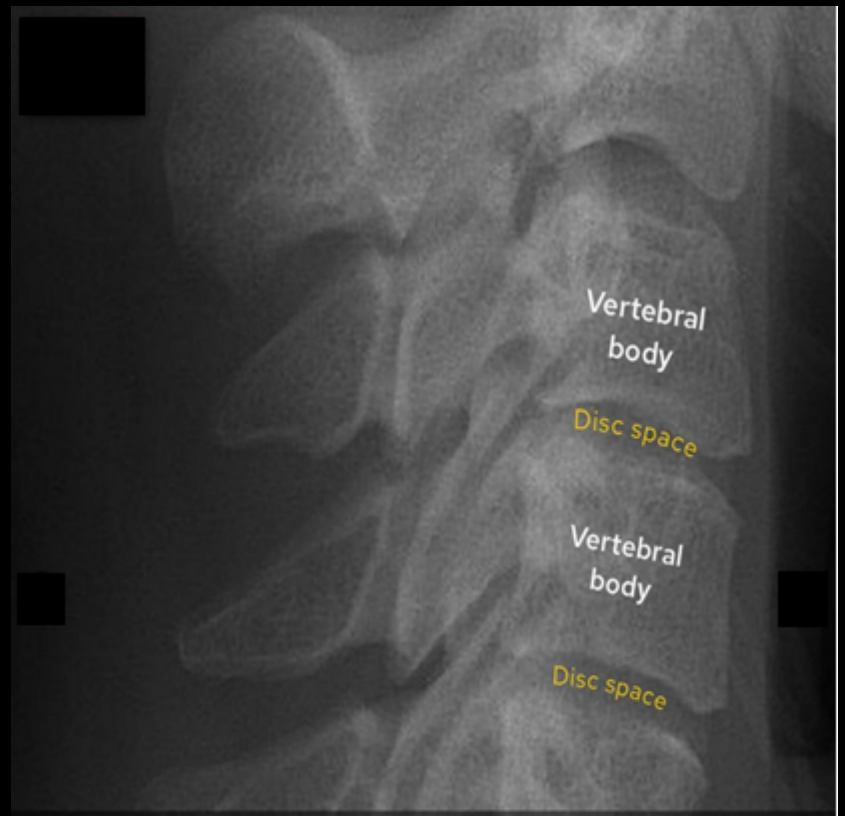
TRAUMA :ASSESSMENT OF LATERAL C-SPINE XRAY



6. Assess spinous processes

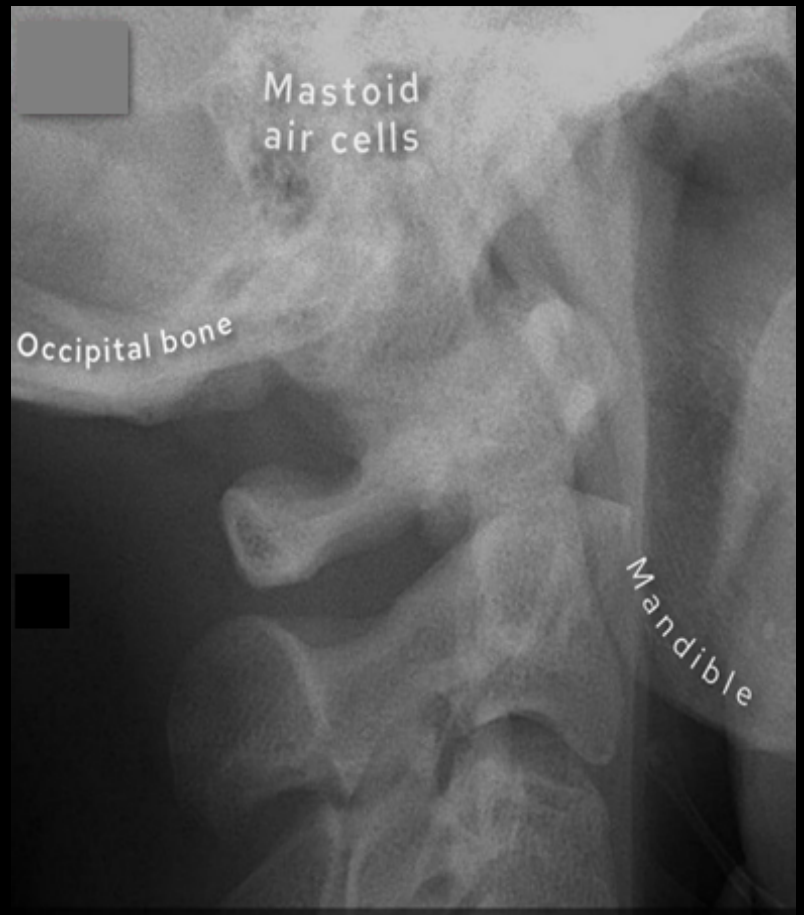
Outline each of the spinous processes

Assess each interspinous distance - a marked increase in a single distance is a sign of an anterior dislocation



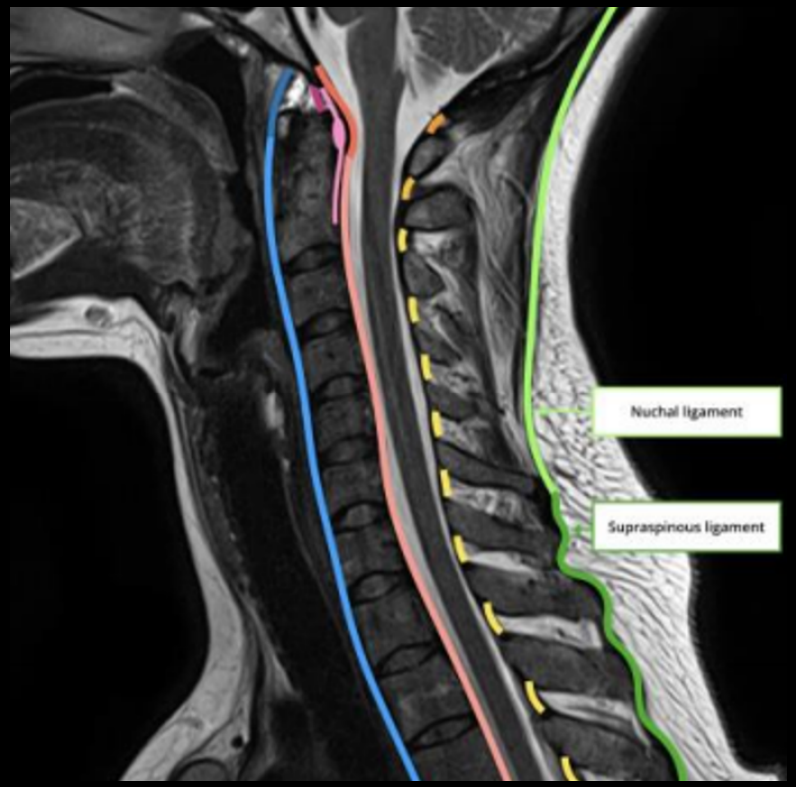
7. Assess remaining vertebral bodies and disc spaces

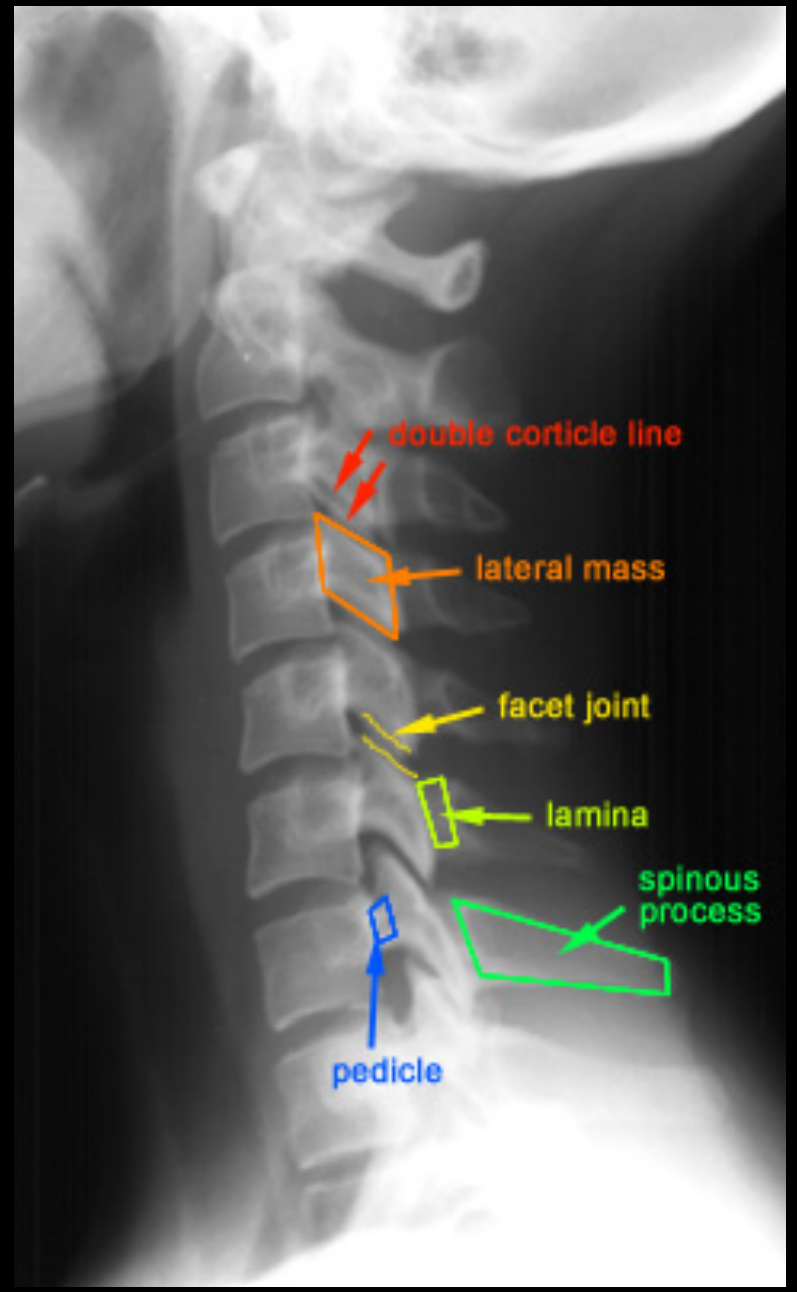
Outline each vertebral body - assess for loss of height that may represent a compression fracture and for small fragments that may represent avulsion



8. Assess for further fracture

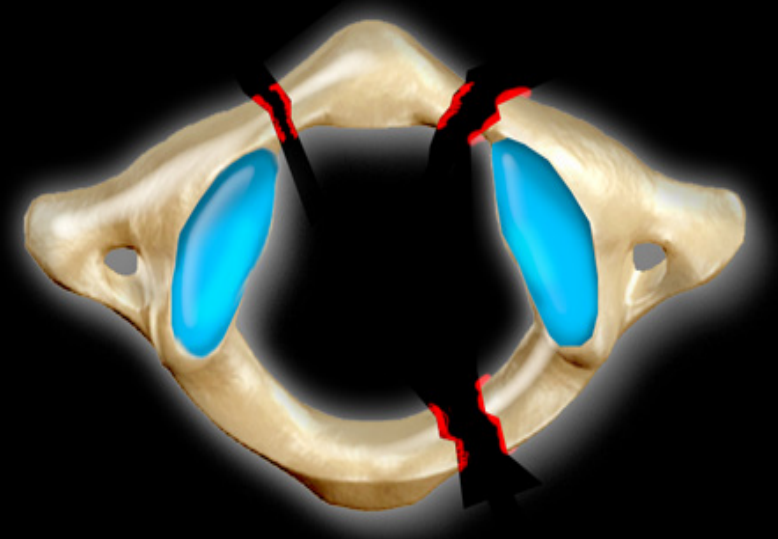
Check the occipital bone and mandible for fracture and check the mastoid air cells for a fluid level


