Lecture 10:

# Radiology of spinal Diseases

Radiology Team
Med433

● Slides ● Explanation ● Notes ● Additions ● Important

# Objectives

Not given

# Imaging Methods to Evaluate Spine

- ✓ **Plain X-Ray Films.** (it's usually the first used imaging modality)
- ✓ **Myelogram** – injection of contrast medium in CSF through lumbar puncture followed by x-ray images. Rarely performed now-a-days. (because of risk of injury and infections.Only performed in selective cases that is contraindicated to MRI).
- ✓ **Computed Tomography (CT Scan):** best for bones, less for tissues.
- ✓ **Magnetic Resonance Imaging (MRI):** best for soft tissues, less for bones.

} **In spinal cases usually both are done.**

- ✓ **Discogram** - injection of contrast medium in the disc followed by x-ray images. (because of similar information we can perform it only in selected cases that is contraindicated to MRI)
- ✓ **Spinal angiography** – We inject a contrast in the spinal artery, to evaluate arteries and veins. Very rarely used now.
- ✓ **Ultrasound** – more in children. ( because the skeleton is still cartilaginous compared to the adult )
- ✓ **Radionuclide Bone Scan** – intravenous injection of radioactive material bound to phosphonates which deposit in bones, followed by images by gamma camera. (Performed to evaluate the whole skeleton when multiple lesions are suspected).
- ✓ **DEXA** – radionuclide scan for bone density (osteoporosis).

# X-RAYS (RADIOGRAPHS)

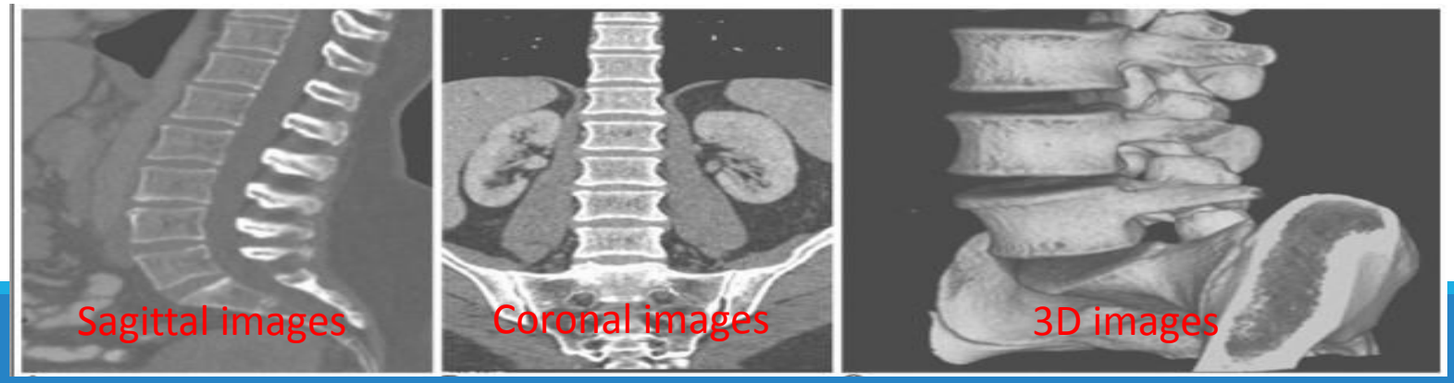
- Often the first diagnostic imaging test, quick and cheap.
- Small dose of radiation to visualize the bony parts of the spine.
  - **Can detect:**
    - Spinal alignment and curvature.(scoliosis , kyphosis)
    - Spinal instability – with flexion and extension views.
    - Congenital (birth) defects of spinal column.
    - Fractures caused by trauma.
    - Moderate osteoporosis (loss of calcium from the bone).
    - Infections.
    - Tumors.
- May be taken in different positions (ie; bending forward and backward) to assess for instability.

(It is not useful in detailed structure of spine)

# COMPUTERIZED TOMOGRAPHY (CT SCAN)

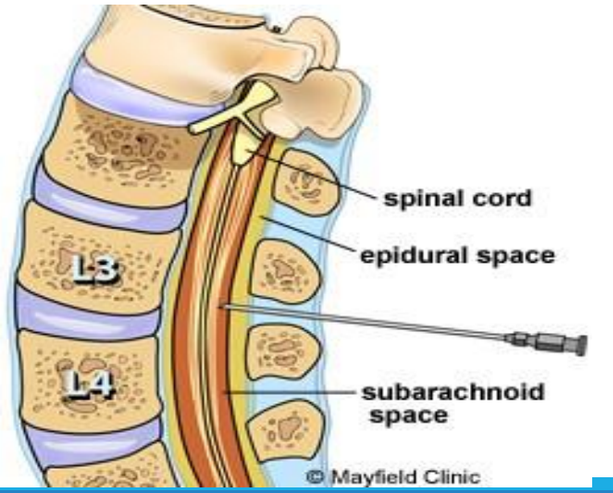
- Uses radiation to obtain 2-D and 3-D images.
- Patients must lie still on a table that moves through a scanner.
- Cross-sectional images are obtained of the target areas.
- Much detailed information regarding bony and soft tissues compared to plain films.
  - **Better in visualizing:**
    - Degenerative or aging changes, Herniated discs.
    - Spinal alignment.
    - Fractures and fracture patterns. ( we can exactly see which fragment is fractured such as coronal or in the spinal)
    - Congenital / childhood anomalies.
    - Areas of narrowing in spinal canal through which spinal cord and spinal nerve roots pass.
- **Poor in visualizing: inner details of spinal cord.**
- Entire spine can be imaged within a few minutes.
- A contrast material may be injected intravenously or intrathecally to make some areas clear.

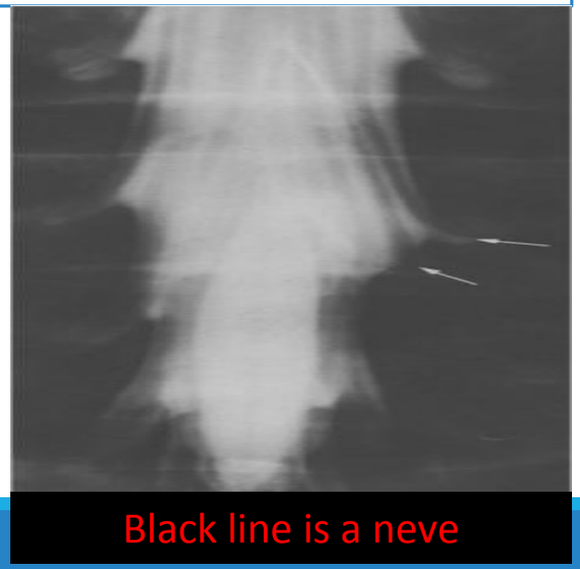
(We can do it in pre-operative planning and spin CT takes 2 seconds only)



# MYELOGRAM

- A contrast material is injected into CSF to better identify areas where spinal cord or spinal nerves may be compressed.
- **PROCEDURE:**
- Under local anesthesia, a needle is placed into lower lumbar spinal canal, and then CSF flow is confirmed. Contrast medium is then injected which mixes with CSF around spinal cord, making it visible on x-ray images.
- There is a needle inserted from the back between L3-L4 then inject a contrast and if you put the patient head down you can get an image of thoracic and cervical .
- Often a CT scan is also performed after this.
- May be performed when MRI is contraindicated.



Black line is a neve

# DISCOGRAM ★

- Discs are the cushions between the vertebral bodies.
- While MRI and CT scans can provide structural information, discogram better identifies the relationship of disc to pain.
  - PROCEDURE:
    - A needle is placed into center of the disc under fluoroscopy (continuous x-ray imaging).
    - A contrast material (dye) is injected.
    - Radiologist then observes if patient experiences pain that is similar to his/her usual pain, and is increased by injecting contrast.
- X-rays (+ CT scan) are then done to see if dye stays within the center of the disc or leaks to outer border of the disc indicating a tear in annulus fibrosus of disc which can be a source of pain.

# Magnetic Resonance Imaging (MRI)

The gold standard of imaging for spinal disorders.

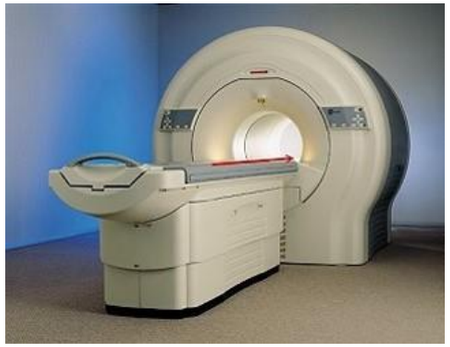
- Does not use ionizing radiation (it is magnetic based).
- Can identify abnormalities of bone, discs, muscles, ligaments and spinal cord.
- Intravenous contrast is sometimes administered to better visualize certain structures or abnormalities.
- Patient lies still in a tunnel like structure for about 25 minutes.
- Claustrophobic patients may need sedation, and children often need general anesthesia.

