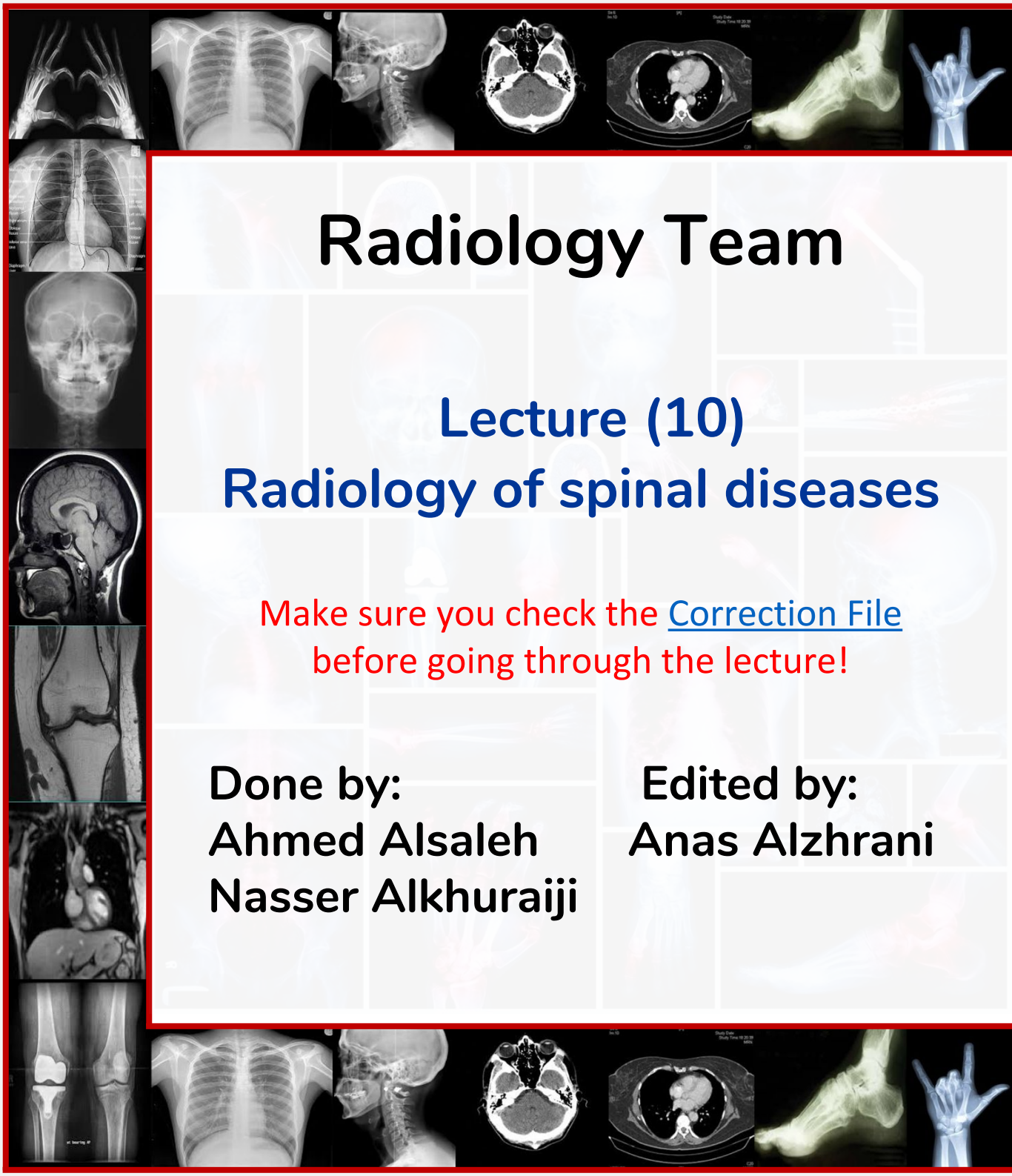

Radiology Team

Lecture (10)
Radiology of spinal diseases

Make sure you check the Correction File before going through the lecture!

Done by:
Ahmed Alsaleh
Nasser Alkhuraiji

Edited by:
Anas Alzhrani

Color Index:

• Important • Females' notes • Males' notes • Explanations

• 433 & 432 Teamwork

Imaging Methods to Evaluate Spine

1- Plain X-Ray Films (it's usually the first used imaging modality).
2- Myelogram – injection of contrast medium in CSF 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).
3- Computed Tomography (CT Scan). best for bone , very poor information about spinal cord.
4- Magnetic Resonance Imaging (MRI). best for soft tissues.
*Preoperatively In spinal cases usually both are done CT and MRI
5- Discogram - injection of contrast medium in the disc followed by x-ray images
6- Spinal angiography – to evaluate arteries and veins
7- Ultrasound – more in children
8- Radionuclide Bone Scan – intravenous injection of radioactive material bound to phosphonates which deposit in bones, followed by images by gamma camera. (the first choice for case of any malignancy and you want to see bone metastasis and when multiple lesions are suspected)
9- 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:

1- Spinal alignment and curvature.

2- Spinal instability – with flexion and extension views.

3- Congenital (birth) defects of spinal column.

4- Fractures caused by trauma , Infections and Tumors

5- Moderate osteoporosis (loss of calcium from the bone).

May be taken in different positions (ie; bending forward and backward) to assess for instability

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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.

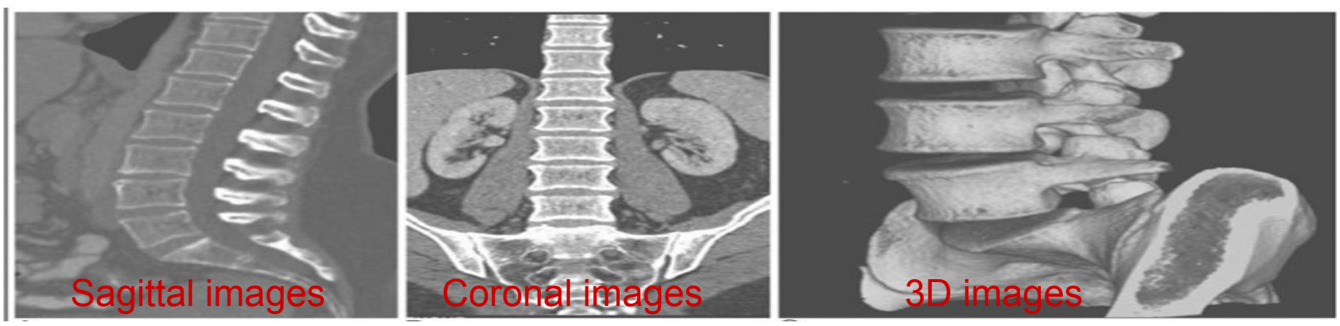
Better in visualizing

* **Degenerative** or **aging** changes, Herniated discs
* Spinal alignment
* Fractures and fracture patterns
*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