Nuchal ligament
Supraspinous ligament

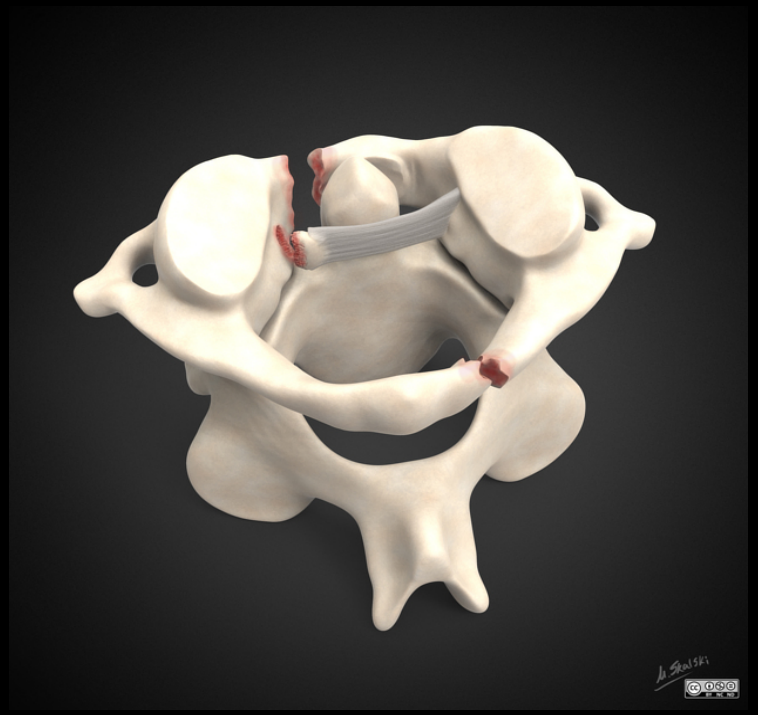

double corticle line
lateral mass
facet joint
lamina
spinous process
pedicle

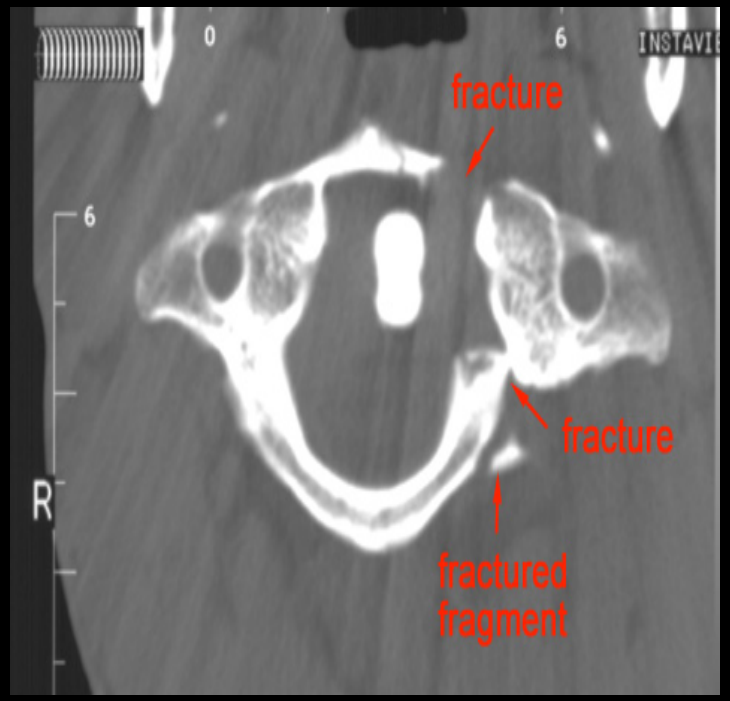
FRACTURES : JEFFERSON

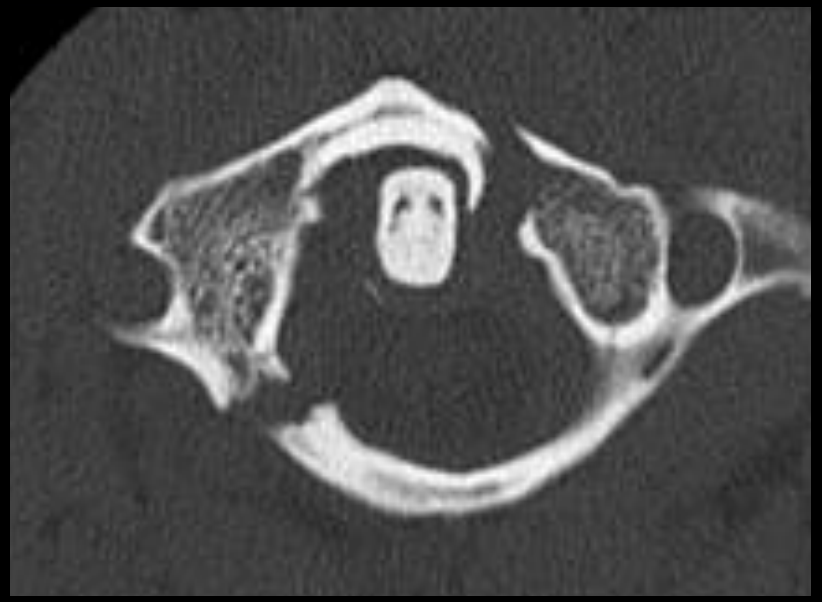
- A burst type fracture of C1 due to axial loading with fractures occurring through both the posterior and anterior arches.
- Typically seen in motor accidents.
- A typical mechanism of injury is diving headfirst into shallow water.
- Axial CT clearly shows the location of the fractures of C1



Jefferson fracture



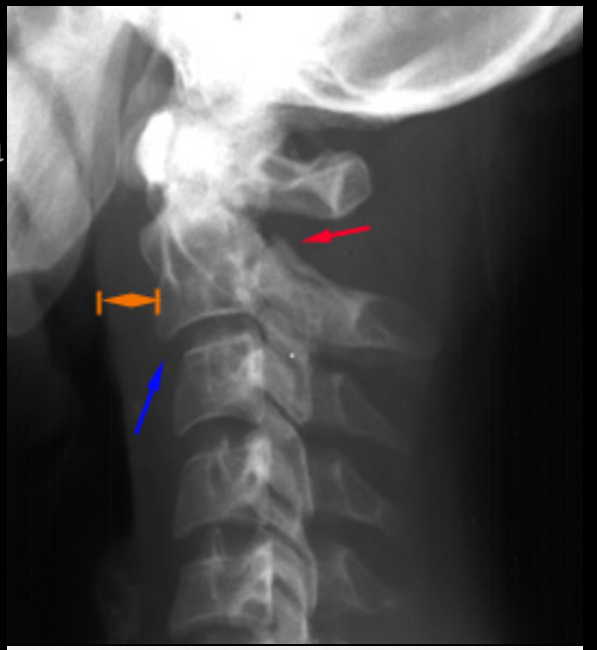


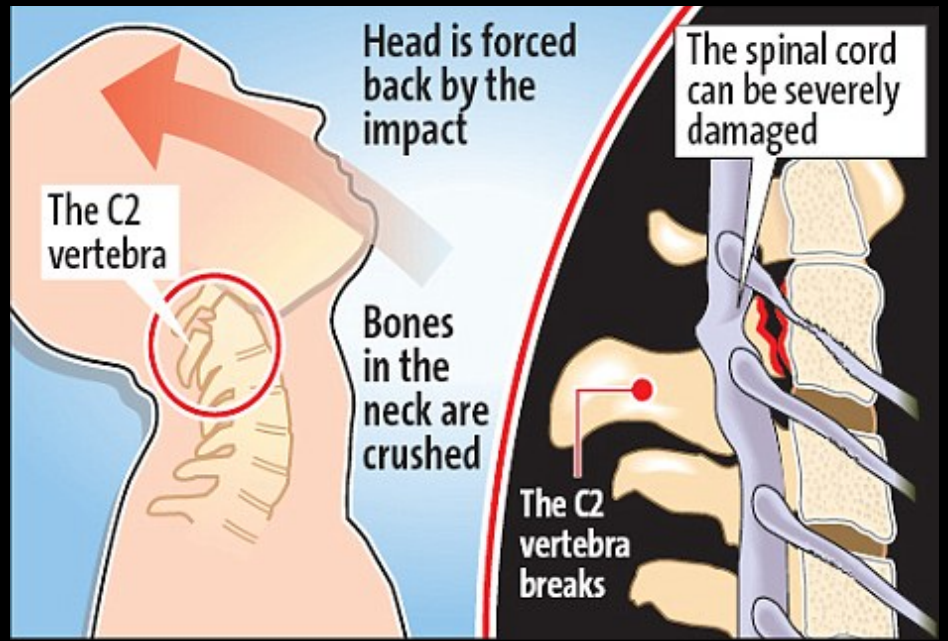


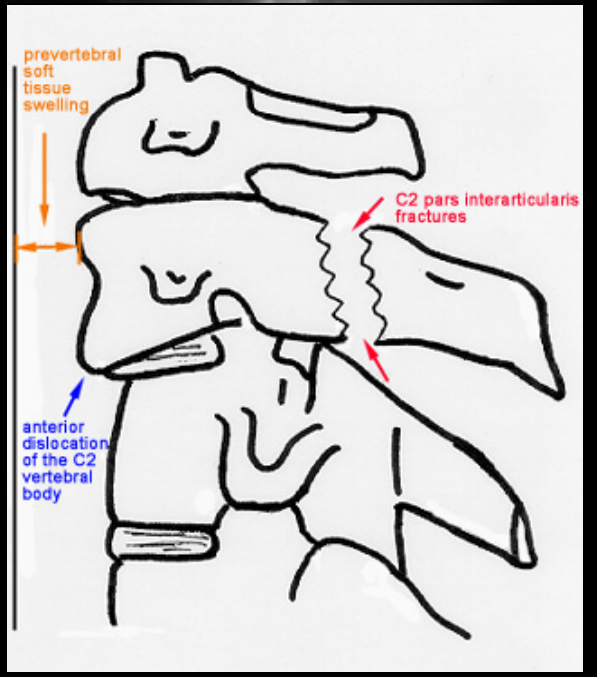
FRACTURES : HANGMAN'S

- Also known as **traumatic spondylolisthesis of the axis**, is a fracture which involves the pa interarticularis of C2 on both sides, and is a result of hyperextension(e.g. hanging, chin hits dashboard in road accident) and distraction.
- Radiographic Features (Best seen in lateral view)

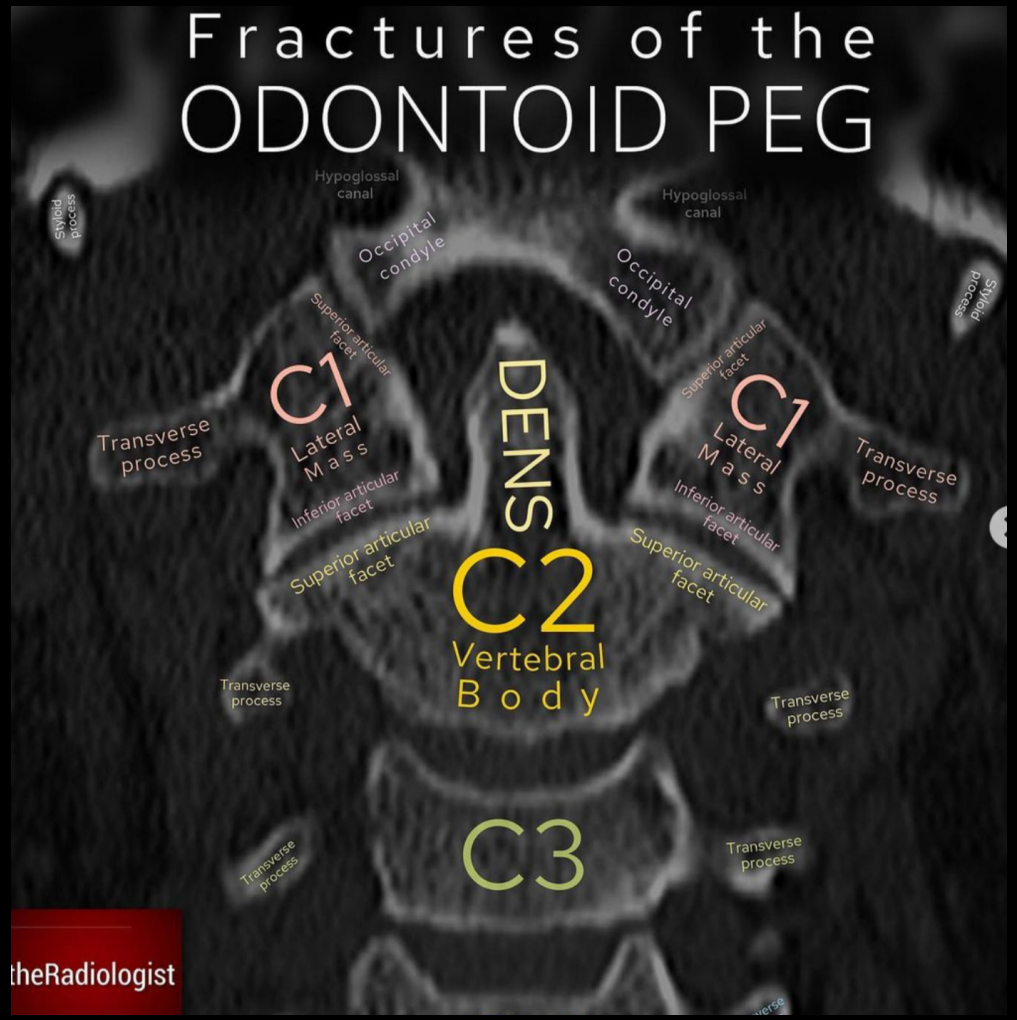
- Prevertebral soft tissue swelling.
- Avulsion of anterior inferior corner of C2
- Associated with rupture of anterior longitudinal ligament.
- Anterior dislocation of C2 vertebral body.
- Bilateral C2 pars interarticularis fractures