**Contraindications include:**

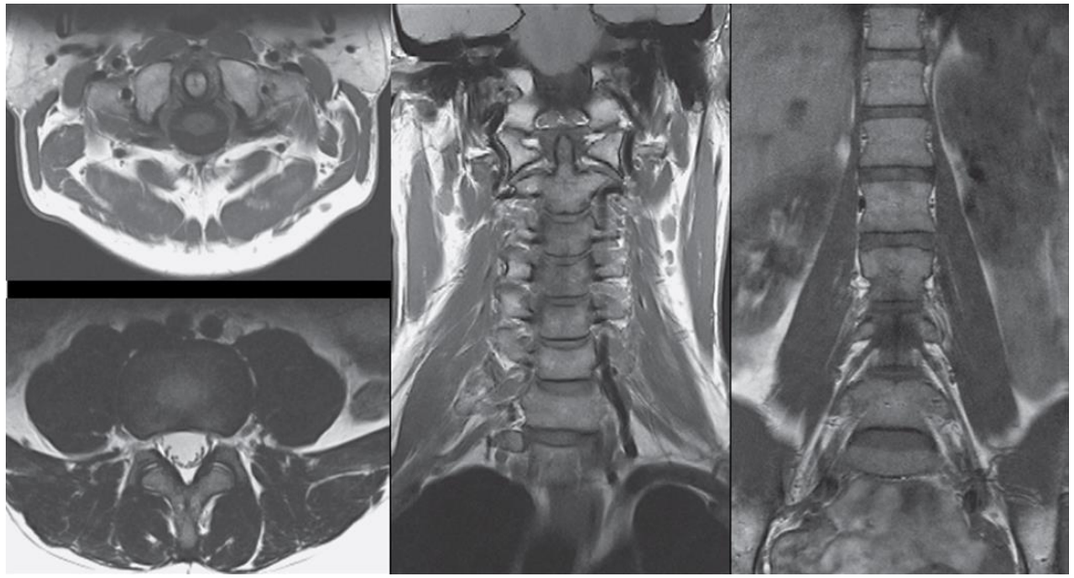
- Implanted devices e.g. cardiac pacemakers and other electromagnetic devices.
- Certain metal clips and stimulators.
- Artificial joints and spinal hardware may still have MRI scans.
- MRI is considered as a gold standard for spine imaging, but fracture fragments are better seen in CT. So, when we have a trauma patient, we usually do both MRI & CT, because we need to evaluate the spinal cord, the nerve roots and the fracture fragments.

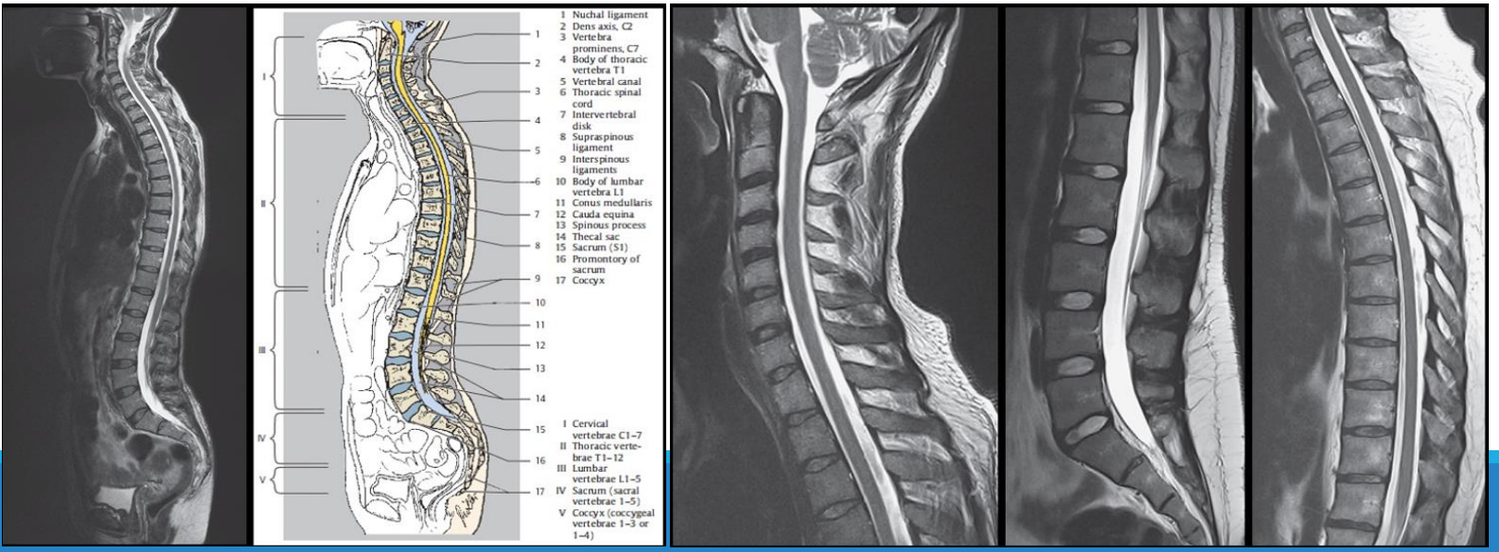
MRI SCANNER (open type)

MRI SCANNER (closed type)



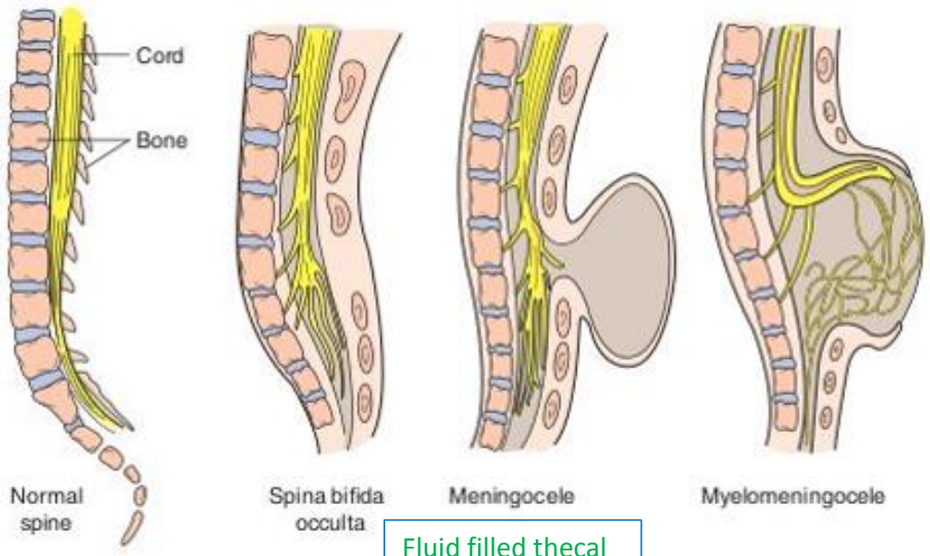
MR images are multi-planar



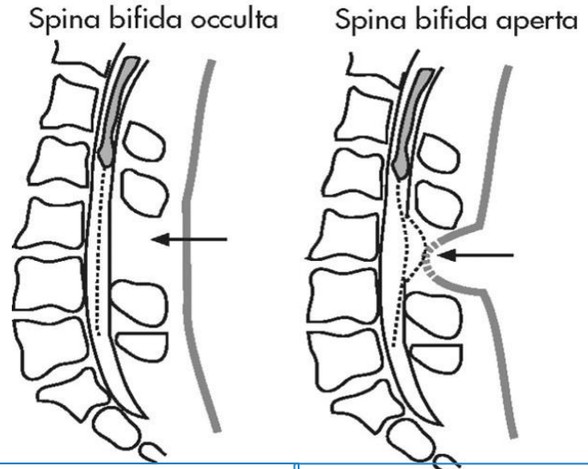


# 1)CONGENITAL ANOMALIES

- Skin covered defects and Open skin defects.
- Spina bifida occulta skin is normal but, you feel defect on exam.
- Spina bifida aperta skin lesion is apparent by mass, dimple or batch of hair.
- **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.**

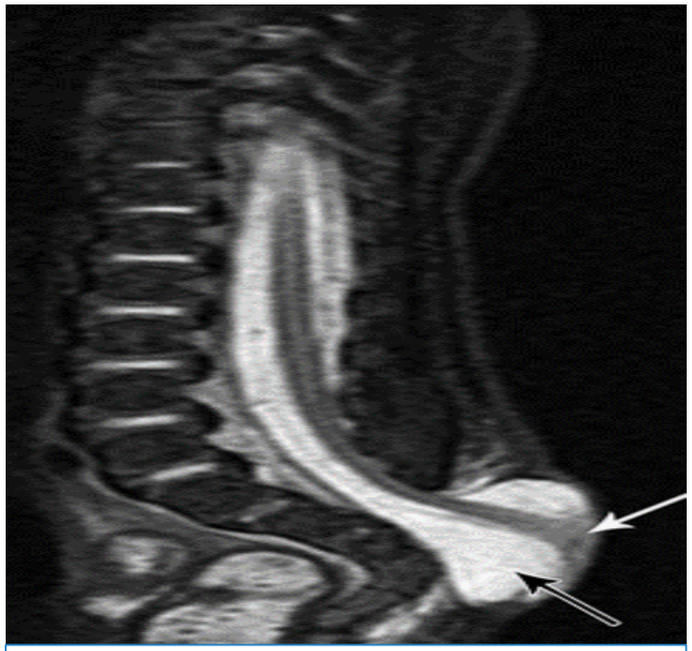



Fluid filled thecal sac with meninges and CSF it comes out like a balloon >> called meningocele.