MYELOGRAM

A contrast material is injected into CSF to better identify areas where spinal cord or spinal nerves may be compressed

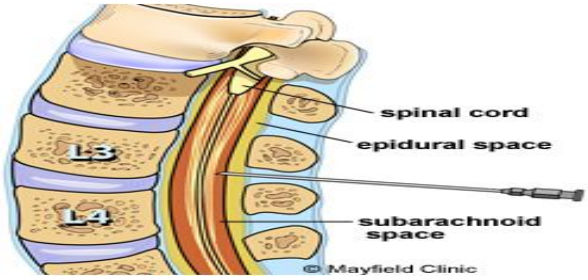
PROCEDURE:

Under local anesthesia, a needle is placed into lower lumbar spinal canal (the needle inserted from the back between L3-L4), 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

Often a CT scan is also performed after this

May be performed when MRI is contraindicated.



Magnetic Resonance Imaging (MRI)

The gold standard of imaging for spinal disorders and it does not use ionizing radiation.

Can identify abnormalities of bone, discs, muscles, ligaments and spinal cord.

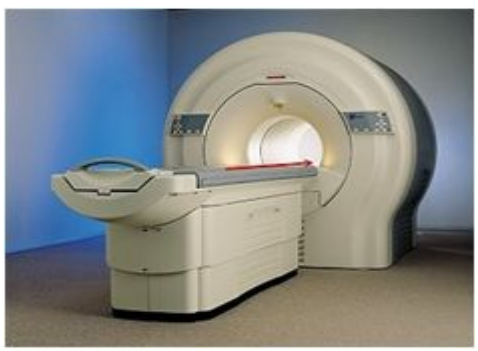
Intravenous contrast is sometimes administered to better visualize certain structures or abnormalities. Patient lies still in a tunnel like structure for about 25 minutes.

Claustrophobic patients may need sedation, and children often need general anesthesia

Contraindications include

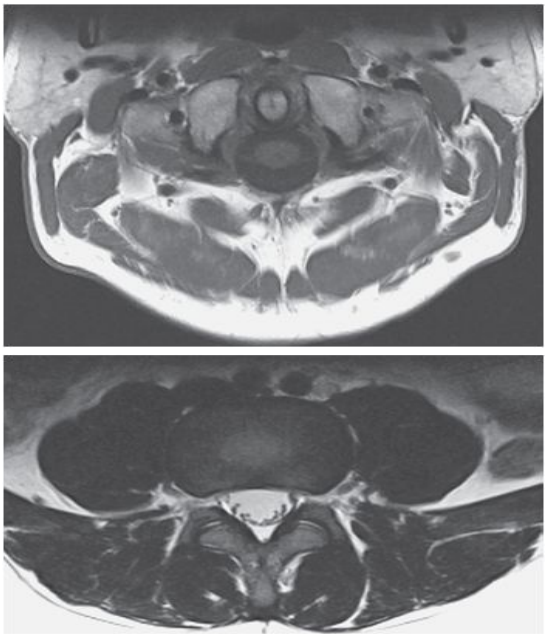
1. Implanted devices e.g. cardiac pacemakers and other electromagnetic devices.
2. Certain metal clips and stimulators.
3. Artificial joints and spinal hardware may still have MRI scans.

MRI SCANNER (open type)

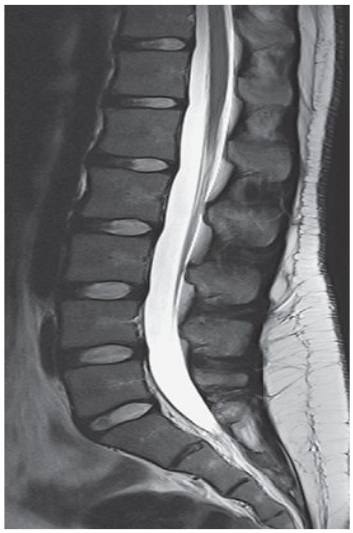


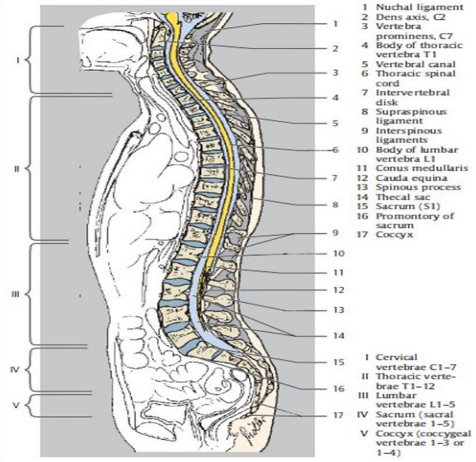
MRI SCANNER (closed type)

MR images are multi-planar



MR images are very high resolution





1 Nuchal ligament
2 Dens axis, C2
3 Vertebra prominens, C7
4 Body of thoracic vertebra T1
5 Vertebral canal
6 Thoracic spinal cord
7 Intervertebral disk
8 Supraspinous ligament
9 Interspinous ligaments
10 Body of lumbar vertebra L1
11 Conus medullaris
12 Cauda equina
13 Spinous process
14 Thecal sac
15 Sacrum (S1)
16 Promontory of sacrum
17 Coccyx

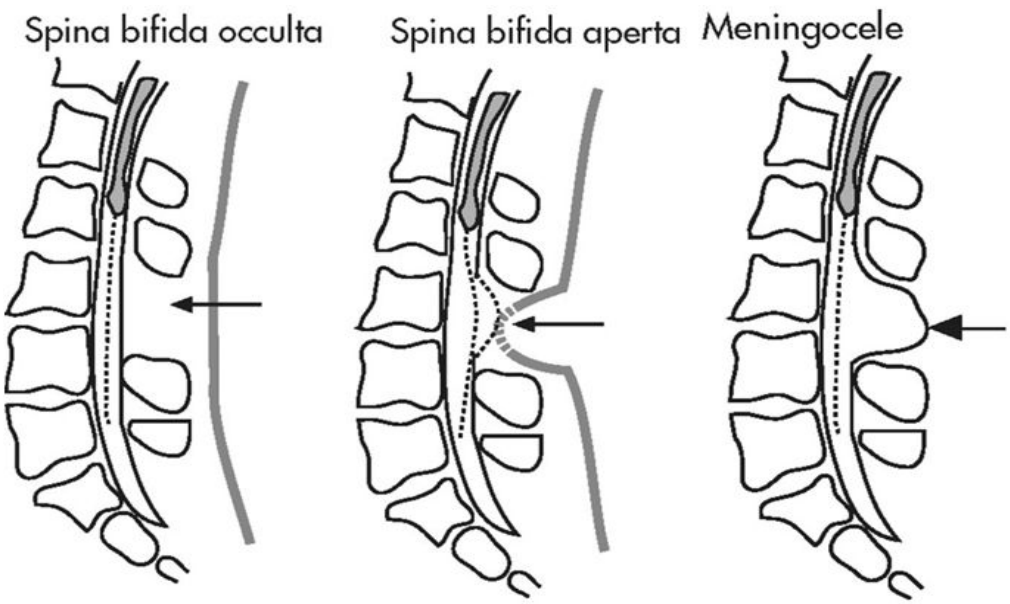
I Cervical vertebrae C1–7
II Thoracic vertebrae T1–12
III Lumbar vertebrae L1–5
IV Sacrum (sacral vertebrae 1–5)
V Coccyx (coccygeal vertebrae 1–3 or 1–4)