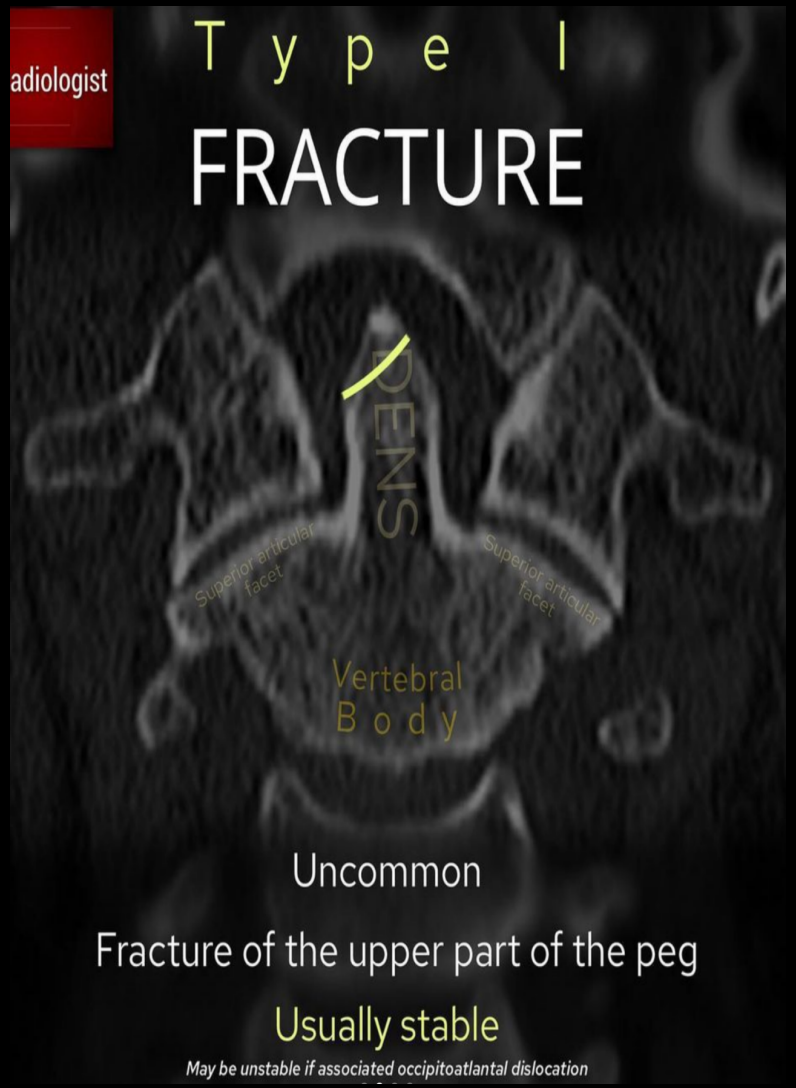


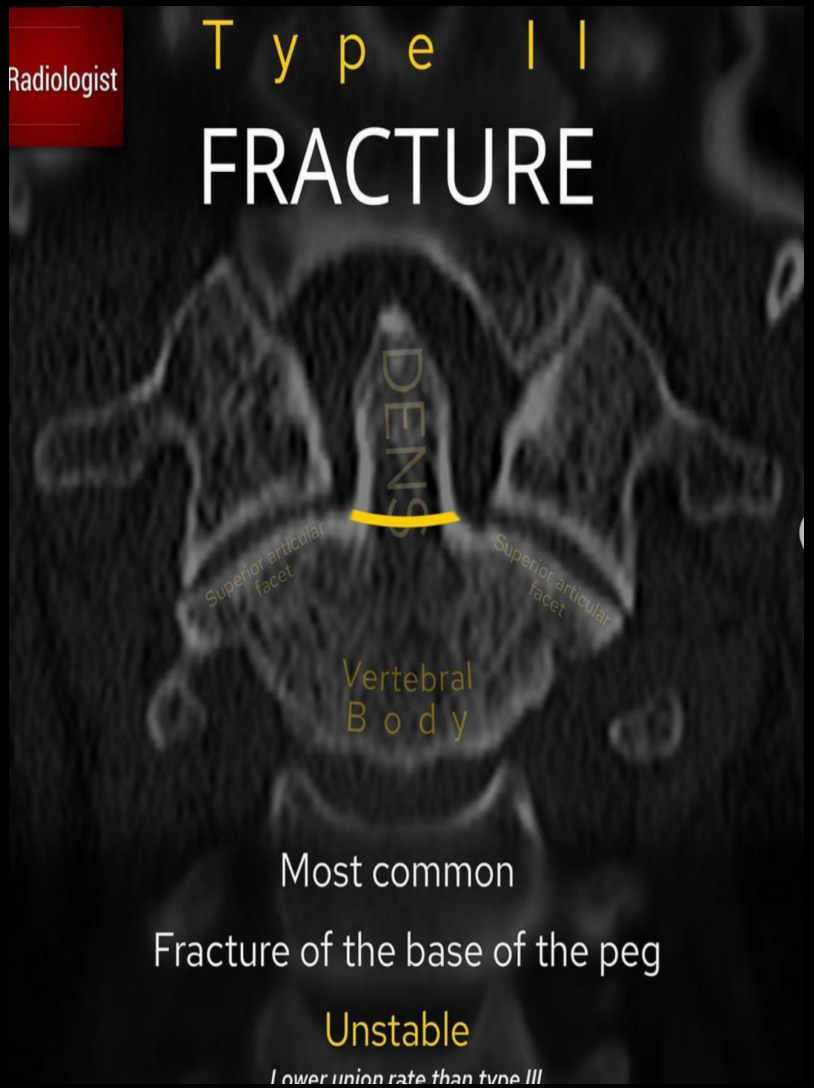


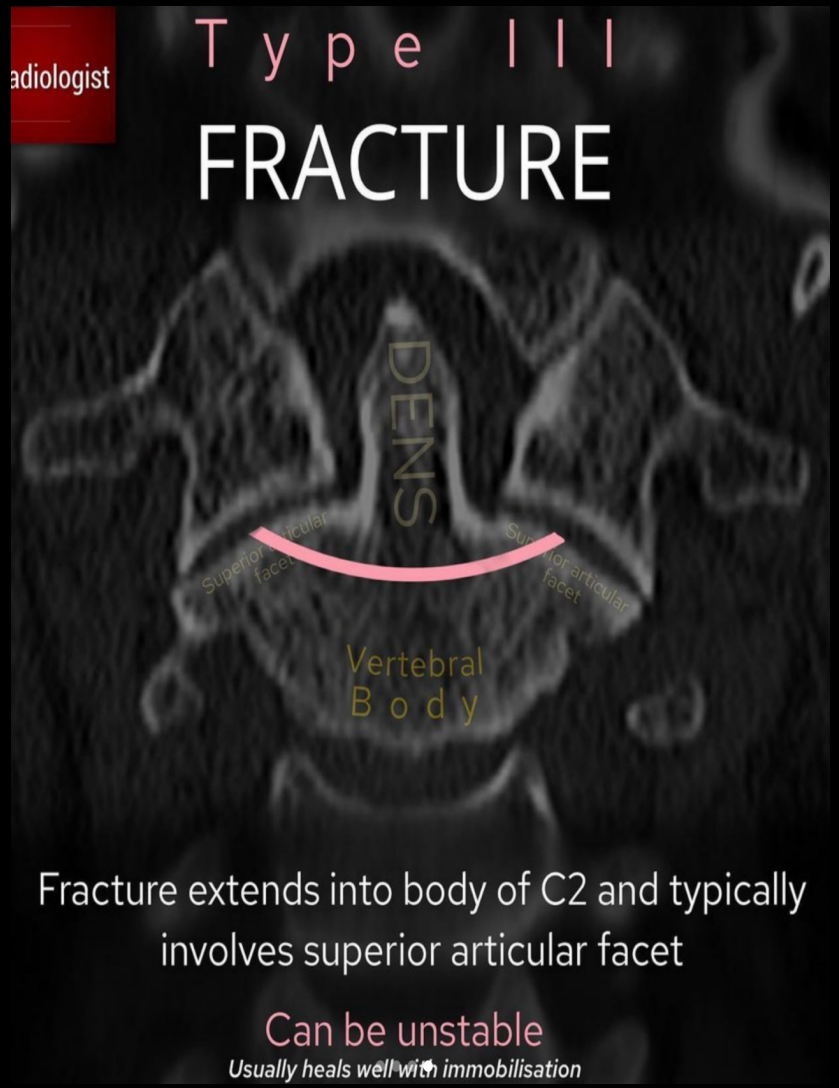
FRACTURES : DENS / ODONTOID



FRACTURES : DENS / ODONTOID







FRACTURES : COMPRESSION (A.K.A WEDGE FRACTURES)

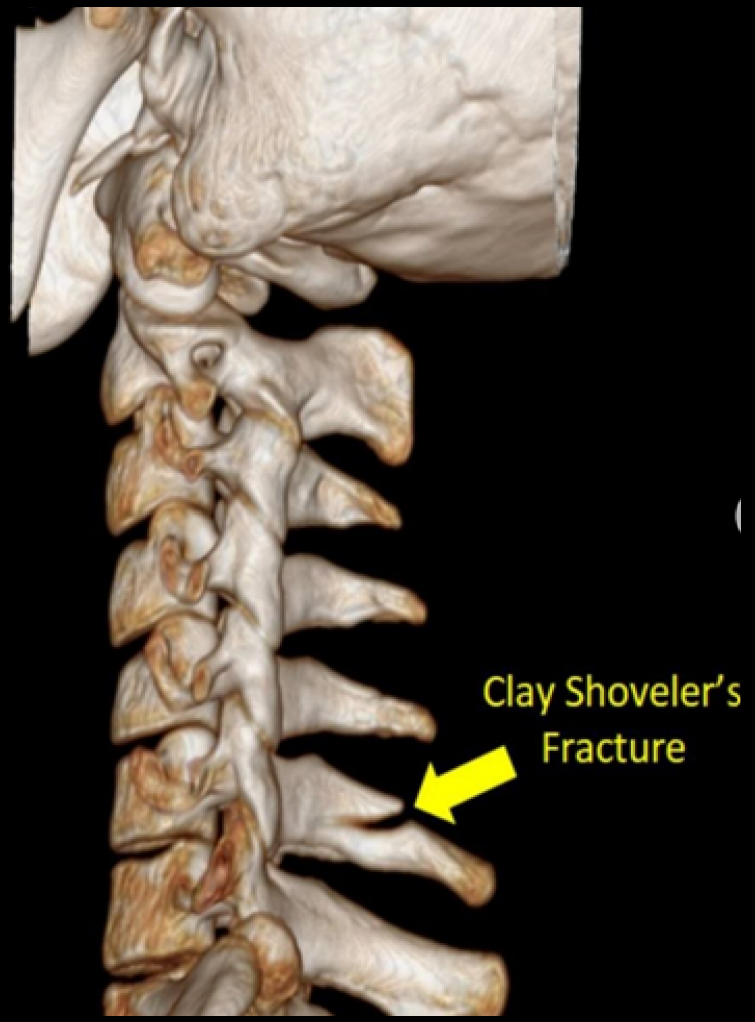
- They are hyperflexion injuries to the vertebral body resulting from axial loading. Most commonly affecting the anterior aspect of the vertebral body, wedge fractures are considered a single-column (i.e. stable) fracture.
- Differential Diagnosis : Burst Fracture: fracture of the anterior and posterior vertebral body (i.e. two-column injury)

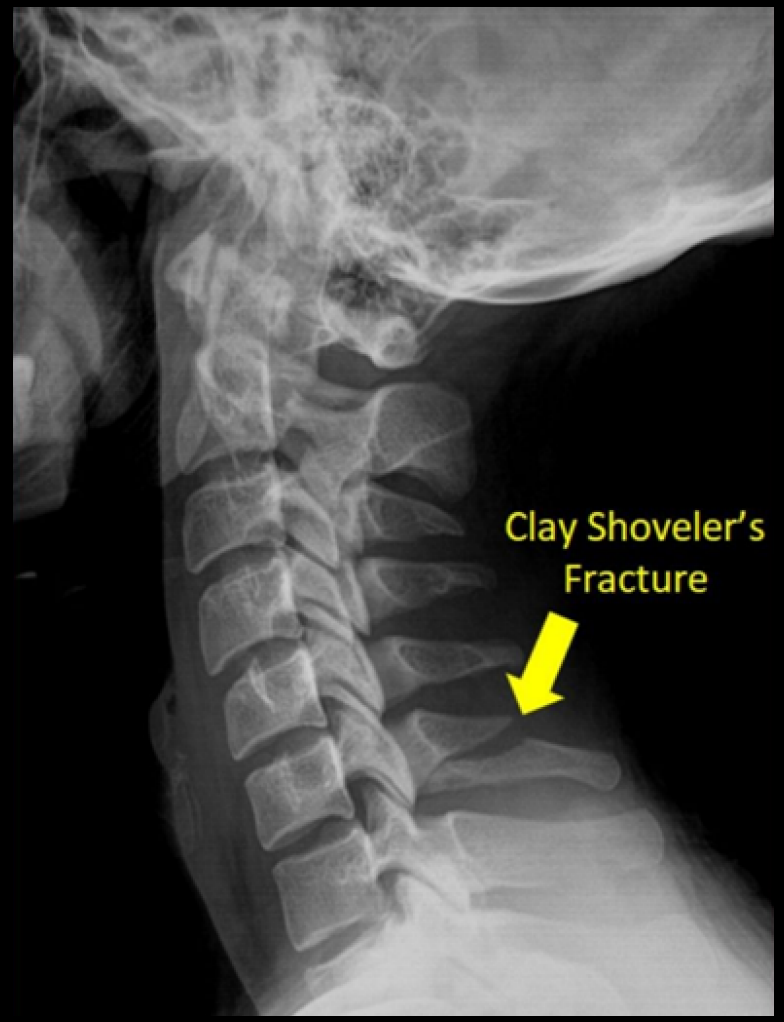
FRACTURES : BURST

A type of compression fracture related to high-energy axial loading spinal trauma that results in disruption of the posterior vertebral body cortex with retropulsion into the spinal canal.