Occulta means something hidden

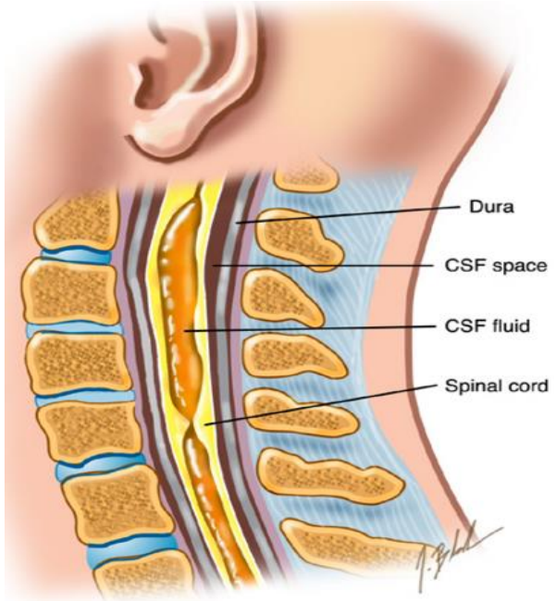
Aperta means something obvious



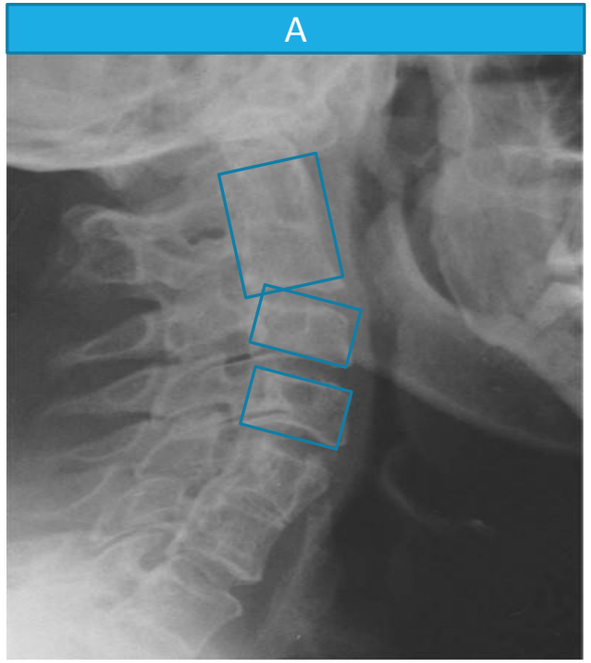
The whole thecal sac even spinal cord is protruding.(meningomylocele)

# Cont…CONGENITAL ANOMALIES

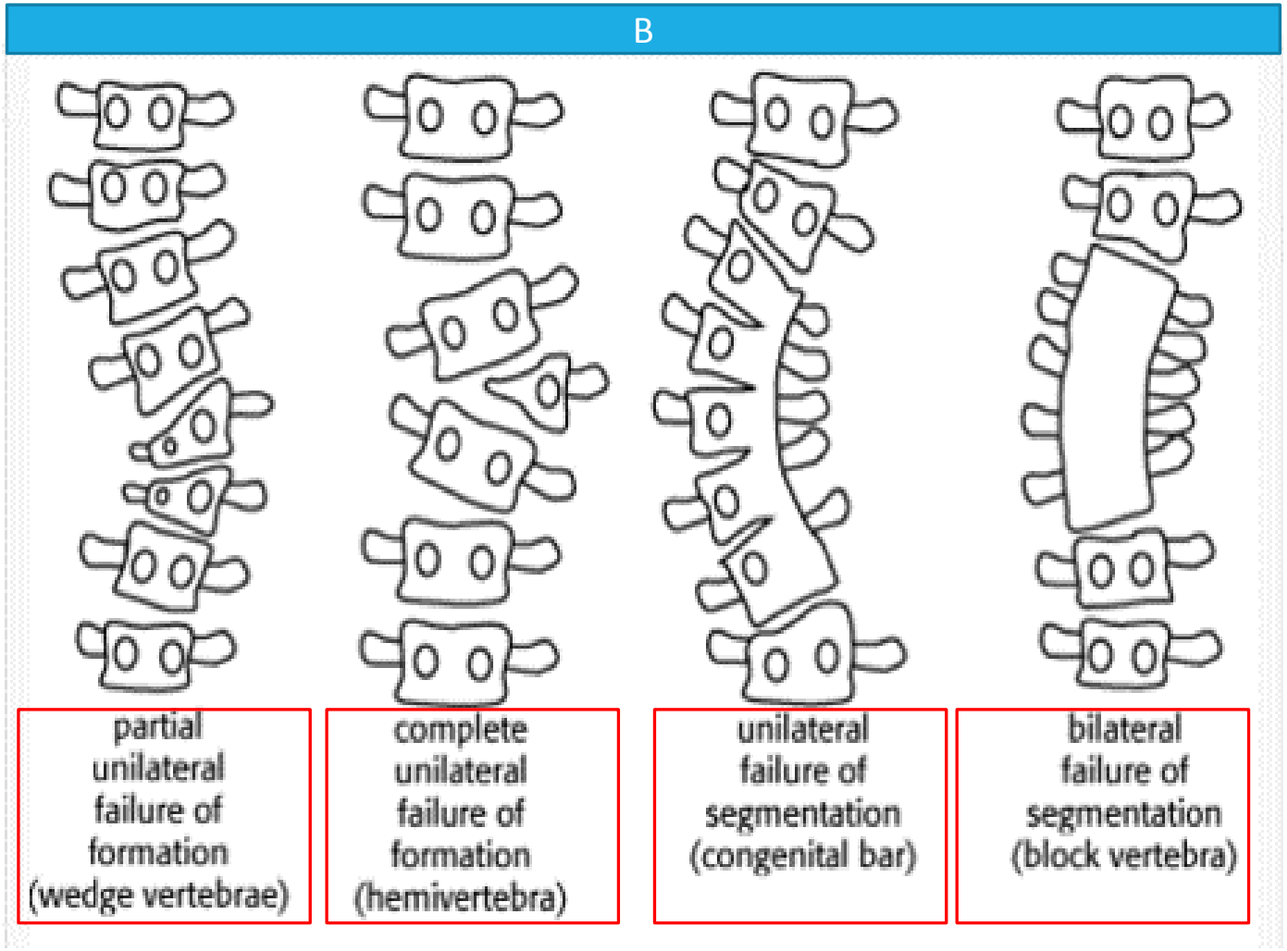
Fusion abnormalities (A,B)




Dilation of spinal canal due to obstruction (by tumors)




Multiple fusion abnormalities of vertebrae on plain film.

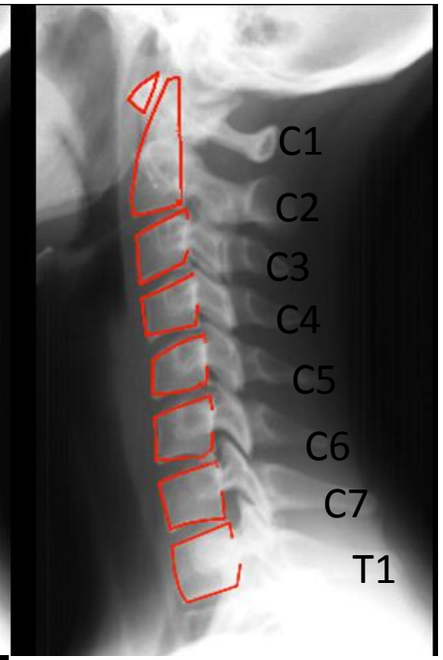


# 2)Trauma

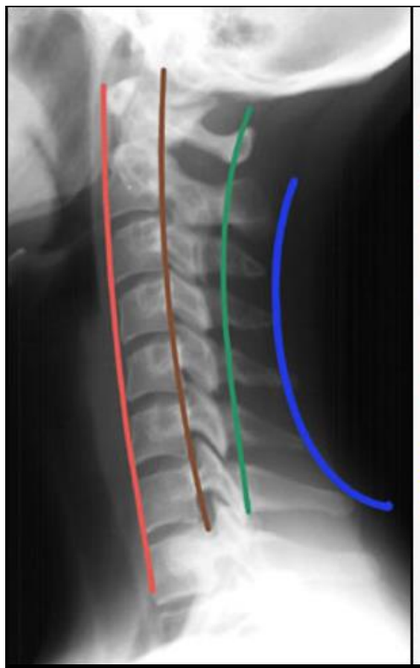
Plain film assessment of trauma – the first imaging method.

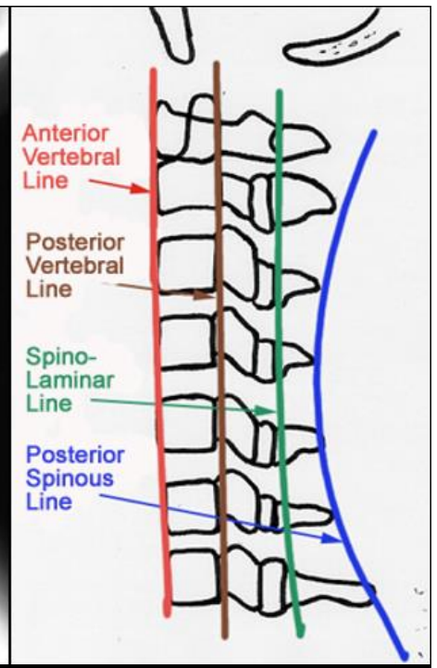
**All of the vertebrae were developed from notochord.**

- **Cervical vertebrae are more in risk for fractures** relatively less covered with tissues than other vertebrae.
- **Upper cervical space(<5mm) should be thinner than retro-tracheal space(less than vertebral body in diameter).**
- **cervical trauma spine is more likely to have fracture because it is uncovered part of the spine a little bit compared to thoracic and cervical.**
- **Cervical is more mobile compared to others .**
- **To assess trauma most of the time we do plain film unless the patient is severely traumatize(head injury, skull laceration and multiple bone fracture ) we do not get a plain film in those patient we do CT trauma survey from head to thigh.**