1) CONGENITAL ANOMALIES

Skin covered defects and Open skin defects

- In Spina bifida occulta skin is normal but some patients have hint like dimple or batch of hair and you feel defect on exam.
- Spina bifida aperta skin defect the neural and subcutaneous tissue can be seen.
- Meningocele : Fluid filled thecal something hidden sac with meninges and CSF it comes out like a balloon . (without the spinal cord)

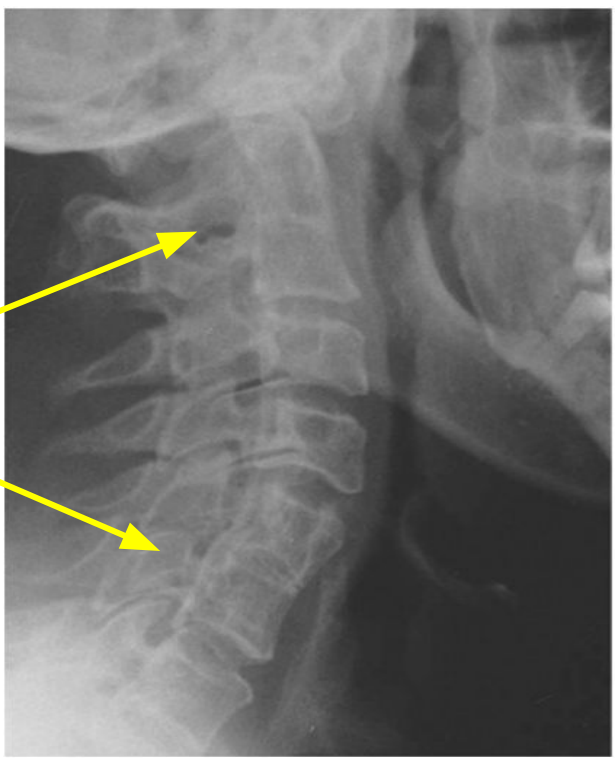
Picture A : The whole thecal sac even spinal cord is protruding.(meningomylocele)



and spinal cord.

CT shows bony structures the best and is often used before surgery

Multiple fusion abnormalities of vertebrae on plain film



fusion

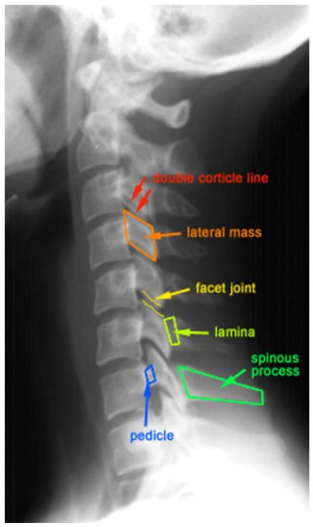
For further evaluation should do CT or MRI

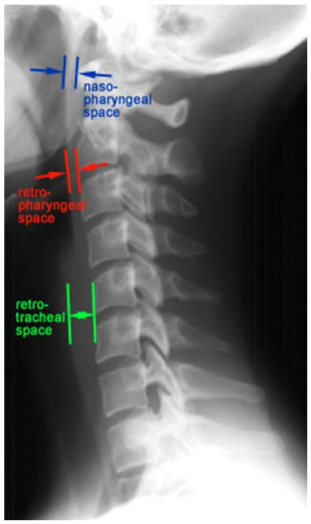
2)Trauma

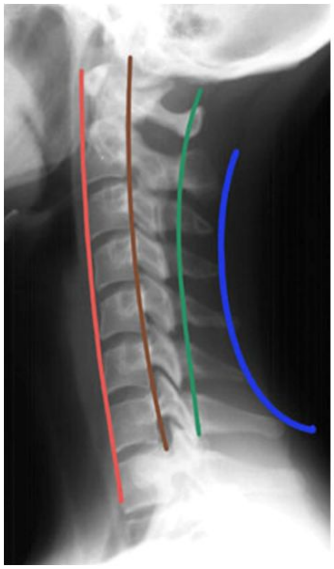
Plain film assessment of trauma – the first imaging method.

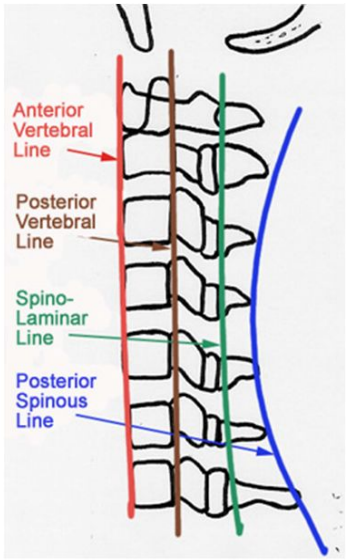
All of the vertebrae were developed from notochord.

- Cervical vertebrae are more in risk for fractures
- 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.
- The film should include up to T1 because Cervical spine is more mobile , Thoracic spine more fixed so in the RTA The mobile part try to move while the fixed part will not this will lead to injury , so if we do not use this maneuver we will miss the injury
- 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.