FRACTURES : CLAY-SHOVELER'S

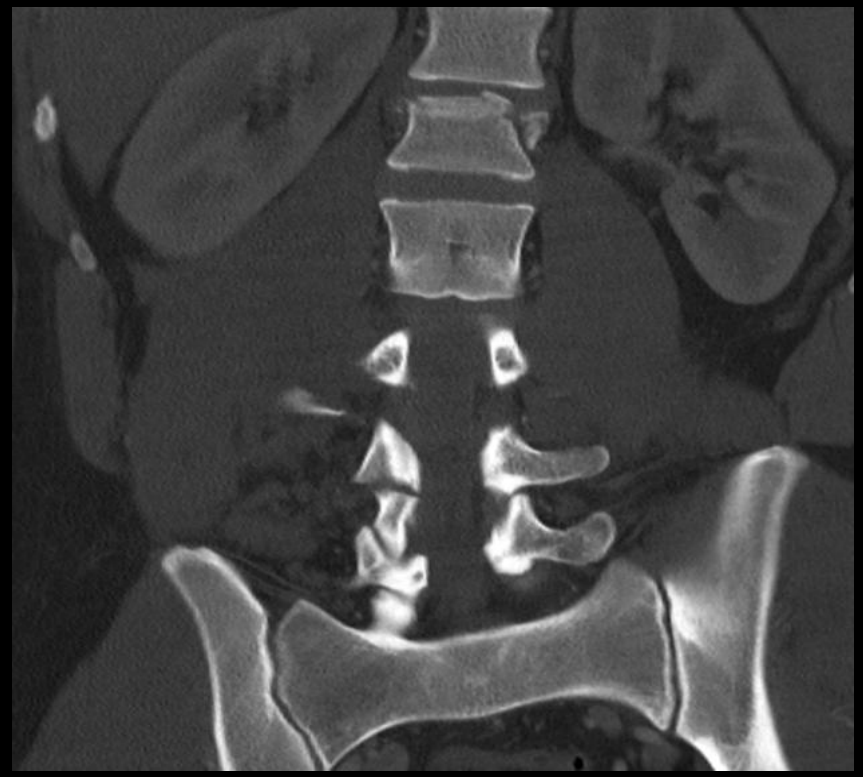
- Fractures of the spinous process of a lower cervical vertebra, usually C7.
- Acutely they tend to be associated with :
  - motor vehicle accidents
  - sudden muscle contraction
  - direct blows to the spine





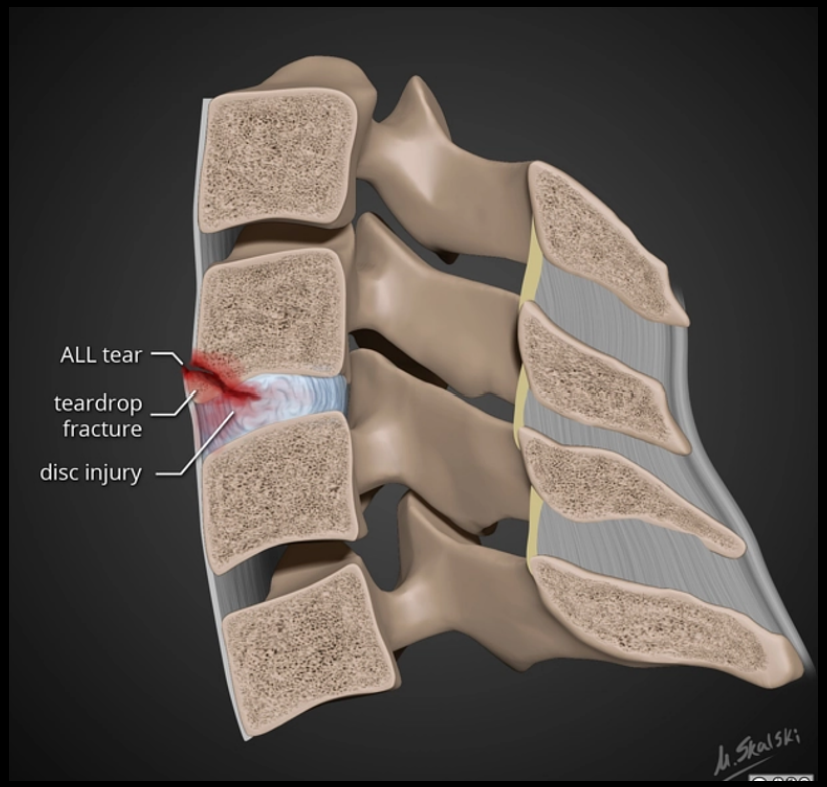
FRACTURES : CHANCE

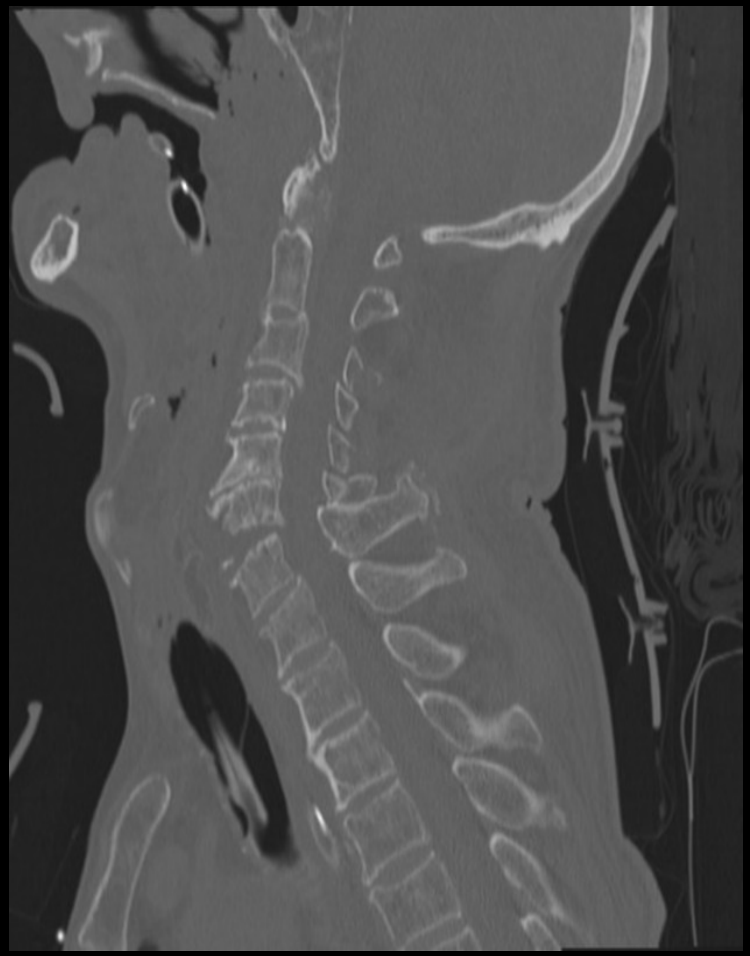
- **Chance fractures**, also referred to as **seatbelt fractures**, are flexion-distraction type injuries of the spine that extend to involve all three spinal columns. These are unstable injuries and have a high association with intra-abdominal injuries.
- Imaging Differential Diagnosis : Vertebral burst fracture.



FRACTURES :TEAR DROP (EXTENSION)

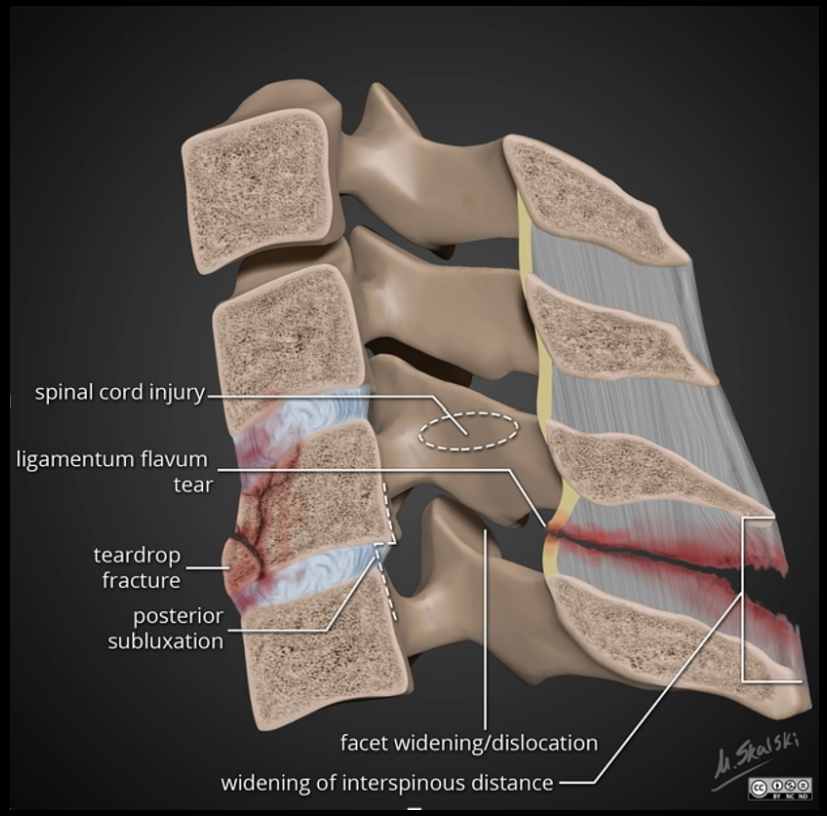
- They occur due to forced extension of the neck (i.e. is a hyperextension injury) with resulting avulsion of the anteroinferior corner of the vertebral body.
- Stable in flexion and unstable in extension as the anterior longitudinal ligament.





FRACTURES :TEAR DROP (FLEXION)

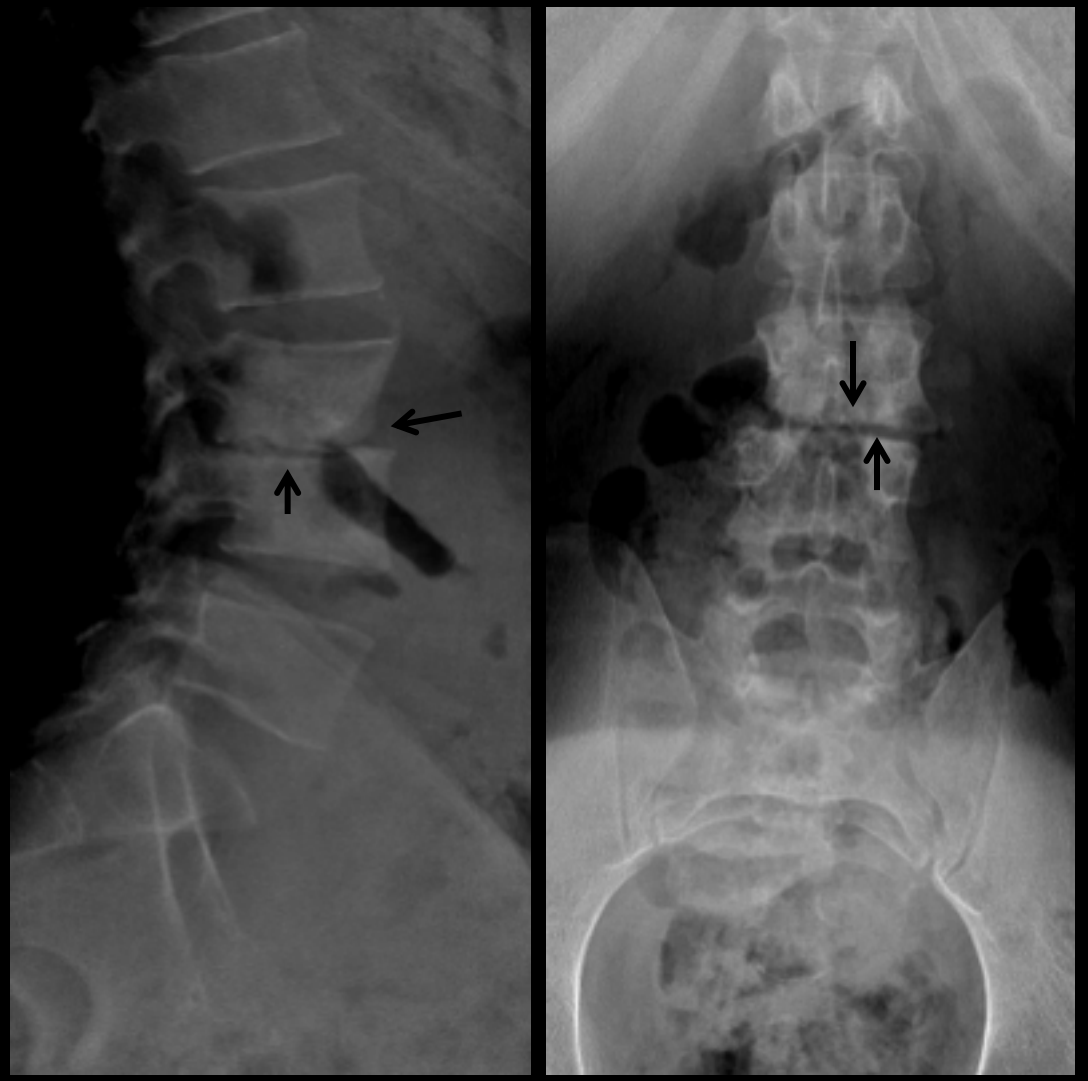
- The injury typically occurs from severe flexion and compression forces (e.g. diving impact, deceleration during motor vehicle collision).
- Extensive underlying ligamentous injury and spinal instability.
- Associated spinal cord injury is common.
- More severe than extension teardrop.