Soft tissue anterior to the spine



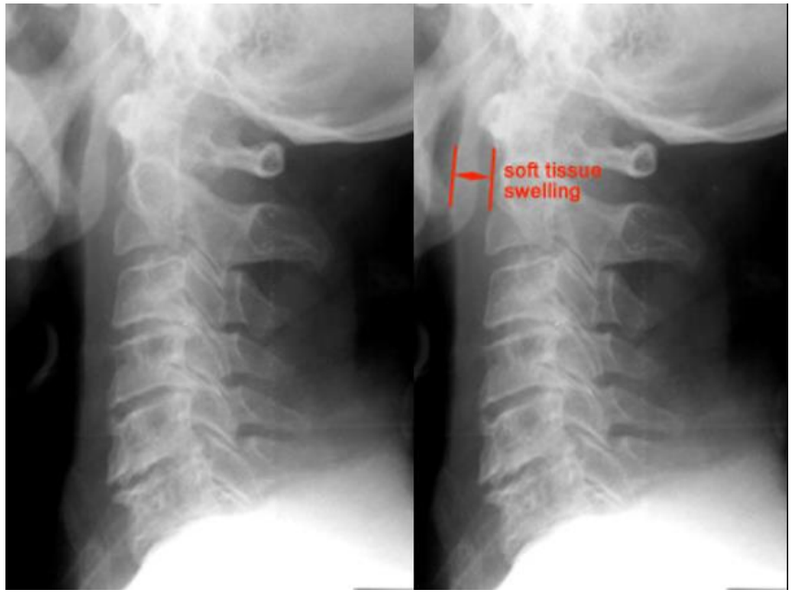


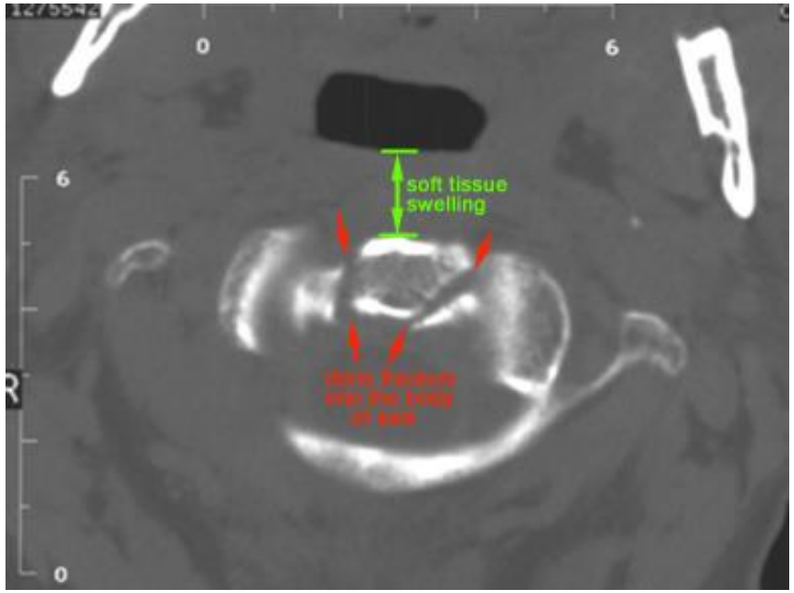

Alignment should be normal-check by drawing lines


# Cont….Trauma

- Increased soft tissue space anterior to upper cervical vertebrae which indicate hemorrhage from fractures.
- Here we don't need to repeat the image because abnormality is already found but, if image was normal we need to repeat the imaging to see cervico-thoracic junction.

(Soft tissue anterior to spine is very important)



# Jefferson Fracture

- Relatively lateral masses are thicker compared to anterior and posterior arches. If there is anything compressing from the top this will slip laterally that will cause fracture in anterior and posterior Arche because they are thin and weak.
- Lateral displacement of C1 in plain film .
- Coronal reconstruction from a CT confirms the findings from the odontoid view.
- Fractures in both anterior and posterior arches of the C1 flexion is called jefferson fracture. But, if the fractures only in the anterior or posterior arches is called anterior or posterior arch fractures.
- Axial CT clearly shows the location of the fractures of C1.
- Mechanism of trauma is Axial Loading :

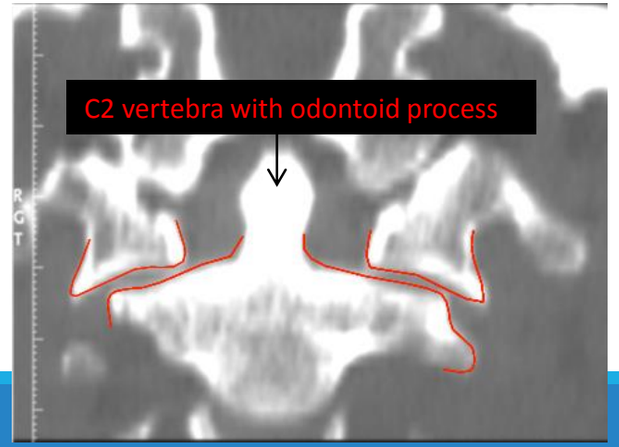
1)Object hitting the head.

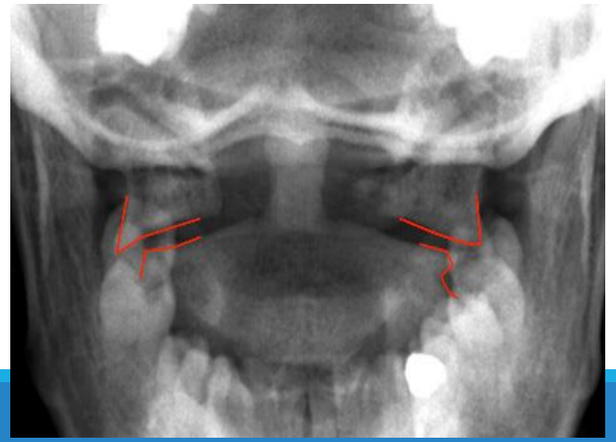
o E.g. when a hard block falls on the head of a worker.

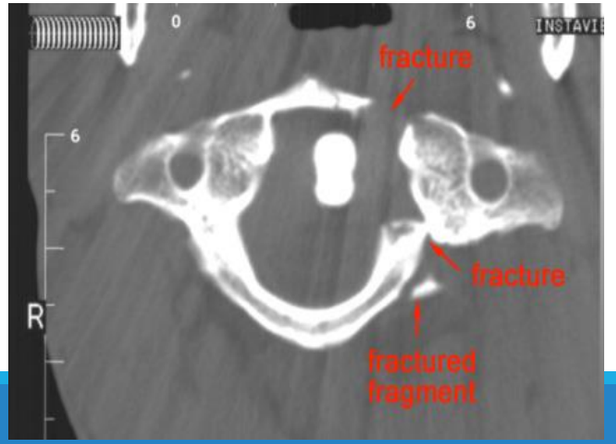
o Nowadays workers wear helmets, but they are still not fully protected. The helmet will protect the direct head injury, but the ultimate weight will transmit to the whole cervical spine. But if the worker didn't wear a helmet he will have a head injury, which is more lethal than cervical spine injury .

2) Head hitting a surface or object.

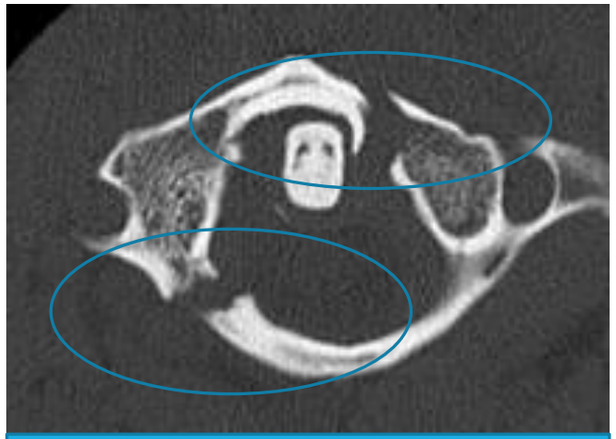
o E.g. Jumping/diving into a swimming pool with shallow water will cause the head to hit the floor directly.