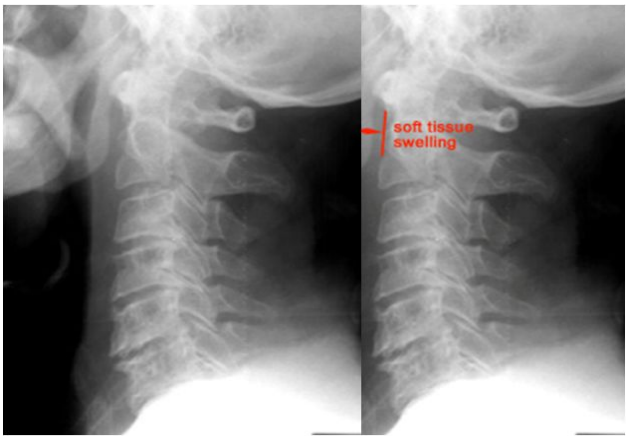


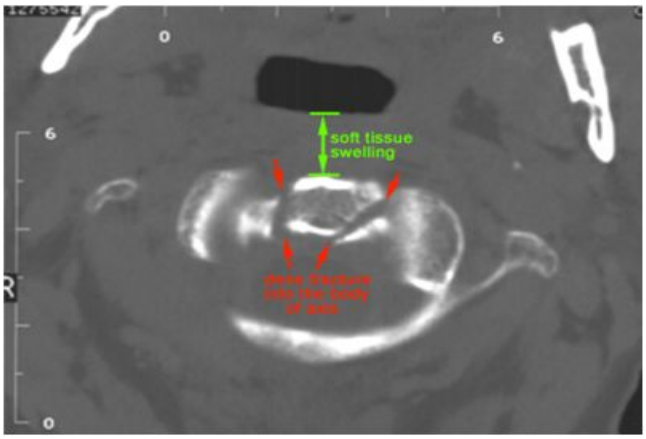






Alignment should be normal-check by drawing lines





Increased soft tissue space anterior to upper cervical vertebrae which indicate hemorrhage from fractures.

Here in the picture there is no C8 and T1 but 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

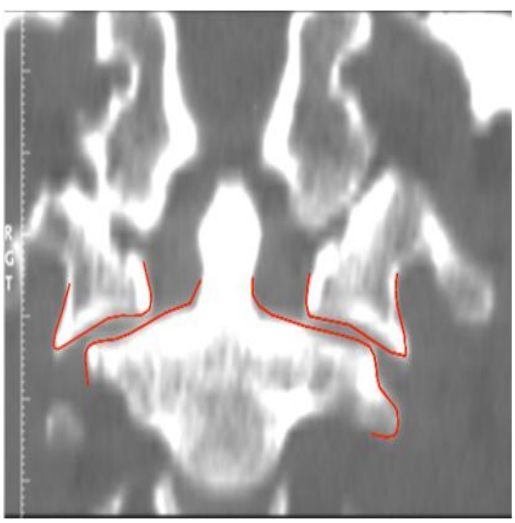
Relatively lateral masses are thicker compared to anterior and posterior arches. If there is anything compressing from the top this will slip laterally that will cause fracture in anterior and posterior arch because they are thin and weak.

There is a 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.

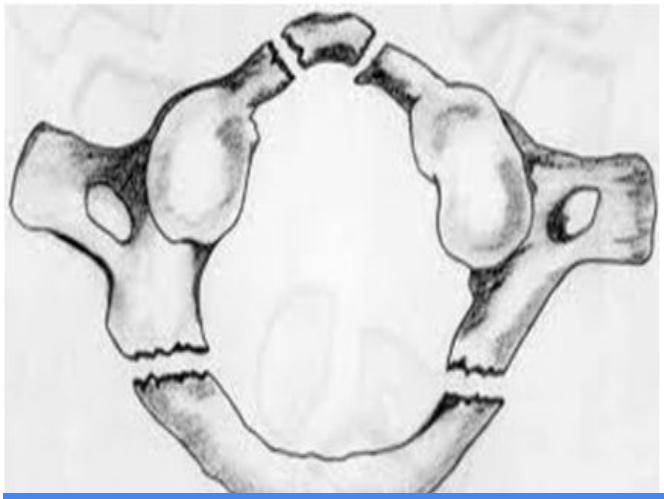
* E.g. when a hard block falls on the head of a worker.

* 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 .

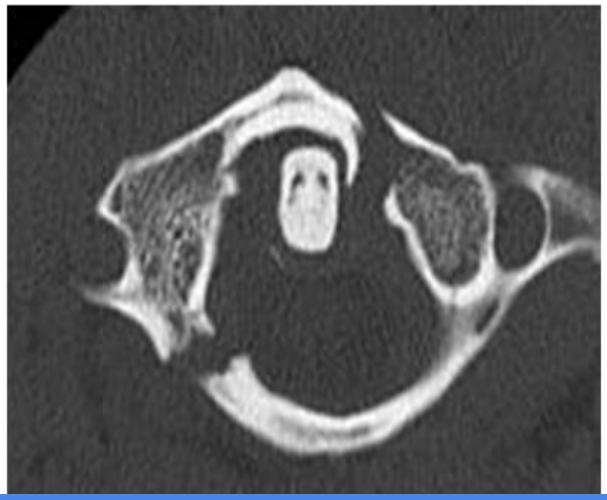
2) Head hitting a surface or object.

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

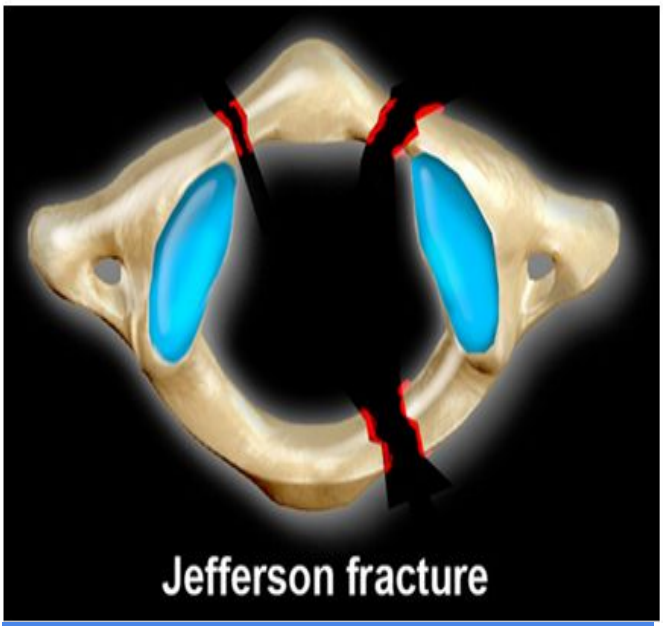
this two mechanism called axial loading injury