INFECTIONS

INFECTIONS : SPONDYLODISCITIS

- Also referred to as **discitis-osteomyelitis**, is characterized by infection involving the intervertebral disc and adjacent vertebrae.
- **Usually the result of blood–borne agents** :
  - Staphylococcus (More common)
  - Streptococcus (Less common)
  - Gram-negative rods in IV drug abusers or immunocompromised patients
  - Others : E. Coli, proteus, non-pyogenic, tuberculosis, brucellosis.
- May occur after invasive procedure like surgery, discography, myelography.
- In children, infection begins in vascularized disc.
- In adults, in anterior inferior corner of vertebral body with spread across disk to adjacent vertebral endplate.



Narrow and destruction of L3-L4 disc space with irregular erosions of opposing endplates

INFECTIONS : SPONDYLODISCITIS

PLAIN FILM :

- Narrowing and destruction of an intervertebral disk.
- Indistinct adjacent endplates with destruction
- Often associated with bony sclerosis of the two
- Contiguous vertebral bodies
- Paravertebral soft tissue mass
- Endplate sclerosis (during healing phase beginning anywhere from 8 weeks to 8 months after onset)
- Bone fusion after 6 months to 2 years.

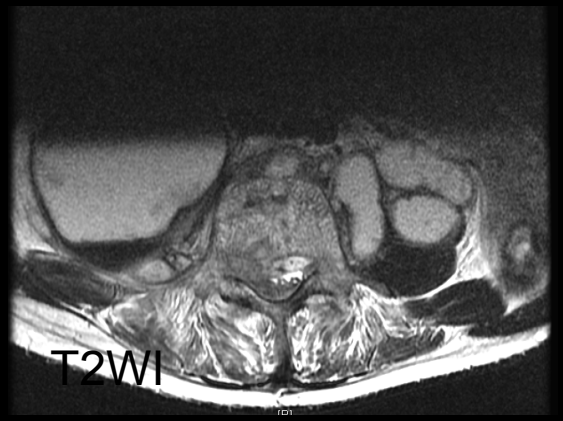
MRI :

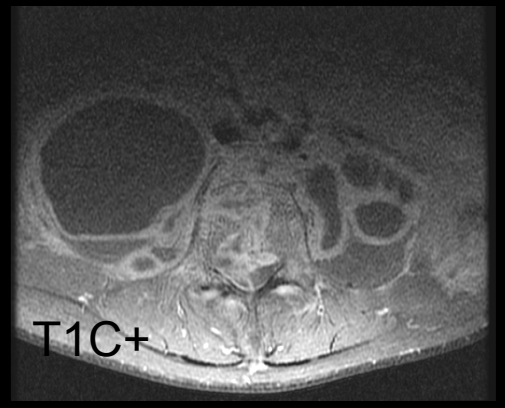
- Bone marrow edema in infected vertebrae, discs and paraspinal soft tissues.
- Dark on T1 and bright on T2 images.
- Enhancement of inflamed tissues after contrast.
- Fluid collections (abscesses) are common.

T1WI

T2WI

T1C+



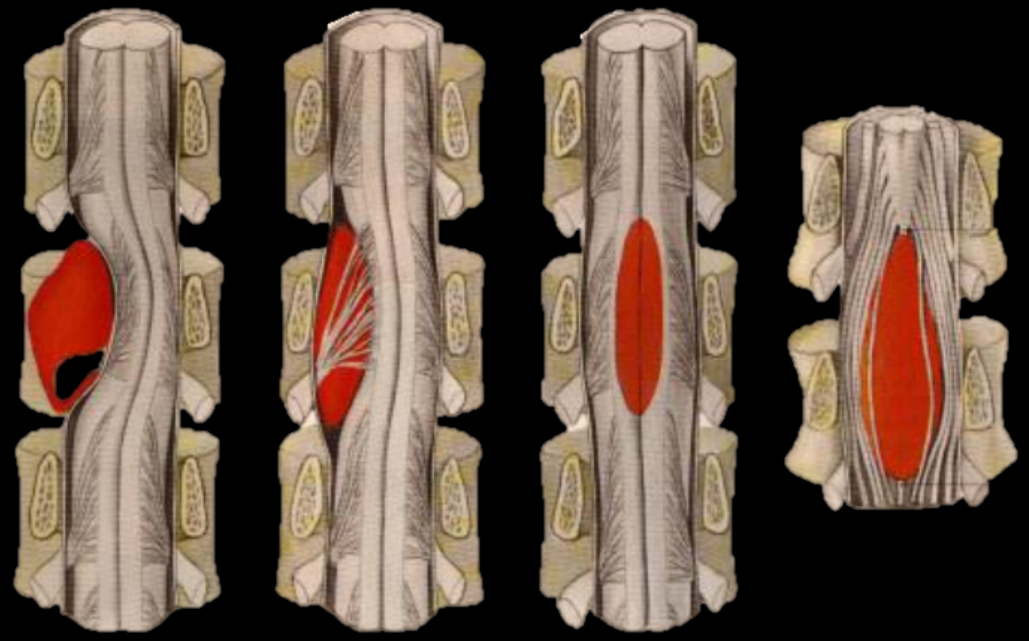


INFECTIONS :TUBERCULOUS SPONDYLITIS (POTT DISEASE)

- Also known as **Pott disease**, refers to vertebral body osteomyelitis and intervertebral diskitis from tuberculosis (TB). The spine is the most frequent location of musculoskeletal tuberculosis, and commonly related symptoms are back pain and lower limb weakness/paraplegia.

TUMORS

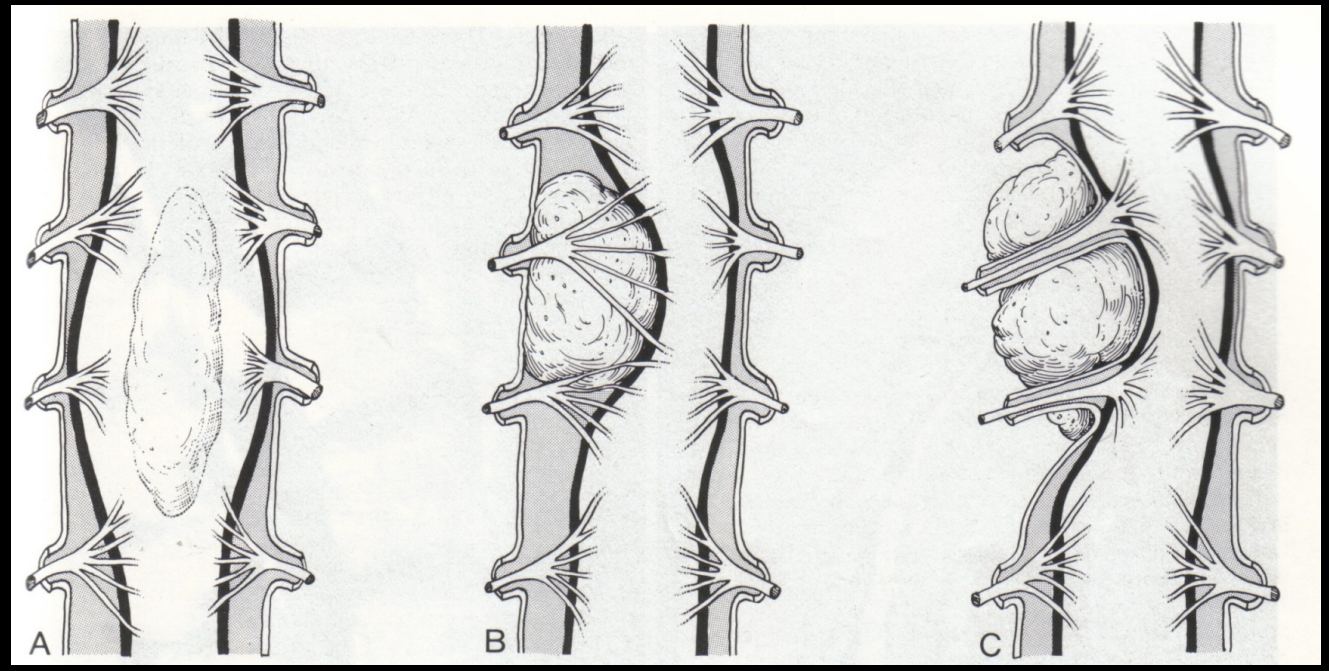
SPINAL COMPARTMENTS



Extradural

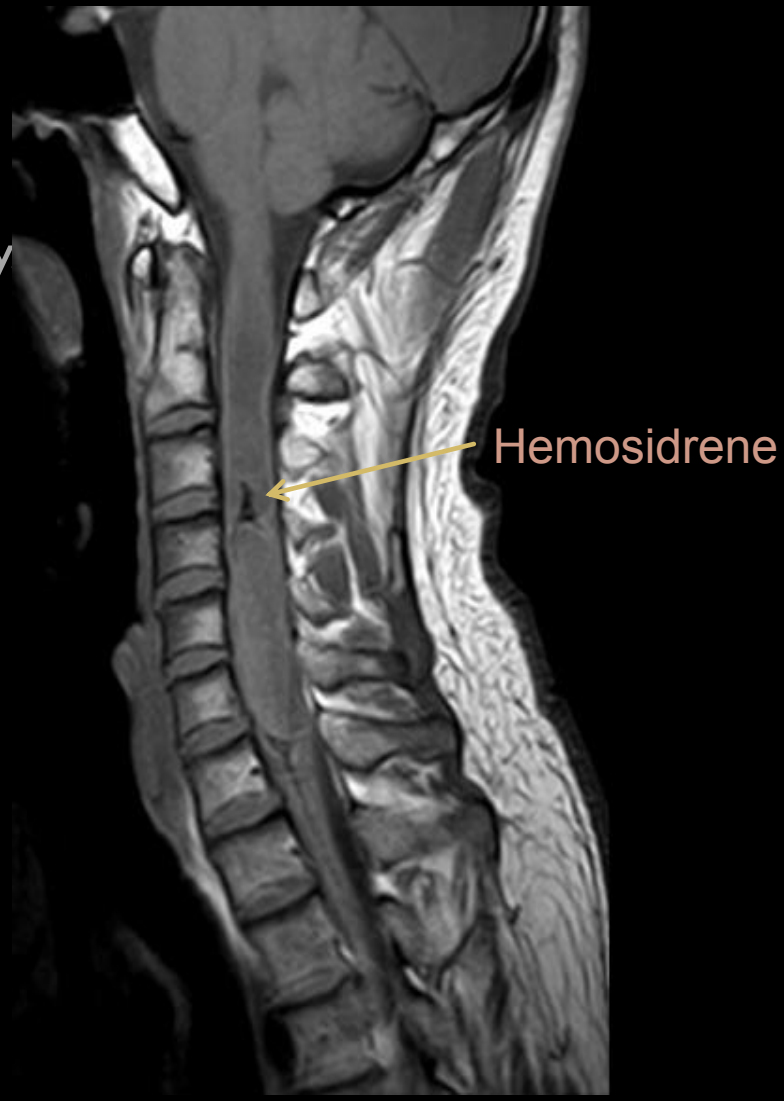
Intradural Extramedullary

Intramedullary



TUMORS : EPENDYMOMA

- Most common spinal cord tumor
- Intramedullary
- Histological subtypes : Cellular, papillary clear cell, tanycytic, melanotic
- They arise from the central canal, distribution is uneven with majority being within cervical cord.
- Best seen in sagittal images
- Adjacent Syrinx extending above or below the tumor.
- Hemosiderin Cap : Due to bleeding of lesions



TUMORS : ASTROCYTOMA

- Second most common spinal cord tumor.
- Intramedullary
- They arise from the cord parenchyma, they typically have an eccentric location within the spinal cord.

TUMORS : SCHWANNOMA

- Most common nerve sheath tumor within the spinal canal.
- Intradural Extramedullary
- They arise from the spinal nerve roots.
- Frequently associated with hemorrhage, intrinsic vascular changes (thrombosis), cyst and fatty degeneration.

