RADIOLOGY
TEAM 435

Radiology of the spinal diseases

[Color index: Important ★ | Notes | Extra | Editing file]

- **Objectives:**

- Not Given

- **Resources:**

- Slides & notes 435
- 434 team

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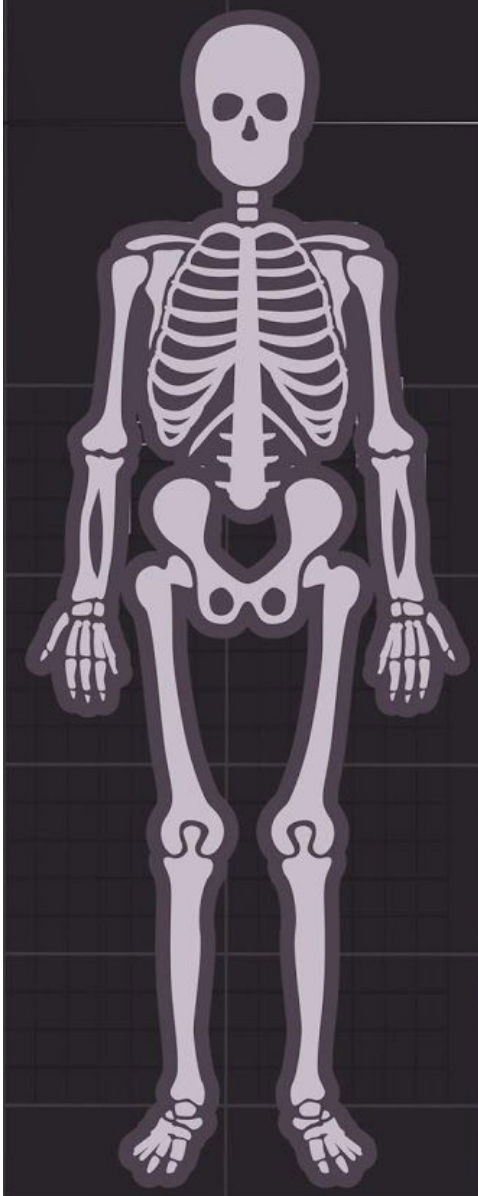


Imaging Methods to Evaluate the Spine

1- Plain X-Ray Films	(usually the first used imaging modality).
2- Myelogram	- Injection of contrast medium in CSF followed by an X-ray. - Rarely performed nowadays (bc of risk of injury and infections. Only performed in selective cases that are contraindicated to MRI).
3- CT Scan	Best modality for bone, very poor information about spinal cord.
4- MRI	Preoperatively in spinal cases we do both CT and MRI
5- Discogram	injection of contrast medium in the disc followed by X-ray imaging.
6- Spinal angiography	To evaluate arteries and veins
7- Ultrasound	More in children (Used in pediatrics because they have more cartilage unlike adults)
8- Radionuclide Bone Scan	- IV injection of radioactive material bound to phosphonates which deposit in bones, followed by images by gamma camera. - (1st choice for malignancy & bone metastasis and when multiple lesions are suspected)
9- DEXA	radionuclide scan for bone density (Osteoporosis only)

X-RAYS (RADIOGRAPHS)

- Often the 1st diagnostic test, quick & cheap.
- Small dose of radiation to visualize the bony parts of the spine.

- Applications/Can detect:

1) Spinal alignment and curvature. (alignment means the vertebrae is aligned with the other vertebrae)
2) Spinal instability – with flexion & extension views.
3) Congenital defects of spinal column.
4) Fractures after trauma, Infections and Tumors.
5) Moderate osteoporosis (loss of Ca^{++} from bone).

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

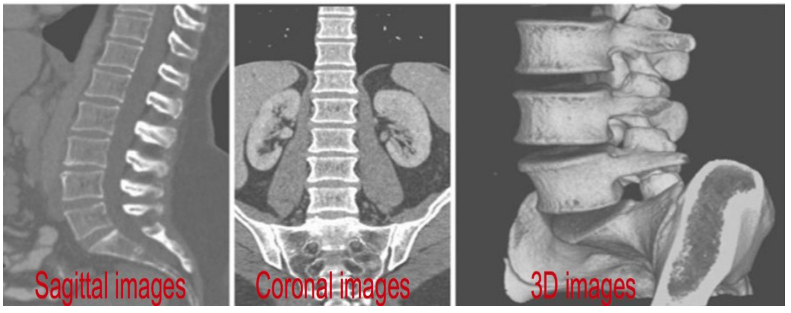
COMPUTERIZED TOMOGRAPHY (CT)