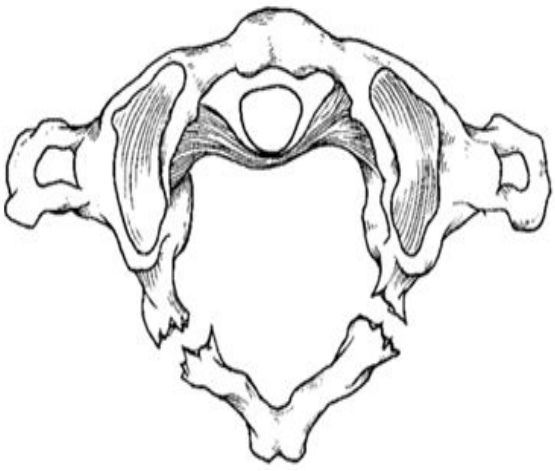
2Anterior and 2posterior fractures



1Anterior and 1posterior fractures



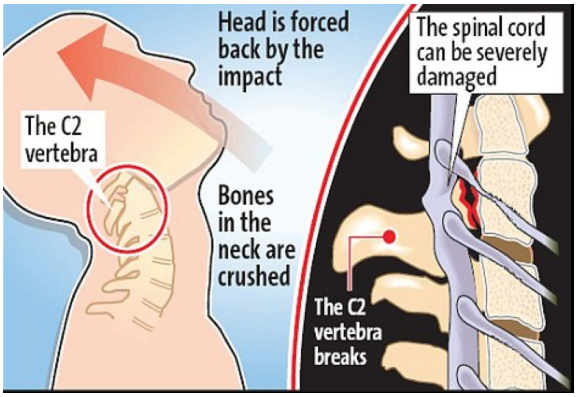
2Anterior and 1posterior fractures

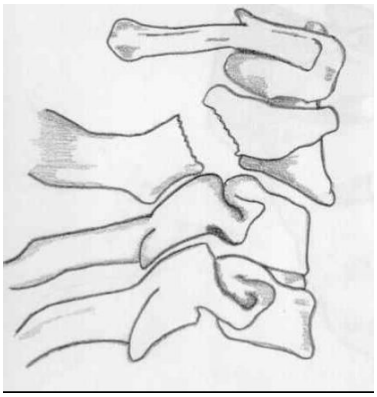


Posterior arch fracture

this is not Jefferson Fracture

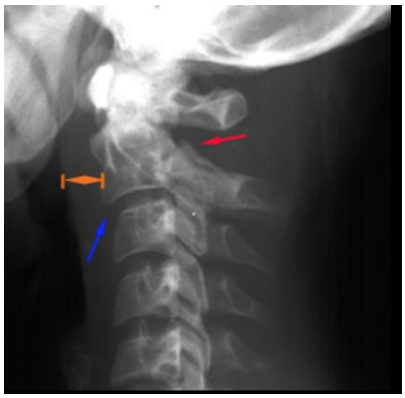
Hangman's Fracture

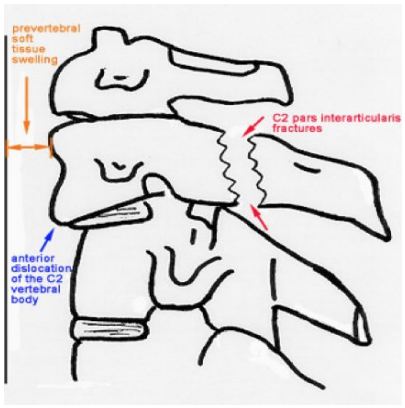




- Fractures through the pars interarticularis of C2 resulting from hyperextension and distraction
- Hyperextension (e.g. hanging, chin hits dashboard in road accident)
- **Radiographic features**: (best seen on lateral view)

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





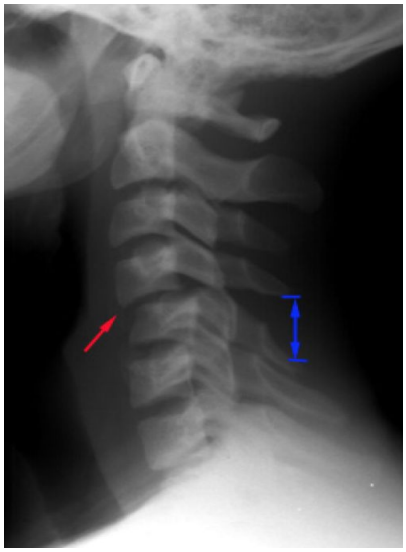
Bilateral Facet Dislocation

Complete anterior dislocation of vertebral body resulting from extreme hyperflexion injury
Associated with a very high risk of cord damage

Unilateral Facet Dislocation

Facet joint dislocation and rupture of the apophyseal joint ligaments resulting from rotatory injury

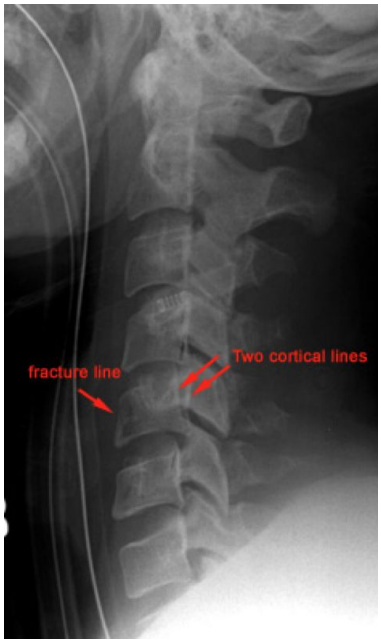
Mechanism: simultaneous flexion and rotation