TUMORS : IVORY VERTEBRA

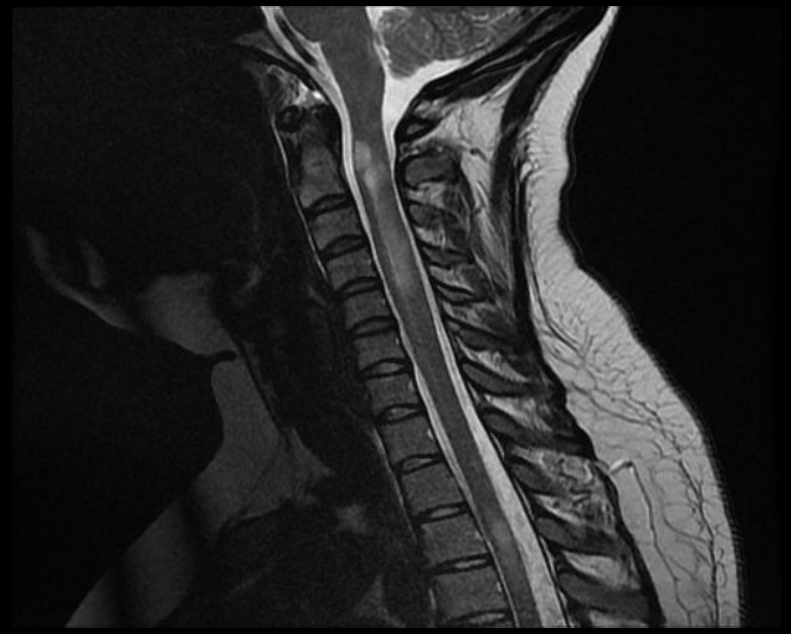
- Most common cause of ivory vertebra in pediatric is Lymphoma.
- Most common cause of ivory vertebra in adults is metastatic disease.
- Fig 2 shows ivory vertebra due to metastatic prostate cancer

Figure 2

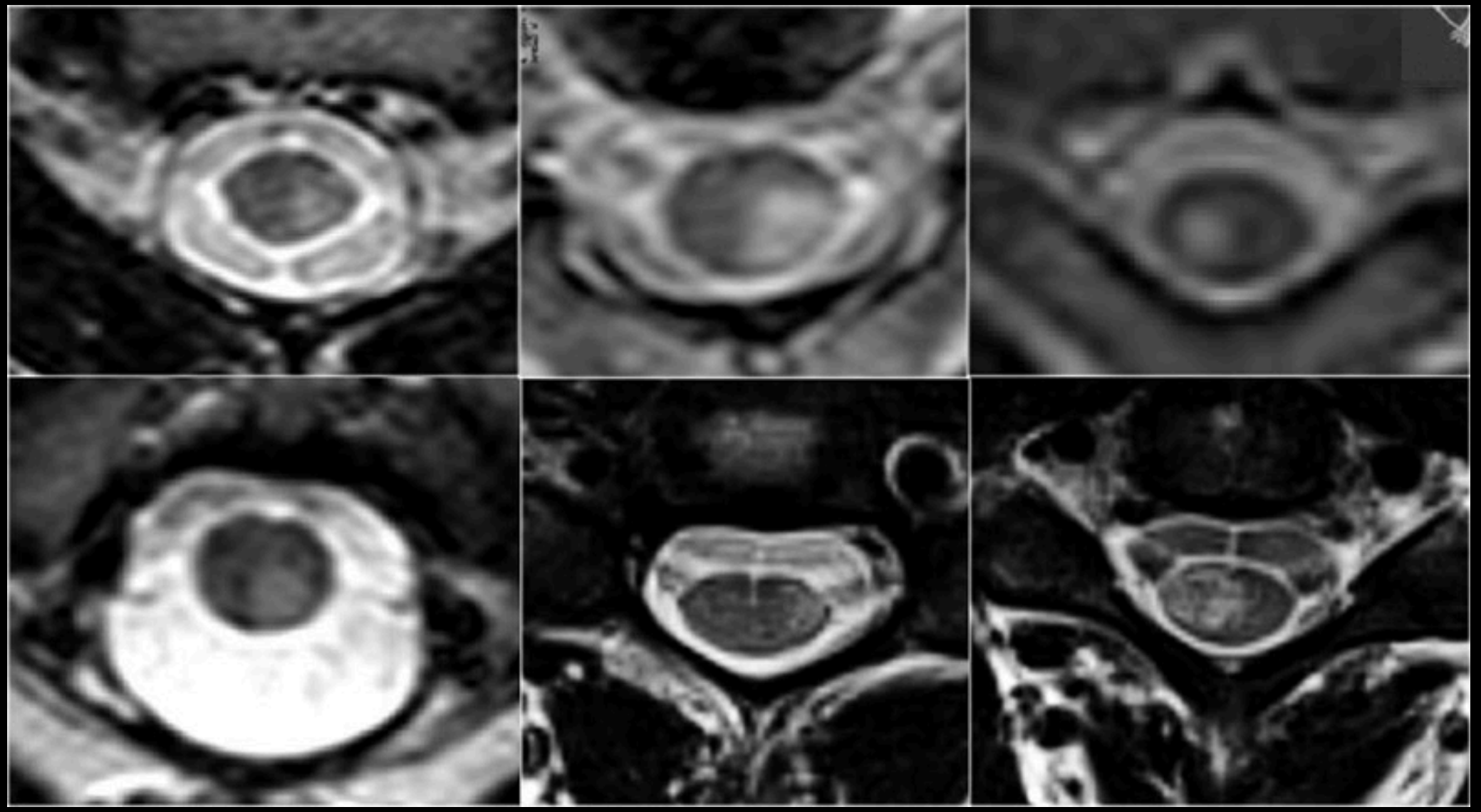
INFLAMMATION

INFLAMMATION : MULTIPLE SCLEROSIS (MS)

- An immune-mediated inflammatory demyelinating disease of the brain and the spinal cord.
- The most common demyelinating disease and there is overlap between these diseases:
  - NMO was first thought to be a form of MS, but is - now considered to be a distinct form.
  - ADEM can relapse and progress to MS.
  - The partial form of transverse myelitis



INFLAMMATION : MULTIPLE SCLEROSIS (MS)



NON-INFLAMMATORY

NON-INFLAMMATORY : SPONDYLOSIS

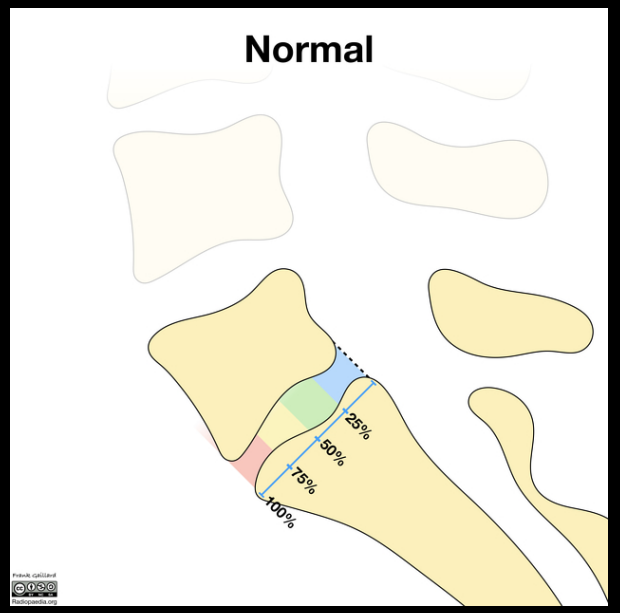
- **Spondylosis** is used as a broad descriptive term referring to degeneration of the spinal column from any cause; it is usually further qualified by the part of the spine affected.
- The key parameters are :
- Osteophyte formation,
- Intervertebral disc height narrowing
- Vertebral end-plate sclerosis

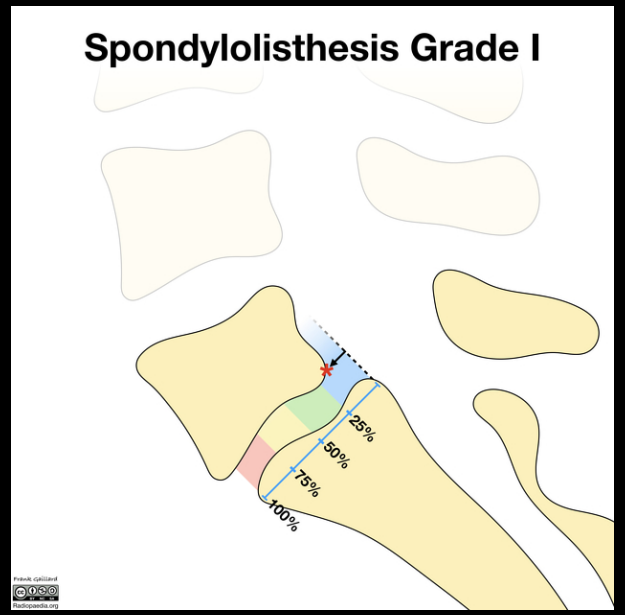
NON-INFLAMMATORY : SPONDYLOLYSIS

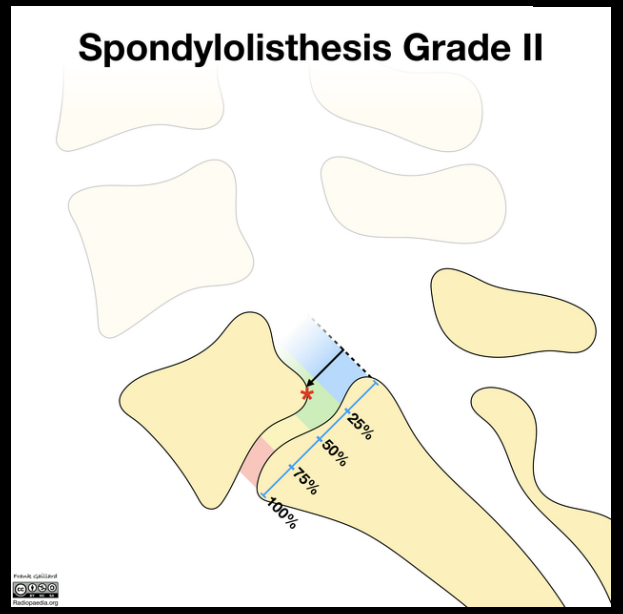
- **D**efect in the pars interarticularis of the neural arch, the portion of the neural arch that connects the superior and inferior articular facets. It is commonly known as **pars interarticularis defect** or more simply as **pars defect**.
- Believed to be caused by repeated microtrauma, resulting in a stress fracture of the pars interarticularis
- 90% of cases of spondylolysis occur at the L5 level.

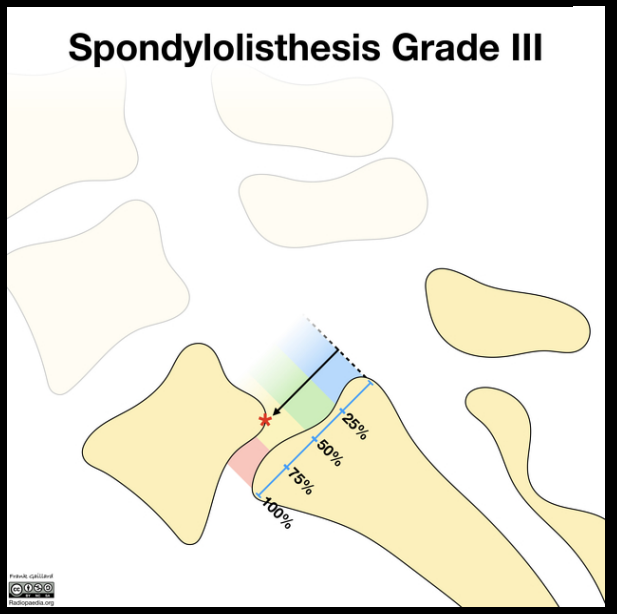
NON-INFLAMMATORY : SPONDYLOLISTHESIS

- **Spondylolisthesis** (plural: spondylolistheses) denotes the slippage of one vertebra relative to the one below.
- It can occur anywhere but is most frequent, particularly when due to spondylolysis, at L5/S1 and to a lesser degree L4/L5