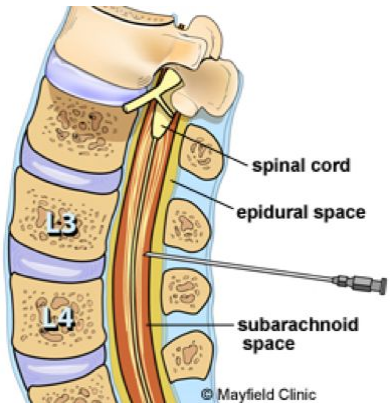
- Uses radiation to obtain 2D & 3D images.
- Patient must lie still on a table, which moves through a scanner.
- Cross-sectional images are obtained of the target areas.
- Much detailed information regarding bony and soft tissues.
- Entire spine can be imaged within a few minutes.
- Might need IV or intrathecal contrast for some areas.

- Better in visualizing:

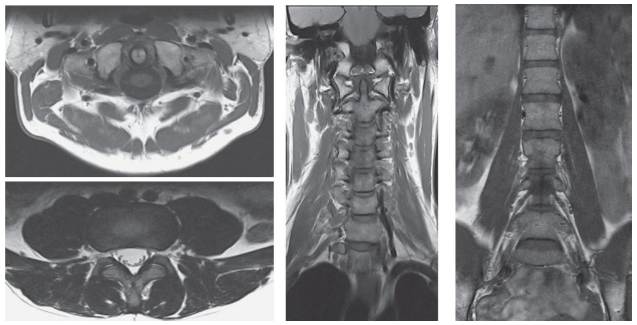
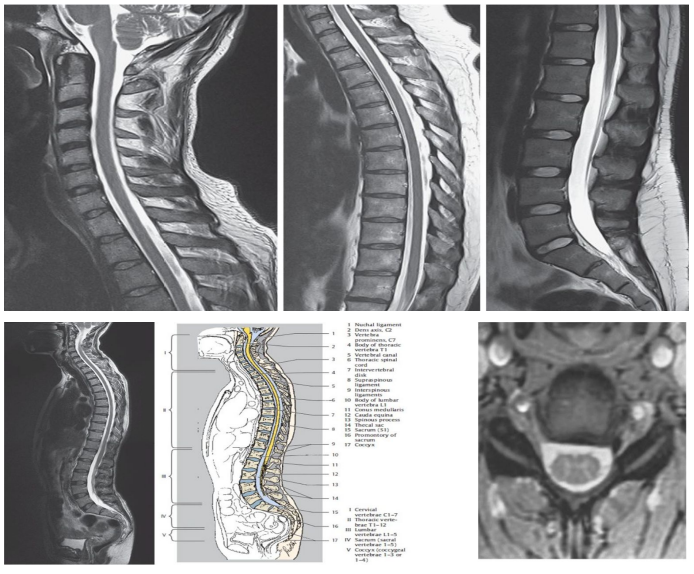
1) Degenerative changes, Herniated discs
2) Spinal alignment (limited information)
3) Fractures and fracture patterns (if there is trauma, CT is a must investigation)
4) Congenital/childhood anomalies
5) Areas of narrowing in spinal canal through which spinal cord and spinal nerve roots pass

- Poor in visualizing: Inner details of spinal cord.



MYELOGRAM	MAGNETIC RESONANCE IMAGING (MRI)
- A contrast material is injected into CSF to better identify areas where spinal cord or spinal nerves are compressed. **- PROCEDURE:** Under local anesthesia, a needle is placed into lower lumbar spinal canal, (between L3-L4 to insure safety) then CSF flow is confirmed. Contrast medium is then injected which mixes with CSF around spinal cord, making it visible on x-ray. Often a CT scan is performed after this. (sometimes done with fluoroscopy) Used when MRI is contraindicated. "that is the only indication"  	- The gold standard for spinal disorders. - Does not use ionizing radiation. - Can identify abnormalities of bone, discs, muscles, ligaments and spinal cord. - IV contrast is sometimes administered to better visualize certain structures or abnormalities. - Patient lies still in a tunnel like structure for 25 mins. - Claustrophobic patients may need sedation, and children often need general anesthesia. **- Contraindications include:** 1) Implanted devices e.g. cardiac pacemakers and all other electromagnetic devices. 2) Certain metal clips and stimulators. (like aneurysmal clips, bc if the clip moves it damages the artery) - Artificial joints & spinal hardware may still have MRI scans. "will not be pulled out, but the metal can get hard to the patient (they feel it)"