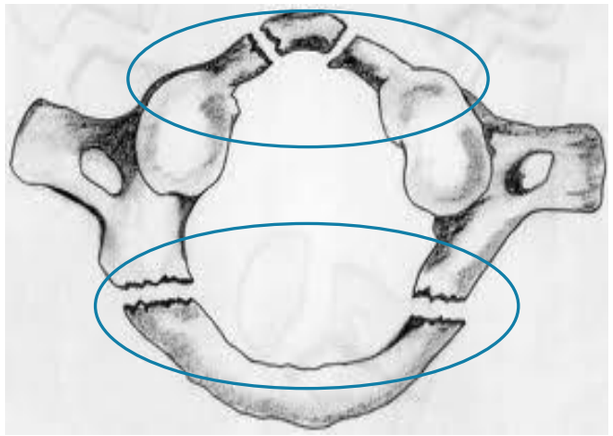





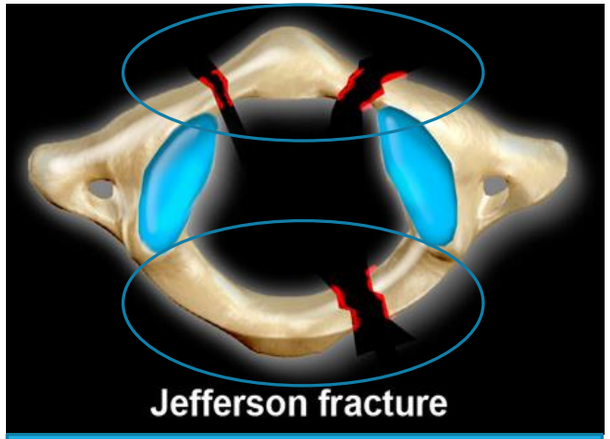
# Cont…Jefferson Fracture



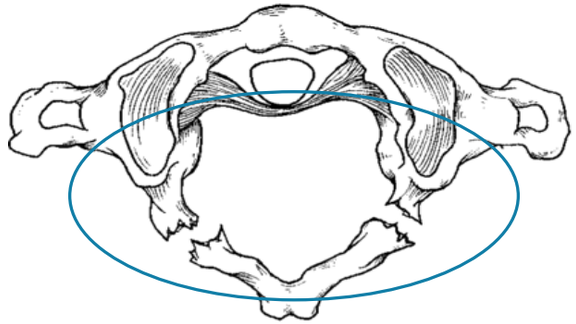
1Anterior and 1posterior fractures



2Anterior and 2posterior fractures



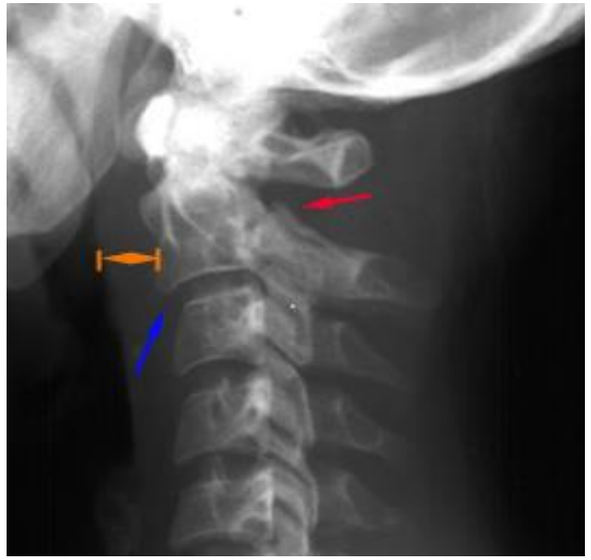

2Anterior and 1posterior fractures

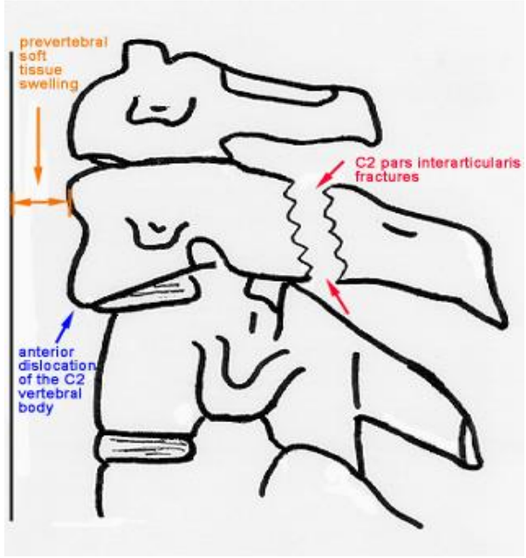


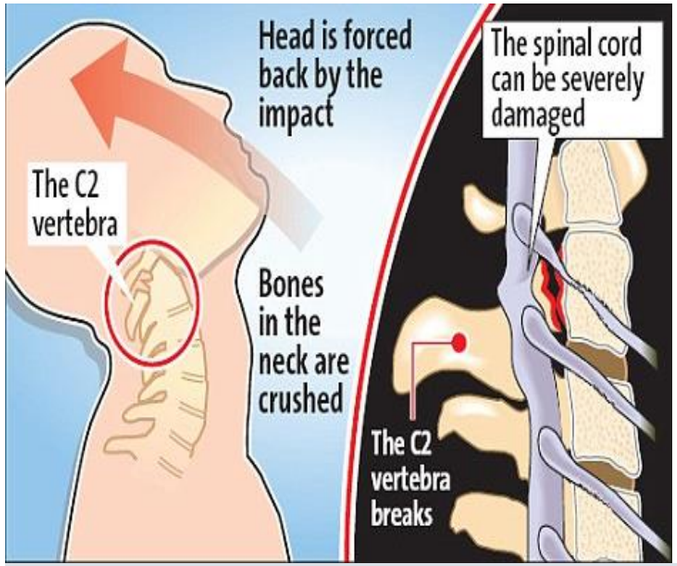
Posterior arch fracture

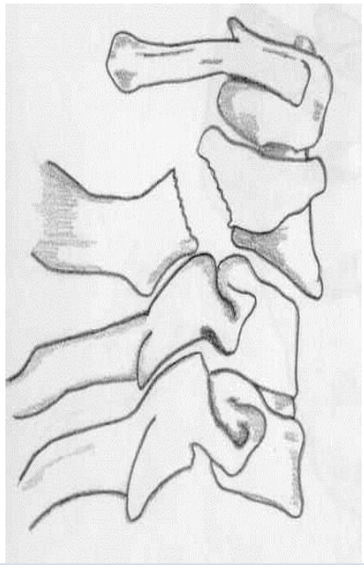
# Hangman's Fracture

- Fractures through the pars interaticularis of C2 resulting from hyperextension(mechanism) and distraction.
- Hyperextension (e.g. hanging, now more due to chin hits dashboard in road accident).
- **Radiographic features**: (best seen on lateral view)
  1. Prevertebral soft tissue swelling.
  2. Avulsion of anterior inferior corner of C2 associated with rupture of anterior longitudinal ligament.
  3. Anterior dislocation of C2 vertebral body.
  4. Bilateral C2 pars interarticularis fractures.





In car accident, sudden stoppage leads to hyperextension of neck from C3 and skull, the C1 is shorter, so not affected → spinal cord is on risk for injury.

# Bilateral Facet Dislocation

- Complete anterior dislocation of vertebral body resulting from extreme hyperflexion injury.
- Associated with a very high risk of cord damage.
- Facet joint keep the spine stable if there is dislocation of that joint the spines becomes unstable If both of them dislocate there will be anterior subluxation and because it is bilateral It will move anteriorly and usually more than half's.

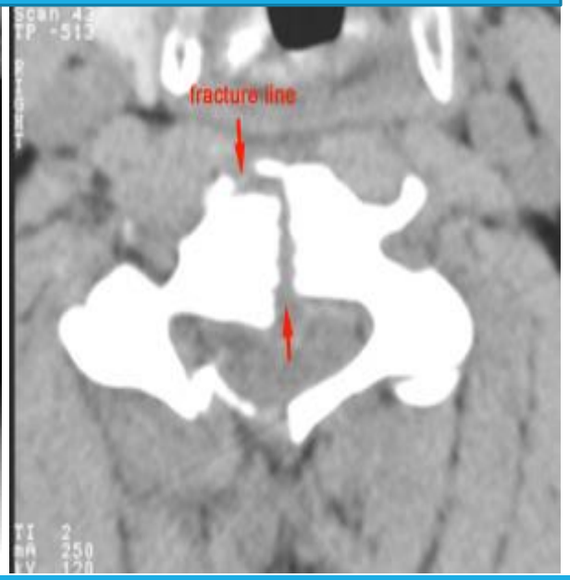
# Unilateral Facet Dislocation

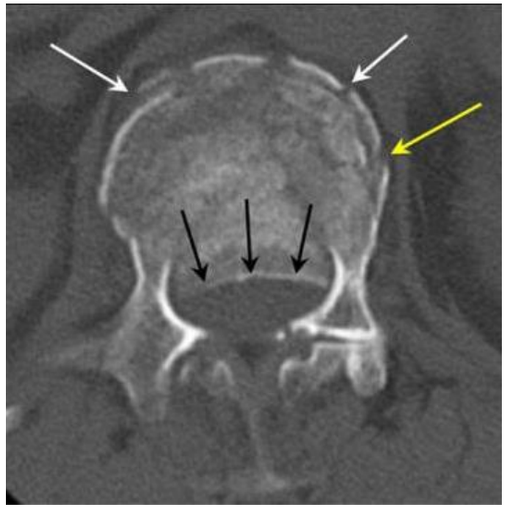
Facet joint dislocation and rupture of the apophyseal joint ligaments resulting from rotatory injury.
**Mechanism**: simultaneous flexion and rotation.

# Burst Fracture

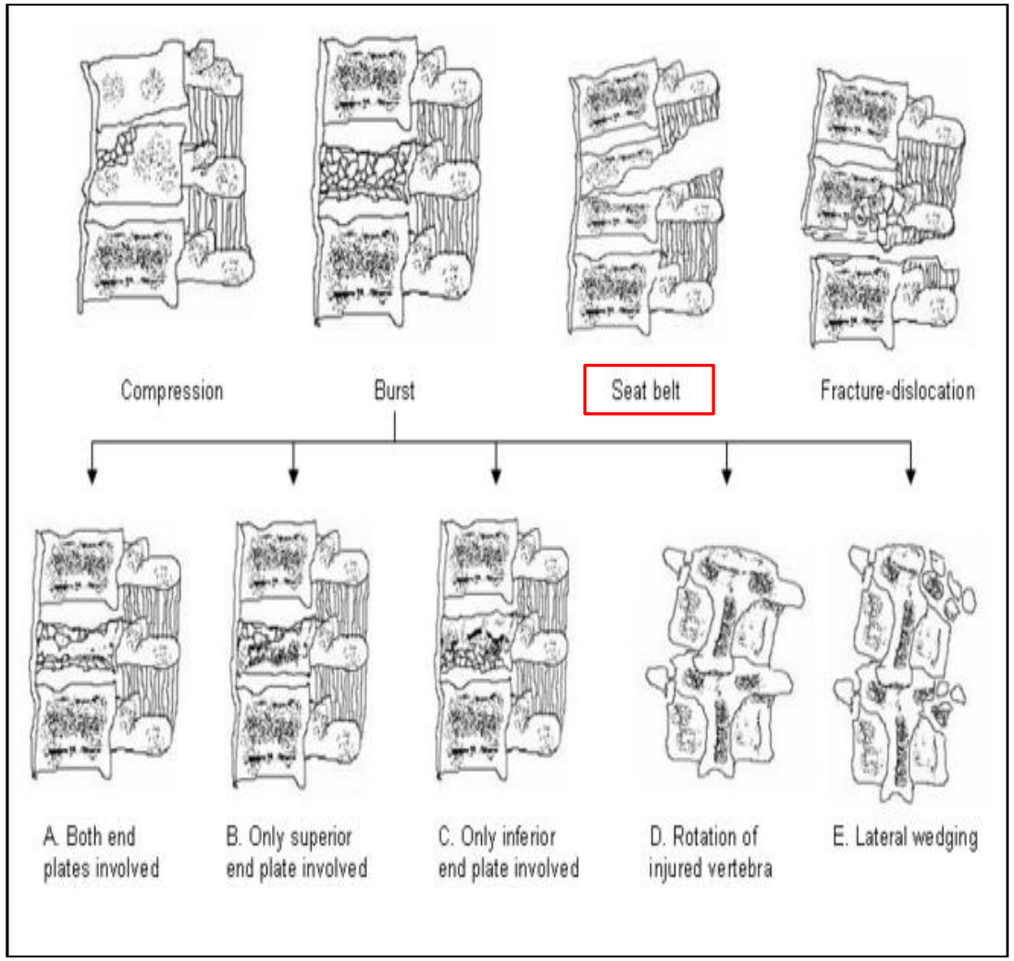
- Results from axial compression.
- Injury to spinal cord is common due to displacement of posterior fragments.
- CT is required for all patient to evaluate extent of injury.
- If there is a sudden hyperflexion it can compress vertebrae partially , the anterior part of the vertebrae become less in height become like wedge, but if there is to much hyperflexion then the posterior part can also break and this called burst fracture.
- If there is wedge fracture and the posterior part is intact this is called compression fracture.