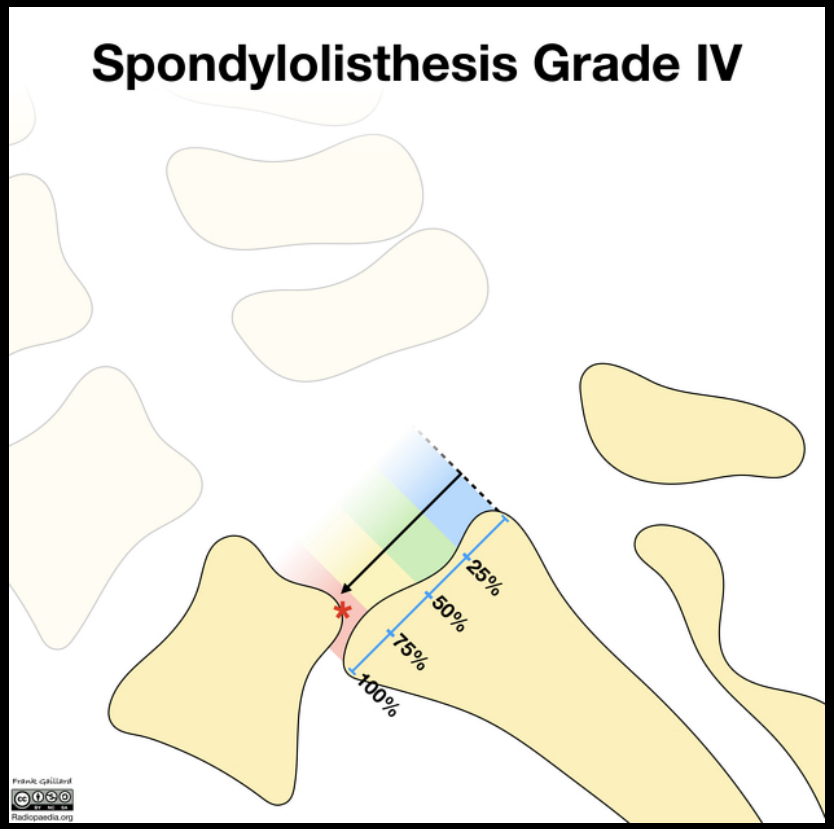


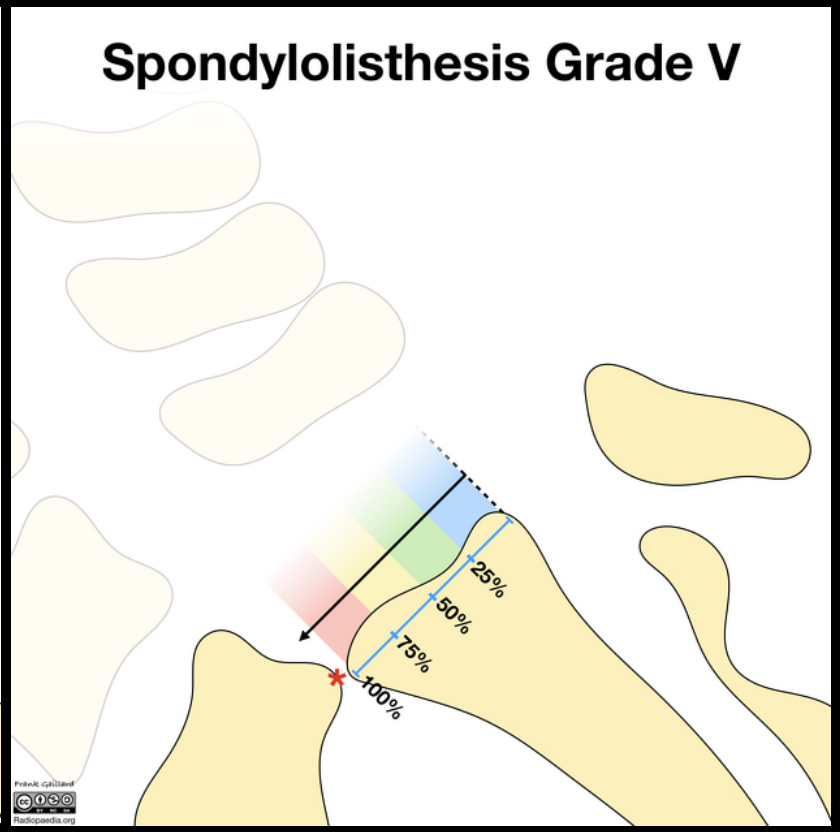






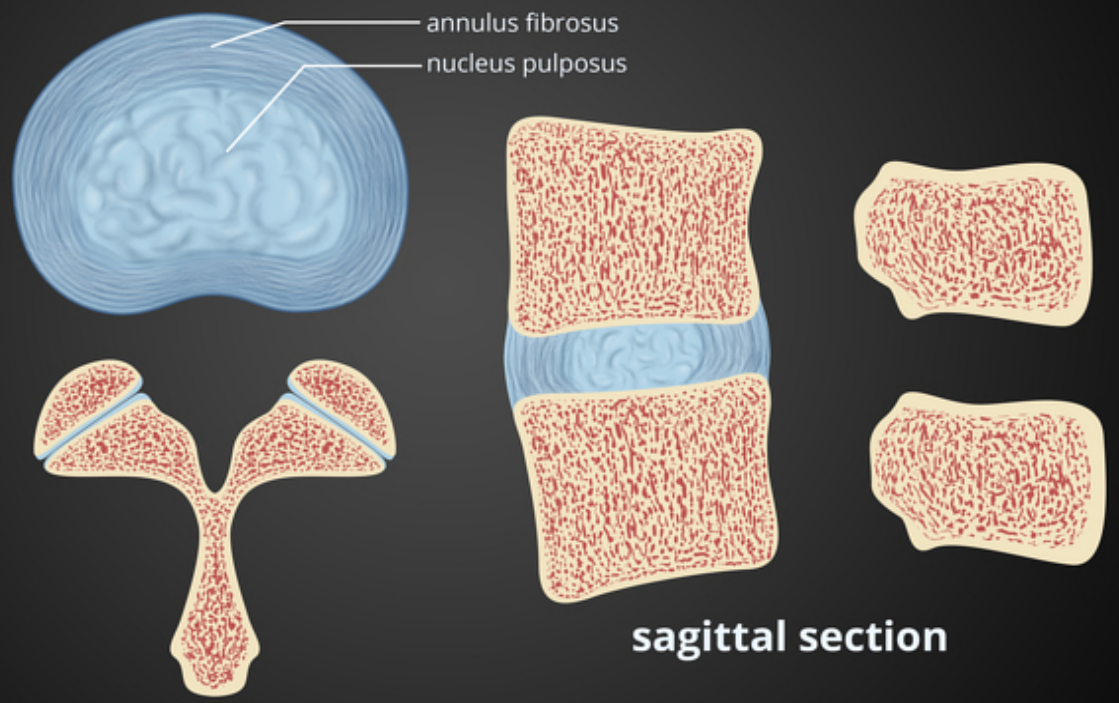
NON-INFLAMMATORY : SPONDYLOLISTHESIS

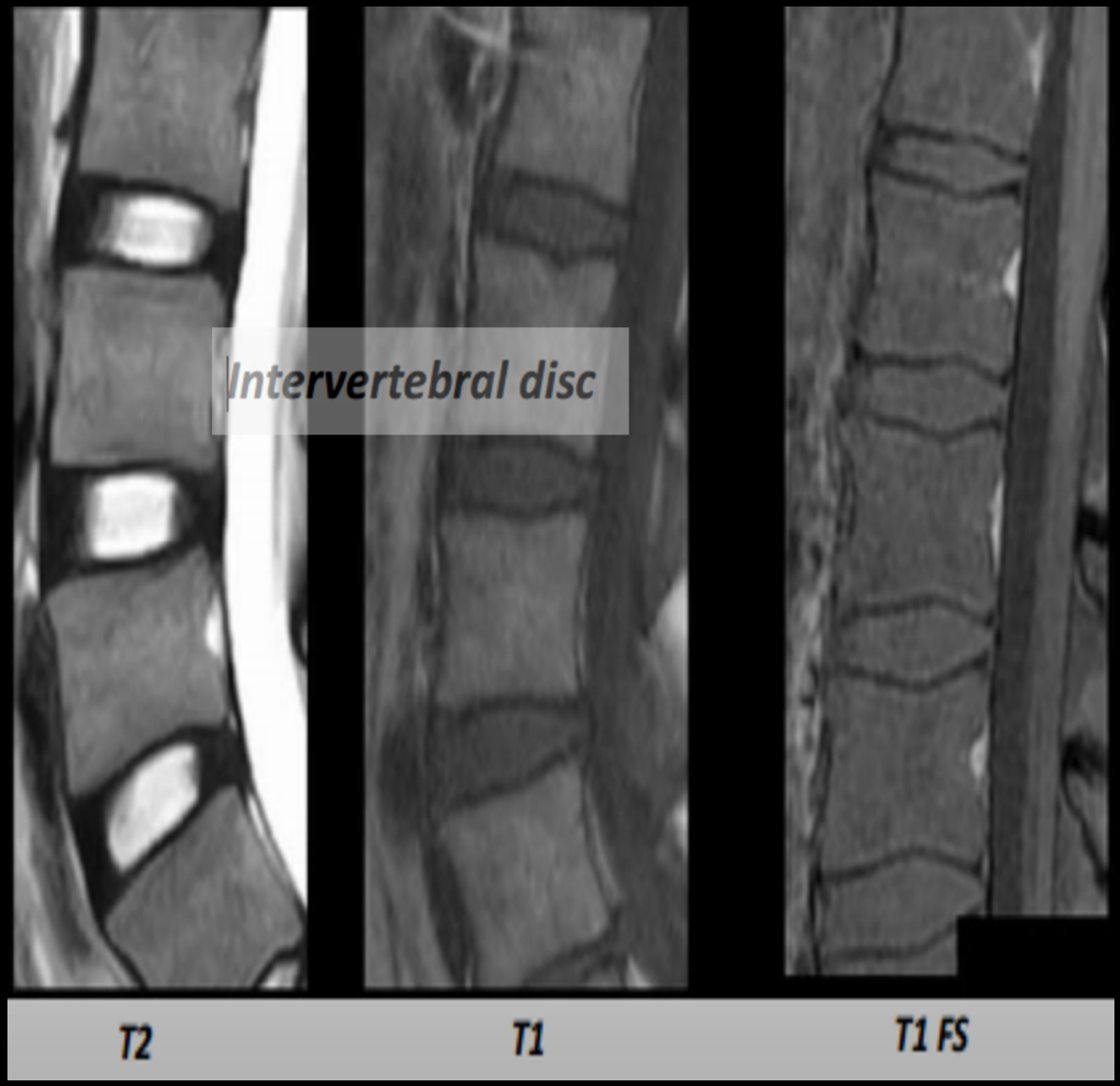




DISK DISEASES

Normal disc morphology

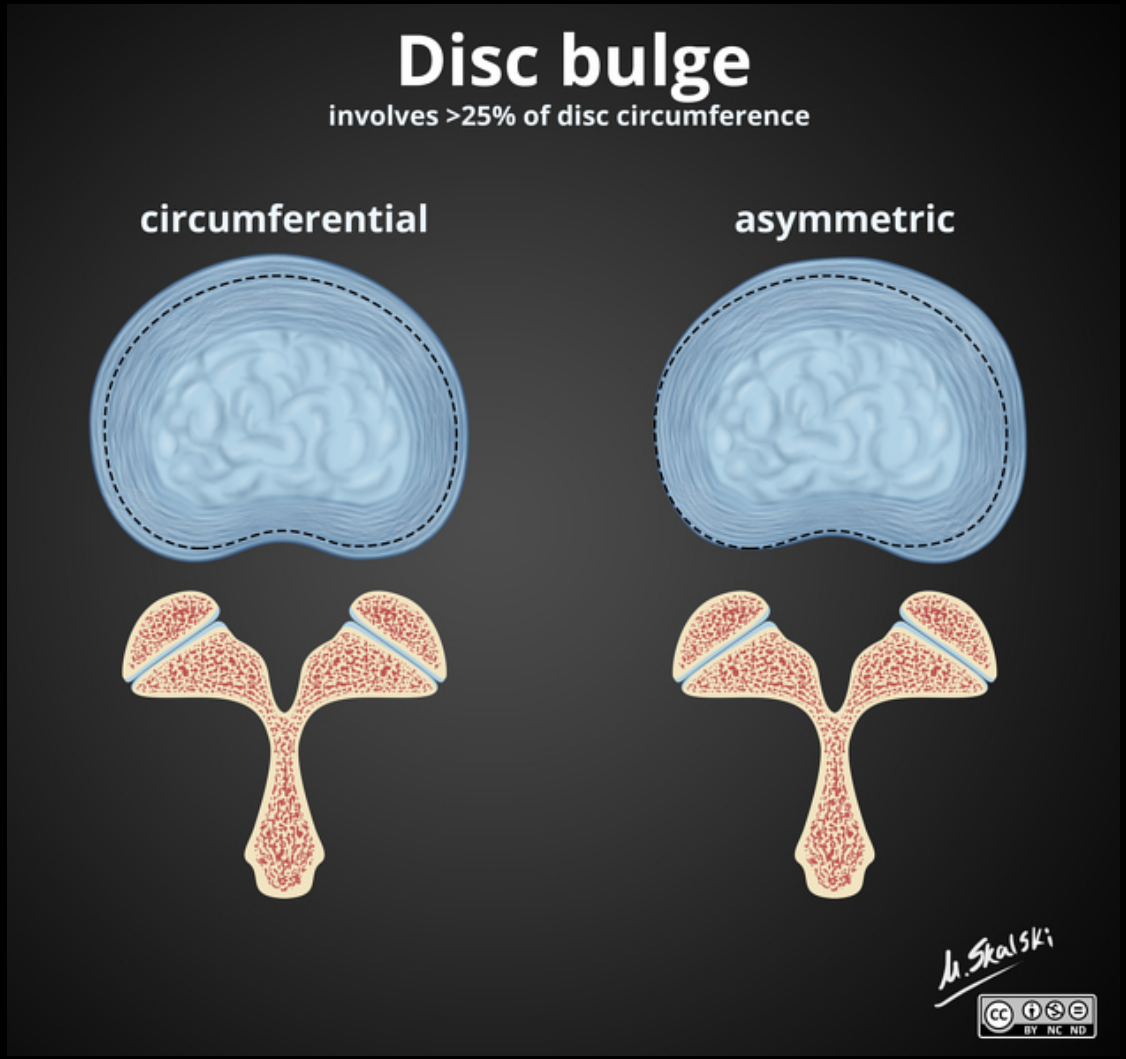




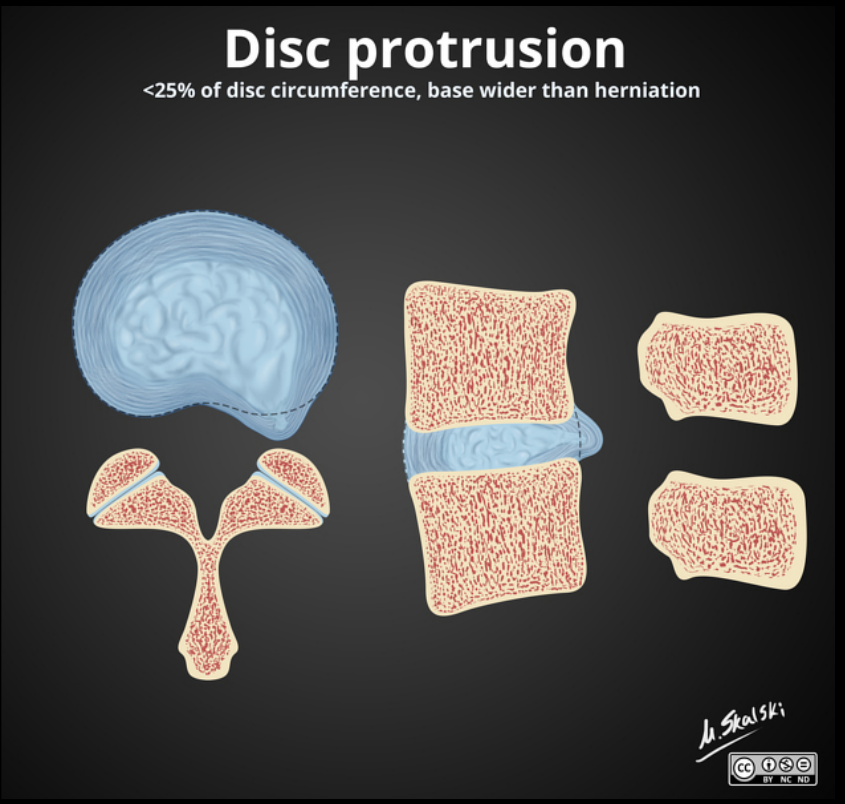
DISK DISEASE : DISK BULGE

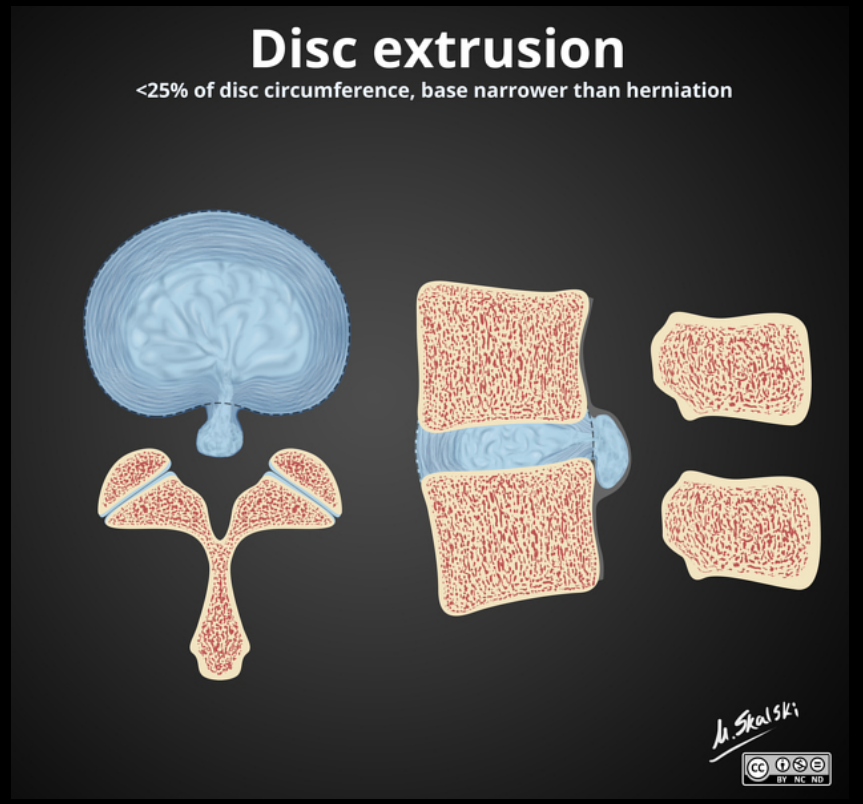
- Displacement of the outer fibers of the annulus fibrosus beyond the margins of the adjacent vertebral bodies.
- Involving more than one-quarter (25% or 90 degrees) of the circumference of an intervertebral disc.
- Divided into :

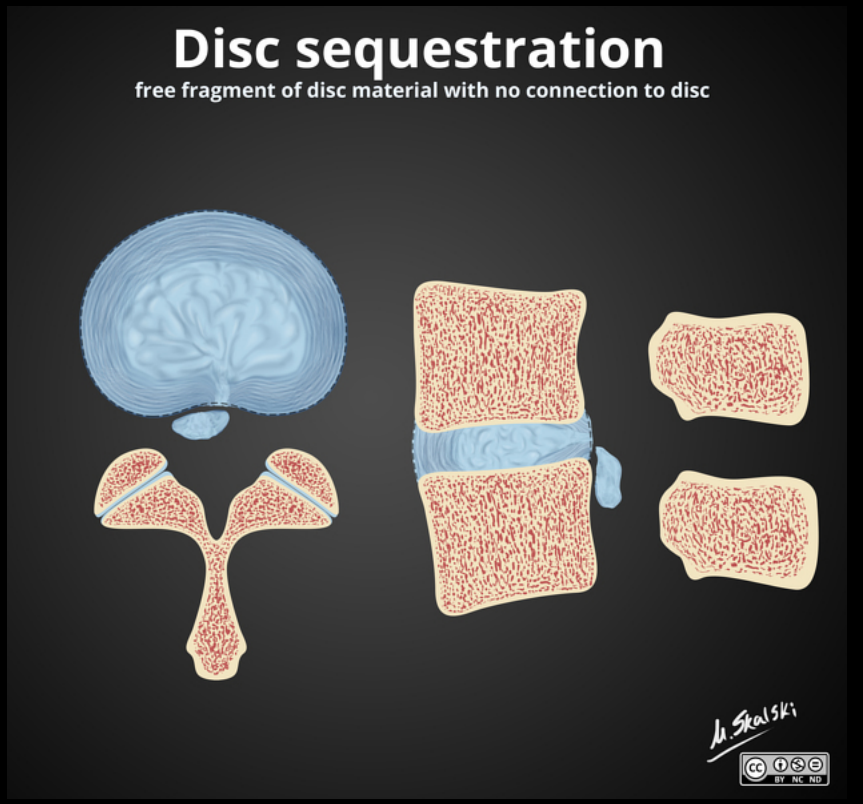
- Circumferential bulge: involves the entire disc circumference.
- Asymmetric bulge : does not involve the entire circumference, but nonetheless more than 90 degrees.



DISK DISEASE : DISK HERNIATION

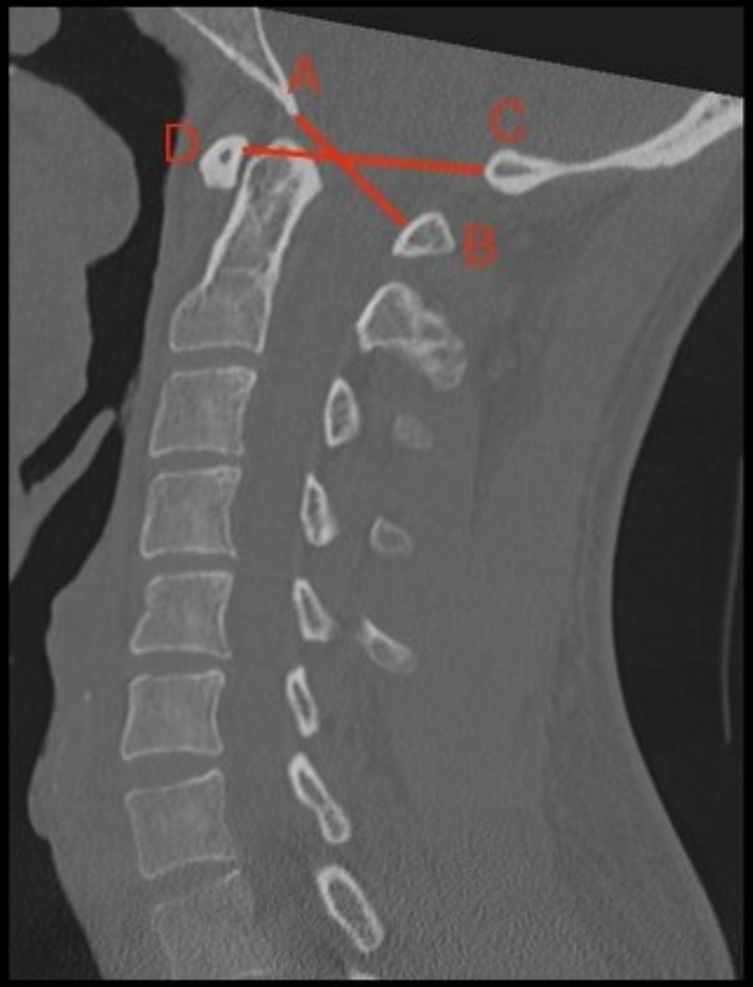






CRANIOCERVICAL MEASUREMENTS : POWERS RATIO

- The **Powers ratio** is a measurement of the relationship of the foramen magnum to the atlas, used in the diagnosis of atlanto-occipital dissociation injuries.