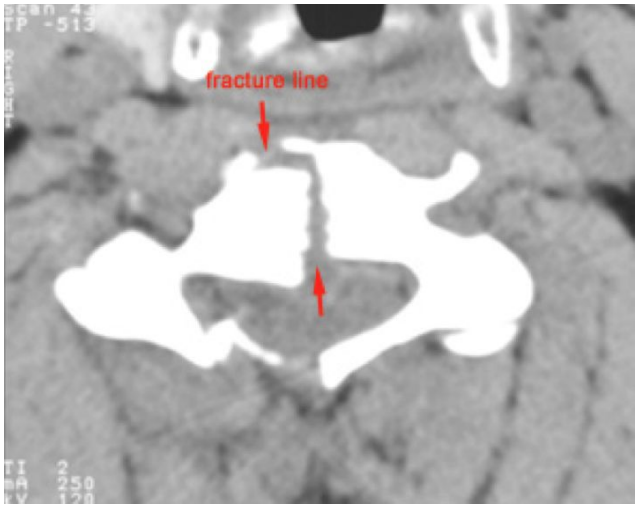


Burst Fracture

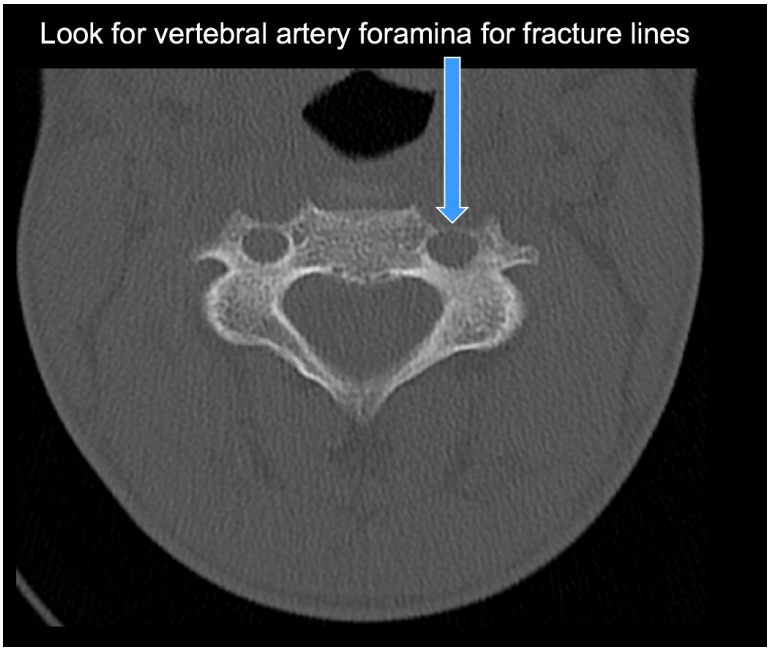
- Results from axial compression
- Injury to spinal cord is common due to displacement of posterior fragments
- CT is required for all patient to evaluate extent of injury

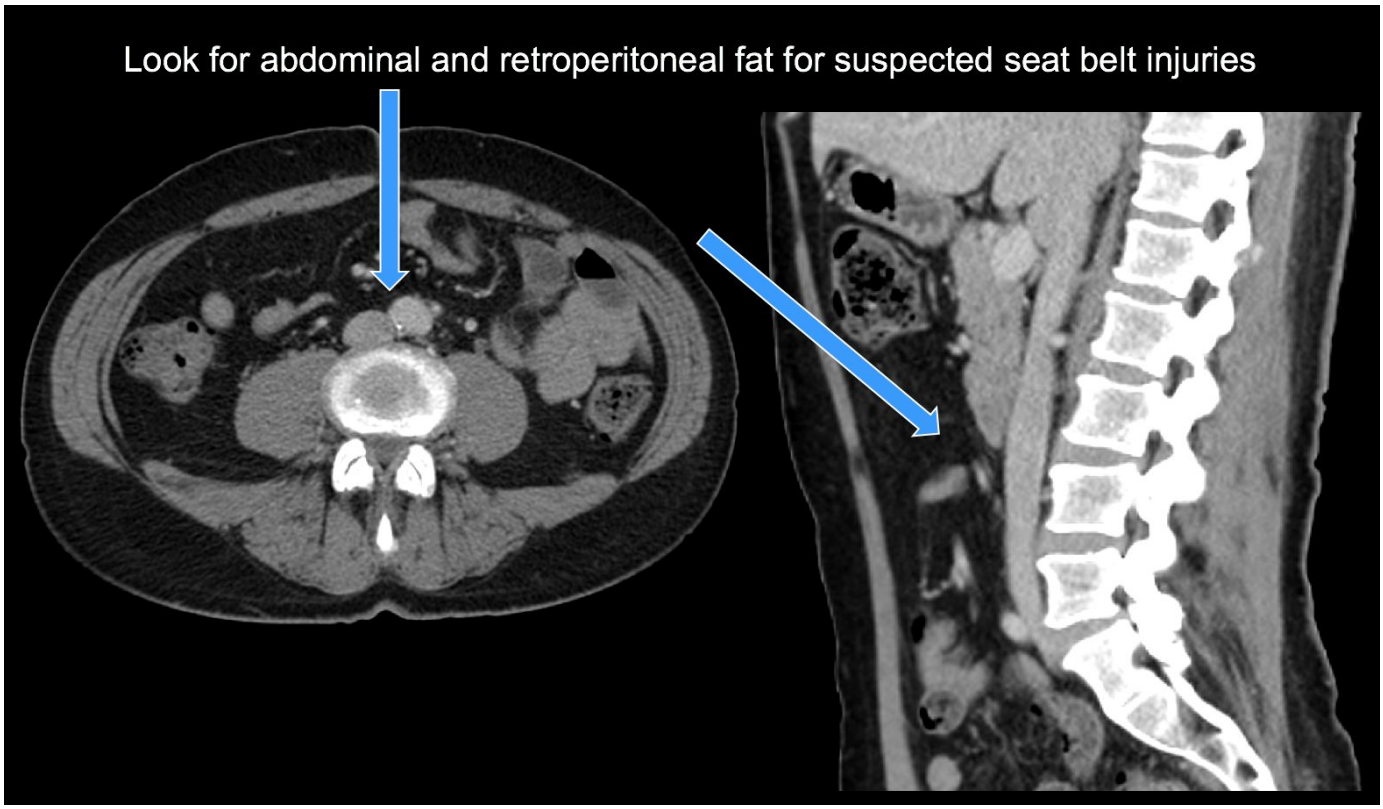
- Too much Hyperflexion or some times it happen with axial loading as well
- Hyperflexion is more stable than hyperextension injuries





- It happens with lateral flexion
- it can injure the vertebral artery which might thrombose or even rupture so the patient after injury might present with stroke





- It can cause extensive visceral abdominal injury (usually the liver and spleen are spared) and it can reach to lumbar vertebral injury, so we have to check if the abdomen and viscera are injured or not.
- Lumbar injury not only happen with seat belt injury it can happen with hyperflexion and hyperextension.

Infections
Discitis and Osteomyelitis

Usually the result of blood–borne agents, Especially from lung and urinary tract.
Most common pathogen is **staphylococcus**, Streptococcus is less common.
Gram-negative rods in **IV drug abusers or immunocompromised patients.**
E. Coli
Proteus
Non-pyogenic
Tuberculosis
Coccidioidomycosis

- **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

Site of involvement:

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

- Infection classically start in vertebral body but it extend quickly to the disc. Vertebra and disc is usually infection , if it is only in the vertebra it is usually tumor because tumor needs blood to survive and the disc have no blood supply.
- Infection from UTI can go to the spine

IMAGING FINDINGS

PLAIN FILMS:

- Narrowing and destruction of an intervertebral disk

Earliest plain film sign

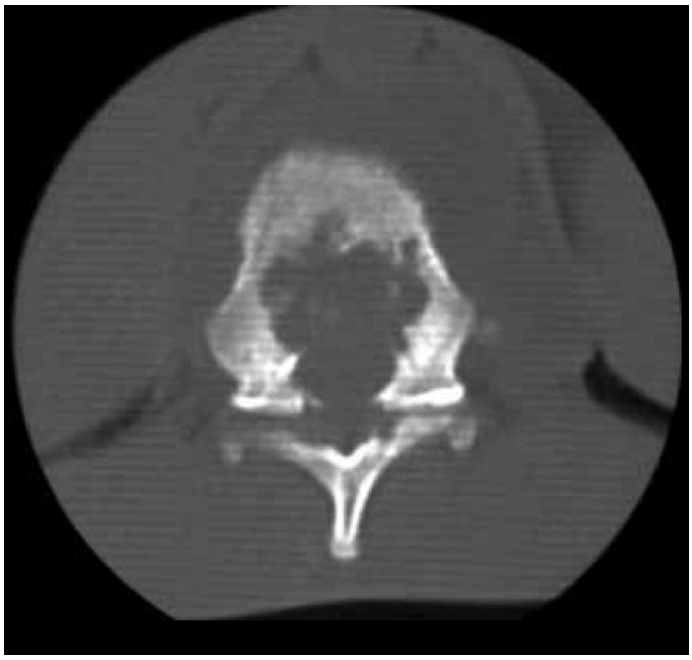
- Indistinct adjacent endplates with destruction
- Often associated with bony sclerosis of the two contiguous vertebral bodies
- Paravertebral soft tissue mass
- Endplate sclerosis (during healing phase beginning anywhere from 8 weeks to 8 months after onset)
- Bone fusion after 6 months to 2 years

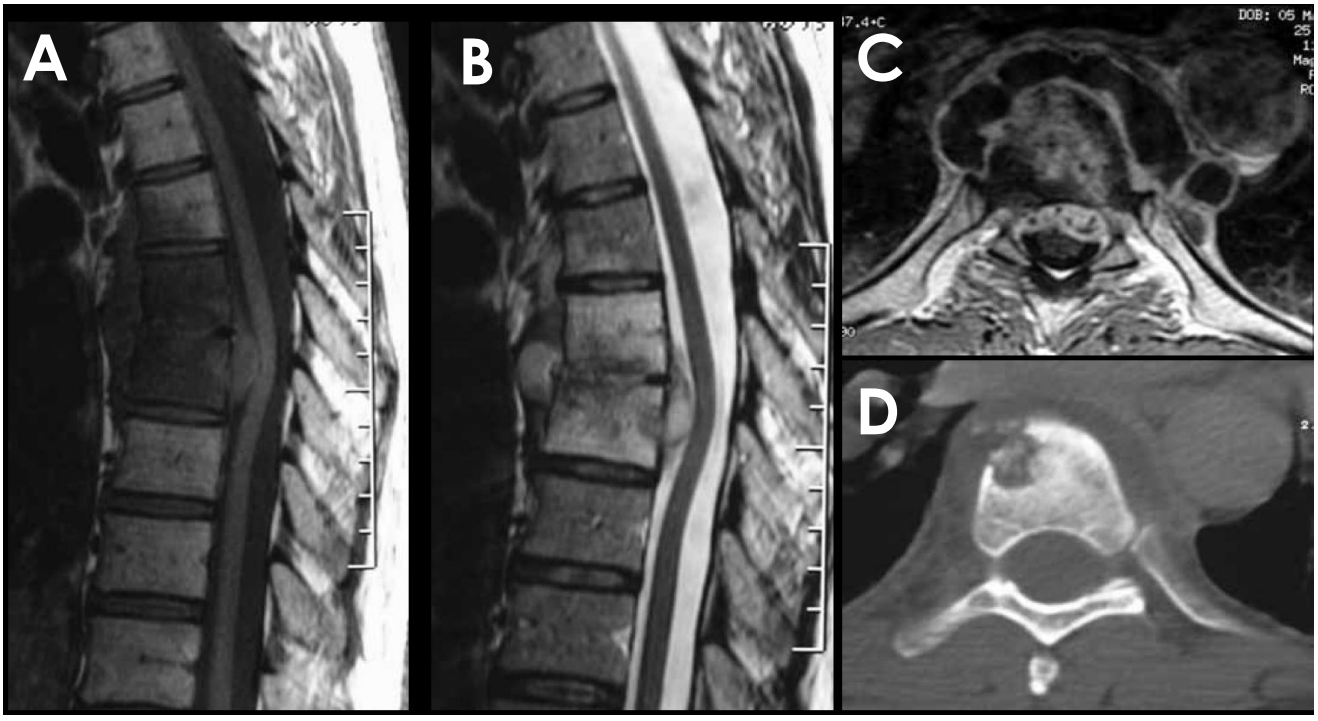
MRI:

- 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

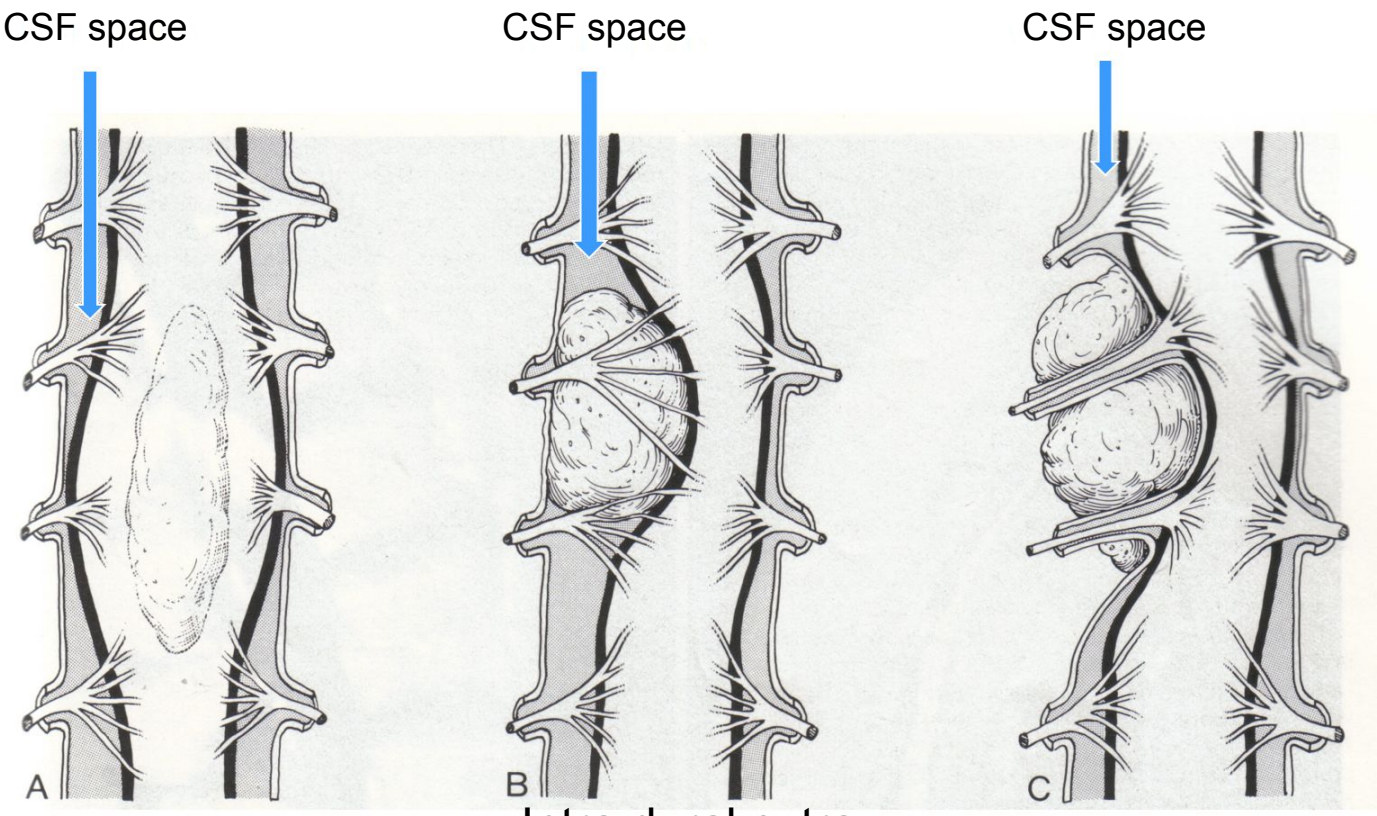
Infections

Discitis and Osteomyelitis





A. Sagittal T1 MRI shows decreased signal of vertebral bodies and disc with end plate destruction.
B. Sagittal T2 MRI shows increased signal in corresponding areas with anterior subligamentous abscess, epidural involvement and extension of inflammation in T6 with preserved endplate.
C. Axial contrast-enhanced T1 MRI shows peripheral enhancement of paravertebral abscess and marked enhancement of epidural tissues causing displacement of spinal cord.
D. CT shows lytic lesion in vertebral body and paravertebral abscess with calcifications.



Intra medullary

Intra dural extra medullary

extra dural

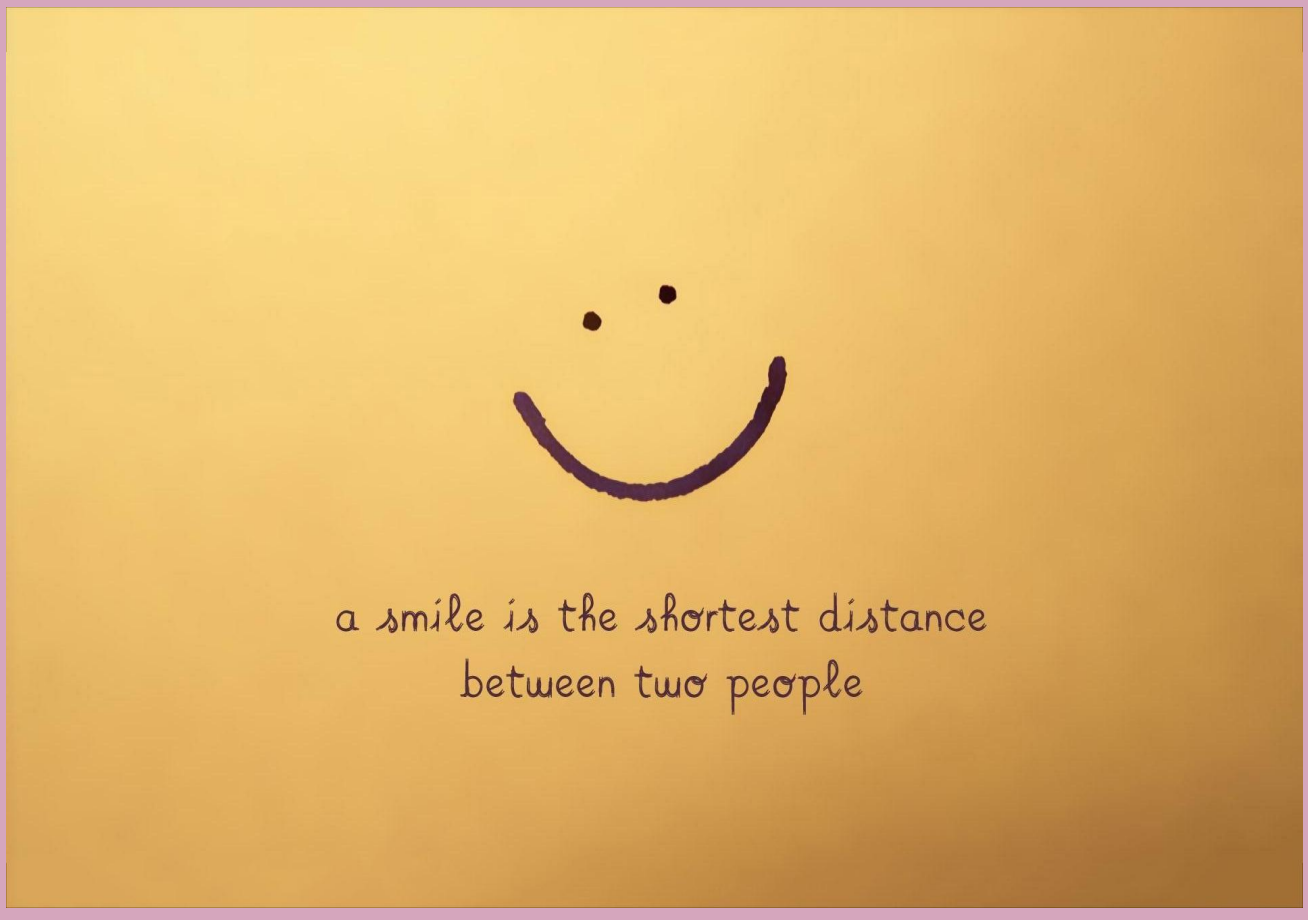
We should answer this question : **is this tumor from the spinal cord or outside the cord??**
Spinal cord tumors can not be removed unless If the tumor is outside the spinal cord it can be removed
---

- If the CSF space is narrowed and the spinal cord diameter becomes big so this is intramedullary tumor
- If the CSF space is larger and the spinal cord diameter becomes small so this is Intra dural extra medullary
- If the CSF space is narrowed and the spinal cord diameter becomes small so this is Extra dural

Intra dural extra medullary

Intra medullary

This is intramedullary but it is not a tumor , we did a brain MRI and it shows multiple lesions so this is Multiple Sclerosis



Thank You