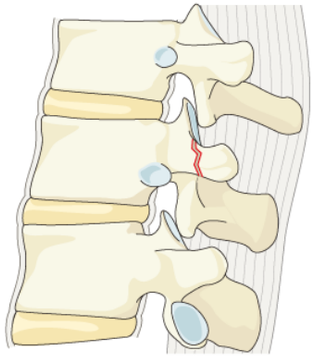
Burst fracture

## Types OF Fractures





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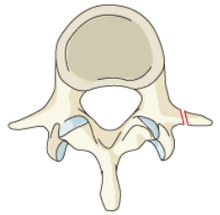
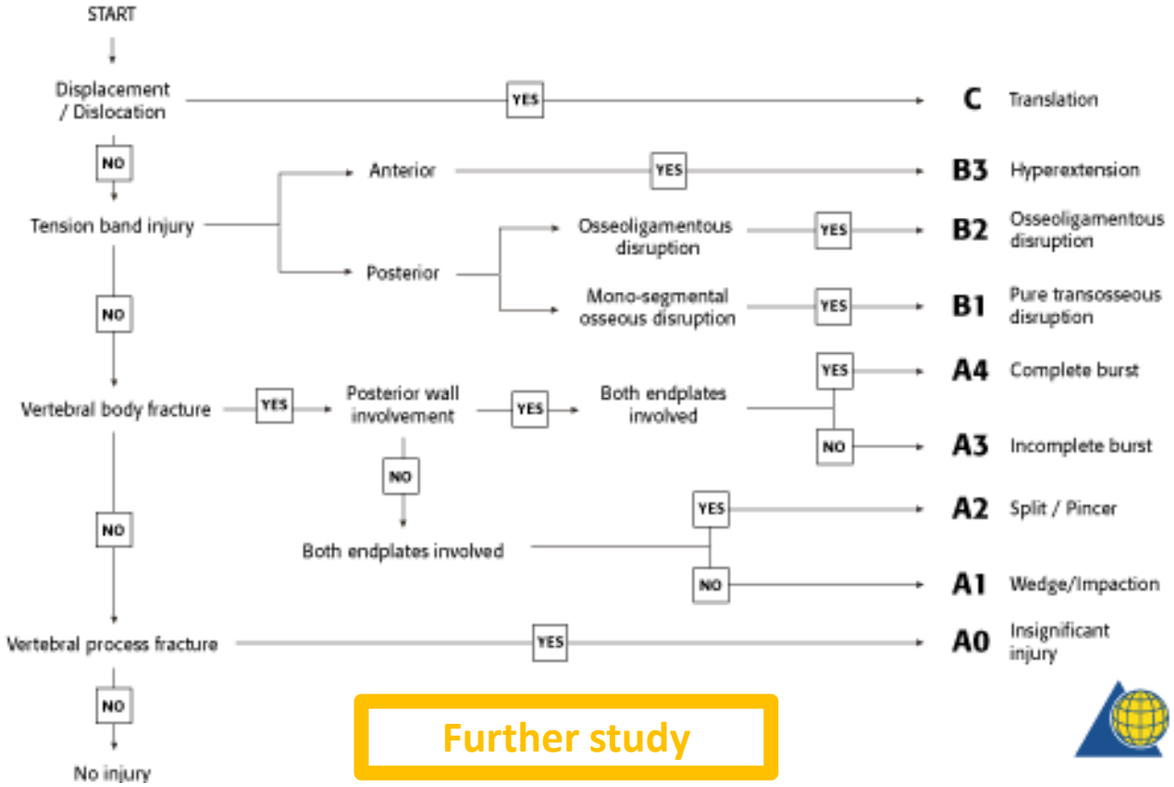
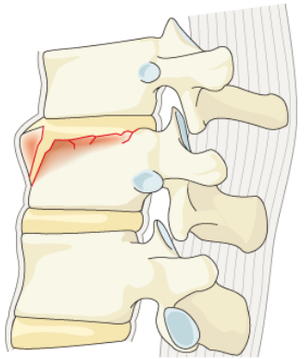


## Algorithm for morphologic classification




Further study



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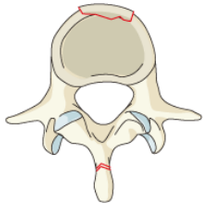

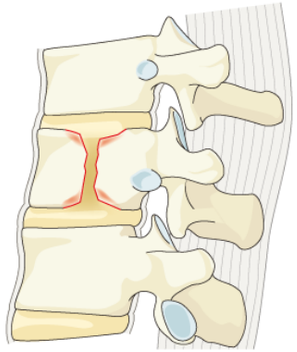

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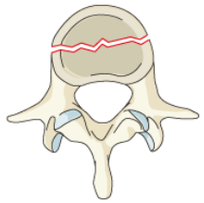

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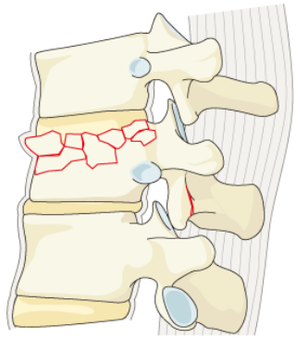

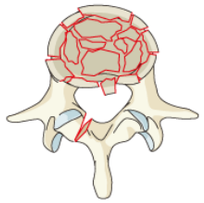



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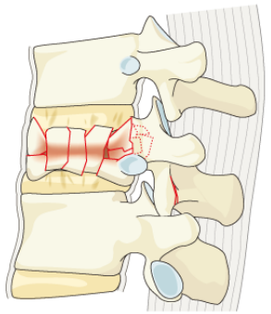
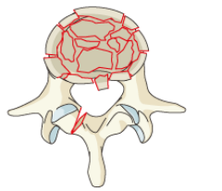
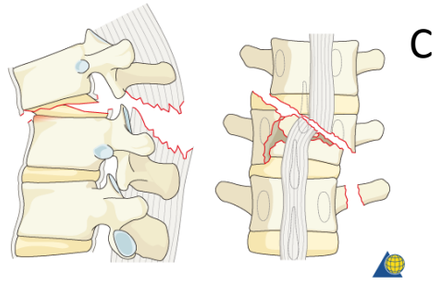


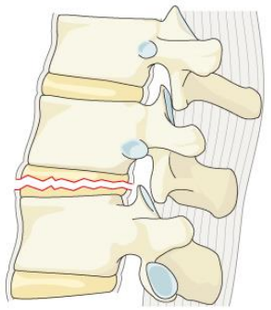




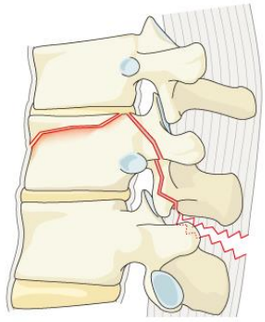
C



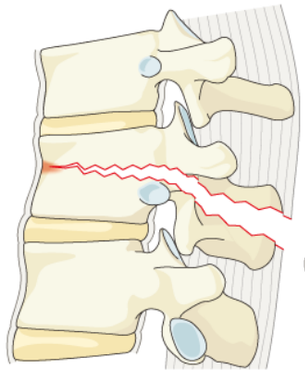


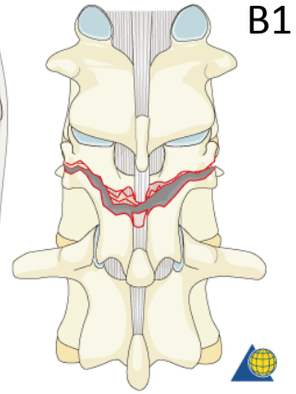


B3



B2





B1



## Further study about spine trauma

https://www٢.aofoundation.org/wps/portal/!ut/p/a٠/٠٤_Sj٩CPykssy٠xPLMnMz٠vMAfGjzOKN_A٠M٣D٢DDbz٩_UMMDRyDXQ٣dw٩wMDAzMjfULsh٠VAbWjLW٠!/?bone=Spine&segment=TraumaThoracolumbar&showPage=A&contentUrl=srg/popup/additional_material/٥٣/D١٠٠-Classification.jsp

# 3)INFECTIONS : Discitis and Osteomyelitis (Usually combined)

**1. Usually the result of blood–borne agents**

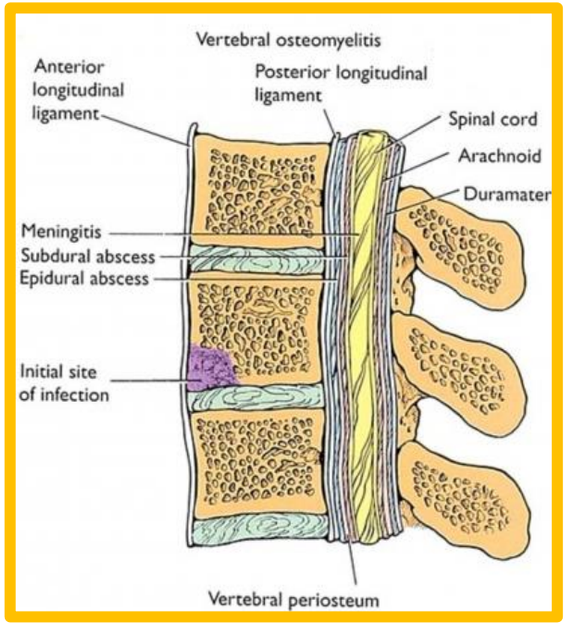
Especially from lung and urinary tract

- Most common pathogen is staphylococcus.
- Streptococcus less common
- Gram-negative rods in IV drug abusers or immunocompromised patients
  - E. Coli
  - Proteus
  - Non-pyogenic
    - Tuberculosis
    - Coccidioidomycosis

**2. May occur after invasive procedure like Surgery, Discography, Myelography**

**Site of involvement**

- L3/4
- L4/5
- Unusual above T9
- Usually involvement of one disk space (occasionally 2)




lumbar infections may often originate from UTI which drain thru Batson's venous plexus

The **Batson venous plexus** (**Batson veins**) is a network of valveless veins in the human body that connect the deep pelvic veins and thoracic veins (draining the inferior end of the urinary bladder, breast and prostate) to the internal vertebral venous plexuses.