- Powers Ratio= AB/CD, is measured as the ratio of the distance in the median (midsagittal) plane between the:
- basion (A) and the posterior spinolaminar line of the atlas (B)
- Opisthion (C) and the anterior arch of the atlas (D)
- Normal values are <1 on plain radiographs and <0.9 on CT .
- If this ratio is >1, then it suggests cranio-cervical junction instability.
- Usually used in assessing trauma cases.

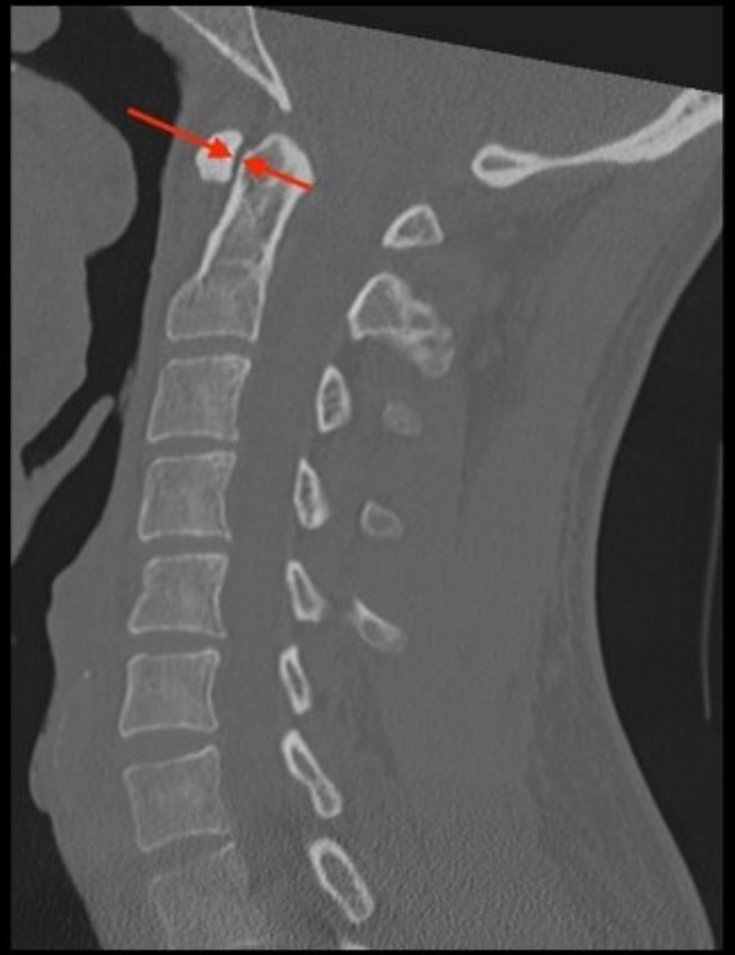


CRANIOCERVICAL MEASUREMENTS : ATLANTO-DENTAL INTERVAL

- The **Atlantodental interval** (ADI) is the horizontal distance between the anterior arch of the atlas and the dens of the axis, used in the diagnosis of atlanto-occipital dissociation injuries and injuries of the atlas and axis.
- Normal values:
  Radiograph:
  - Adults: Male <3mm Female <2.5mm
  - Children: <5 mm

  CT: Adults: <2 mm
- Hence, abnormal ADI value may suggest rupture/injury of (alar ligament, apical ligament, transverse ligament).
- ADI >3mm also suggests narrowing of the spinal canal (spinal cord compression).
- Abnormal ADI is usually seen in

- Rheumatoid Arthritis
- Down Syndrome
- Os odentoideum



ThankYou