**In children,** infection begins in **vascularized disc** (direct blood supply still present)

**In adults,** in **anterior inferior corner of vertebral body with spread across disk to adjacent vertebral endplate**

(almost no direct blood supply to the disc in healthy adults)

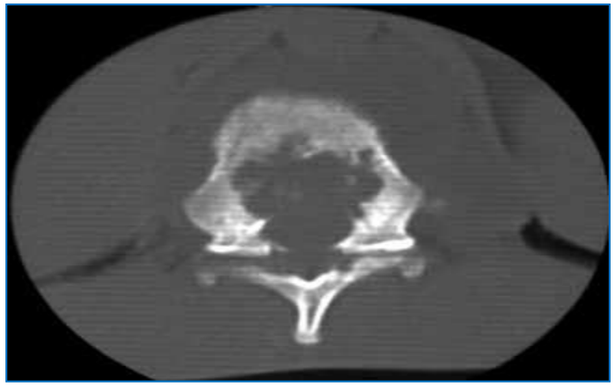
# Cont…INFECTIONS : Discitis and Osteomyelitis

## PLAIN FILMS

- **Narrowing and destruction of an intervertebral disk** "EARLY" (Earliest plain film sign )
- 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**. "LATE"

## MRI

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

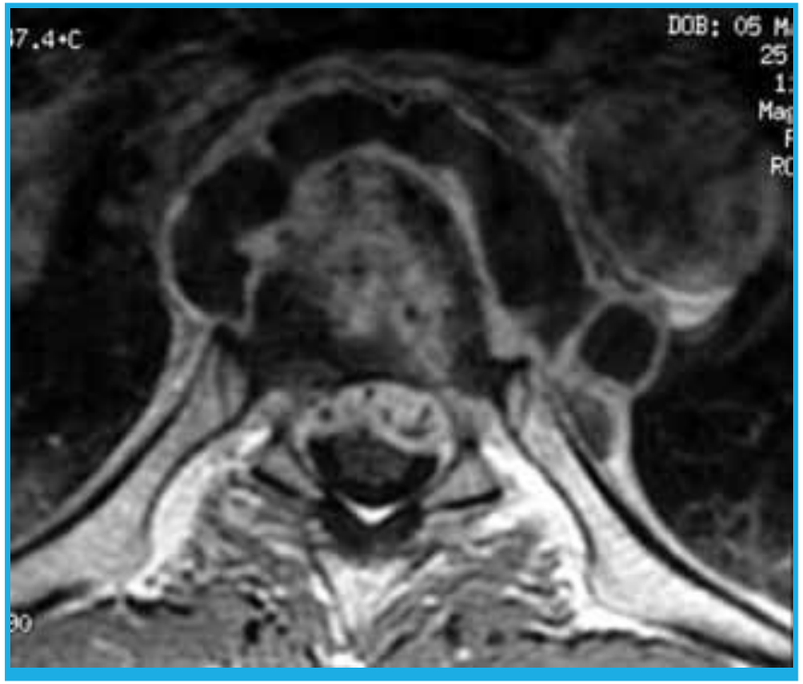



- One vertebra + disc + another vertebra = INFECTION
- Tumors don't cross the disc

## Cont…INFECTIONS : Discitis and Osteomyelitis

**Sagittal T1 MRI shows:**
decreased signal of vertebral bodies and disc with end plate destruction

**Sagittal T2 MRI shows:**
increased signal in corresponding areas with anterior subligamentous abscess, epidural involvement and extension of inflammation in T6 with preserved endplate.

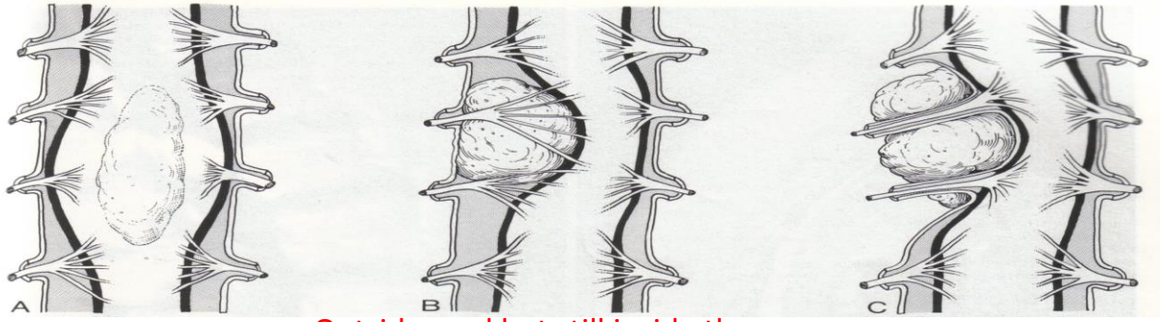


**Axial contrast-enhanced T1 MRI shows:**
peripheral enhancement of paravertebral abscess and marked enhancement of epidural tissues causing displacement of spinal cord

**CT shows:**
lytic lesion in vertebral body and paravertebral abscess with calcifications

# 4)TUMORS

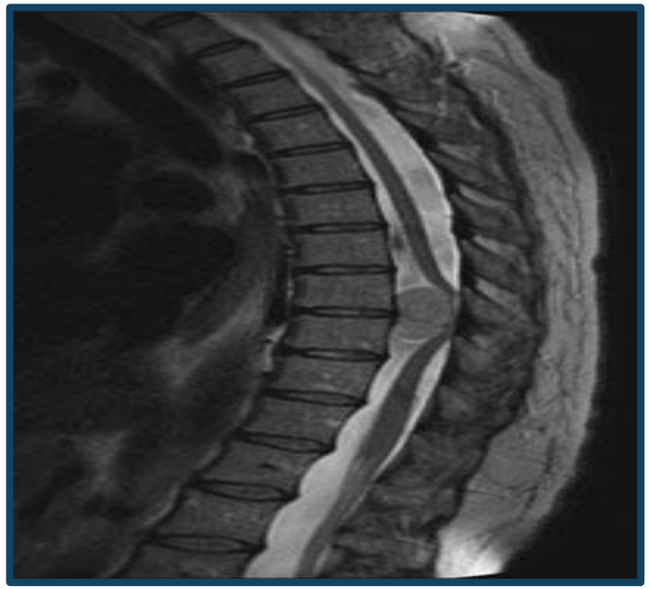
**Whether the tumor in the spinal cord or outside the spinal cord??**
(extend down and gets fat or extend down and gets displace.)
**If It is inside the cord, Is it causing expansion or not??**
Expansion tumor, no expansion not a tumor.



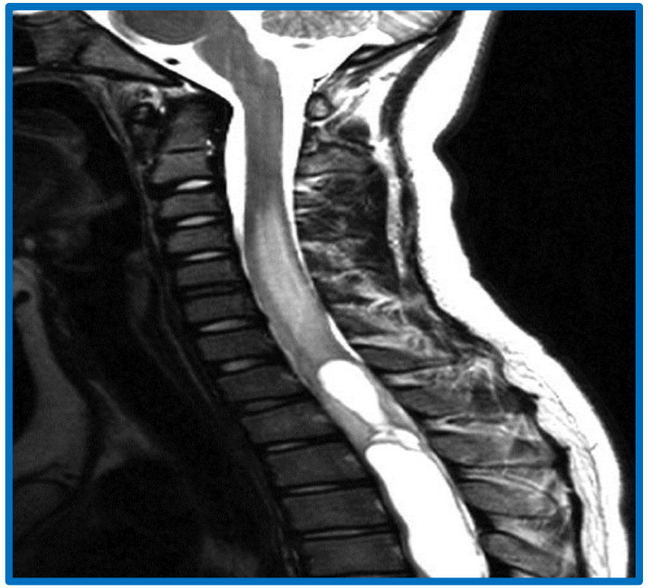

Inside the cord (intramedullary)

Outside cord but still inside the spinal canal (extramedullary intradural)

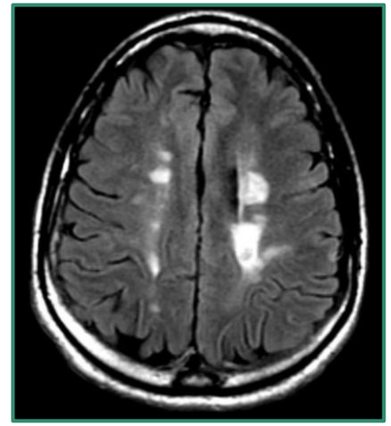
Outside spinal canal (extradural)



Inside the spinal canal but <u>outside the cord</u> :
**Meningioma, Schwannoma**



Inside the cord



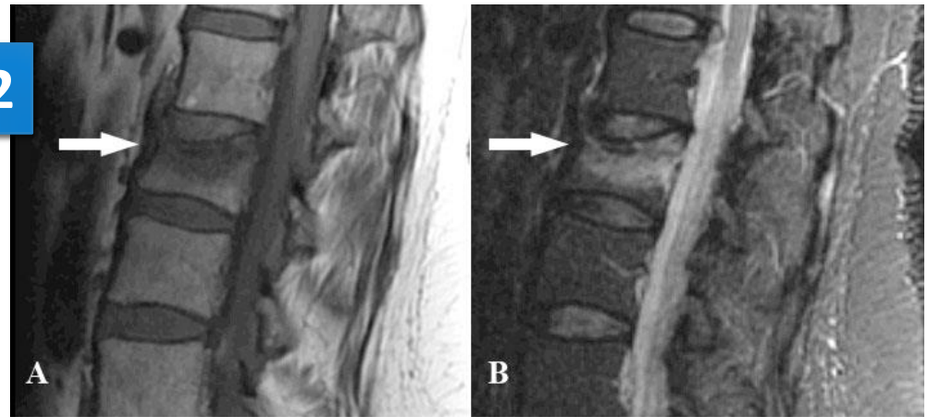
<u>Inside the cord</u> but not a tumor (no Expansion)
**Multiple sclerosis**

# MCQs: from the slides

1

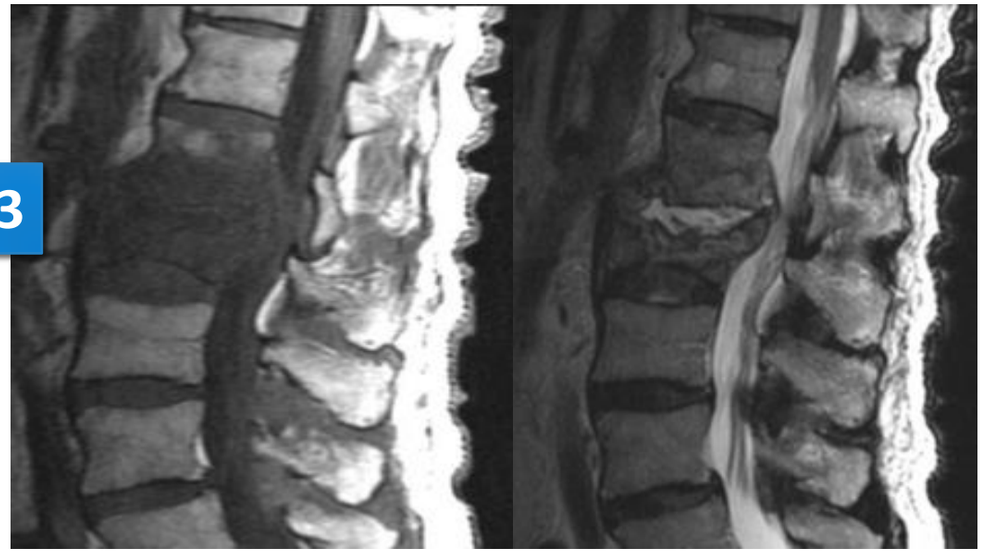
A. Infection.
B. Trauma.
C. Congenital.

2



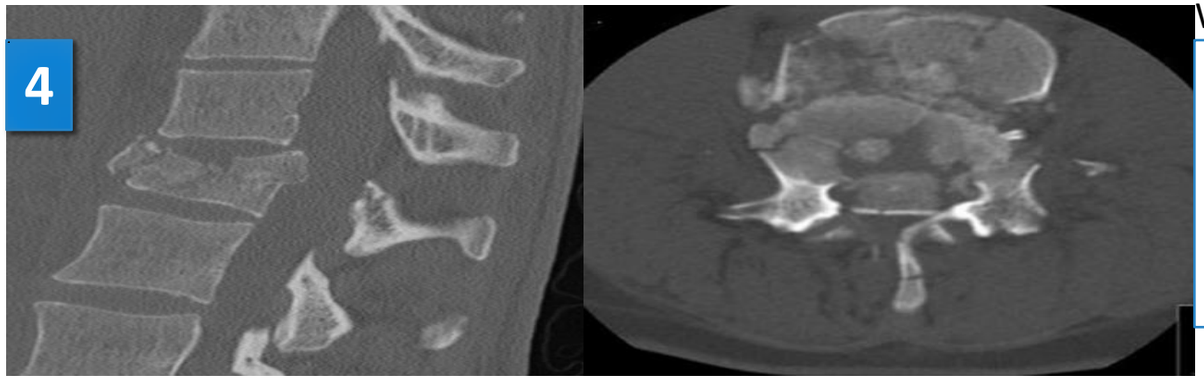

A. Infection.
B. Trauma.
C. Congenital.

3



A. Infection.
B. Trauma.
C. Congenital.

4



What is the mechanism?

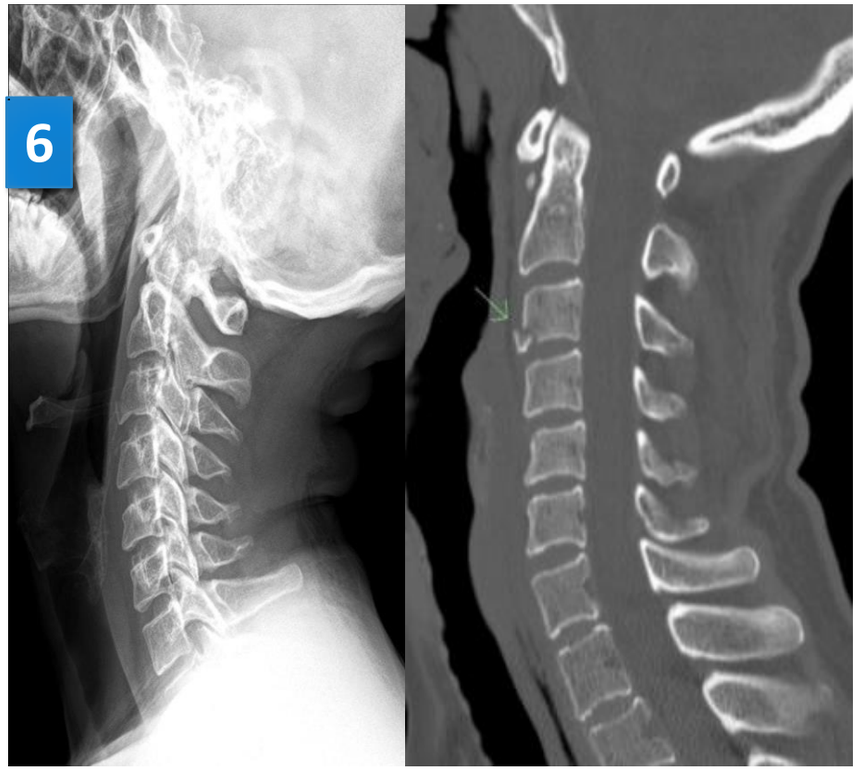
A. Flexion
B. Extension
C. Axial loading
D. Rotation
E. Seat belt

5

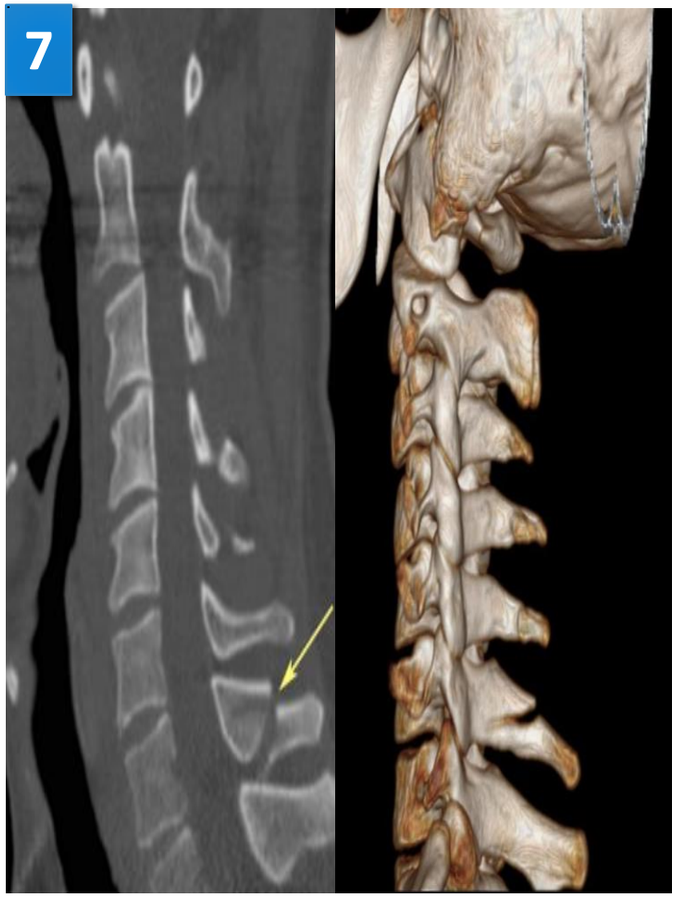
A. Flexion
B. Extension
C. Axial loading
D. Rotation
E. Seat belt
(CHANCE fracture)

# MCQs: from the slides

6



7



8

9

Note:
Loss high (Anterior vertebrae) with fracture> Flexion
Maintain high (Anterior vertebrae) with fracture> Extension

A. Flexion
B. Extension
C. Axial loading
D. Rotation

1-A, 2-B, 3-A, 4-A+C, 5-E , 6-B , 7-A +lower neck muscle contraction,8-A, 9-B.

# Thank You!

## We hope you found this helpful and informative.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