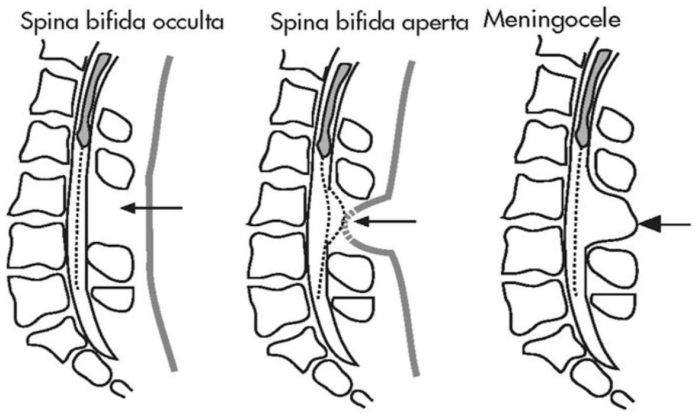
MRI features in contrast to CT

MR images are Multi-planer	MR images are of very high resolution (you can see gray matter, white matter, nerve roots and ganglia)
	

Spinal Abnormalities Assessment

1) Congenital Anomalies:

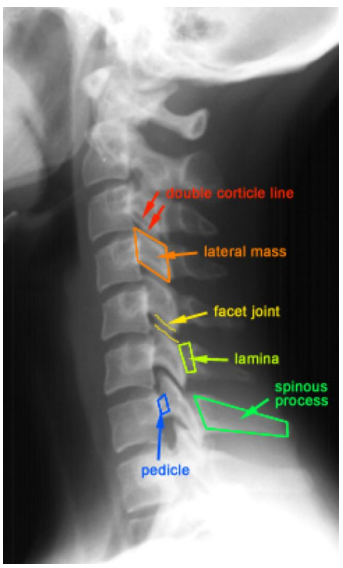
- Skin covered defects and Open skin defects. (Spina bifida occulta, Spina bifida Aperta, Meningocele)
- In Occulta, skin is normal but some patients have a dimple or pathc of hair and you feel defect on exam. (occulta means hidden)
- in Aperta there's skin defect and neural & subcutaneous tissue can be seen.
- Meningocele: Fluid filled thecal sac hidden with meninges and CSF comes out like a balloon.
- Picture A: The whole thecal sac even spinal cord is protruding. (meningomyelocele)
- CT is good to show bony structures and is often used before surgeries.

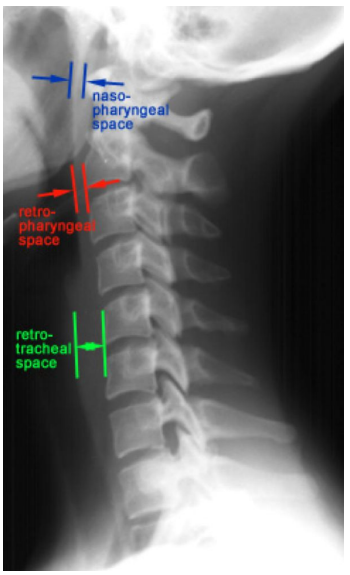


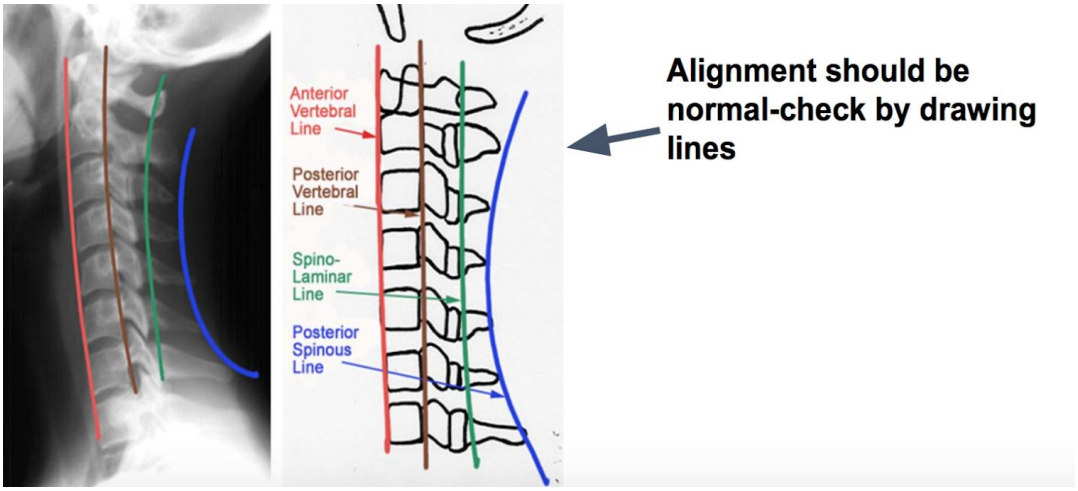
Multiple fusion abnormalities of vertebra on plain film.

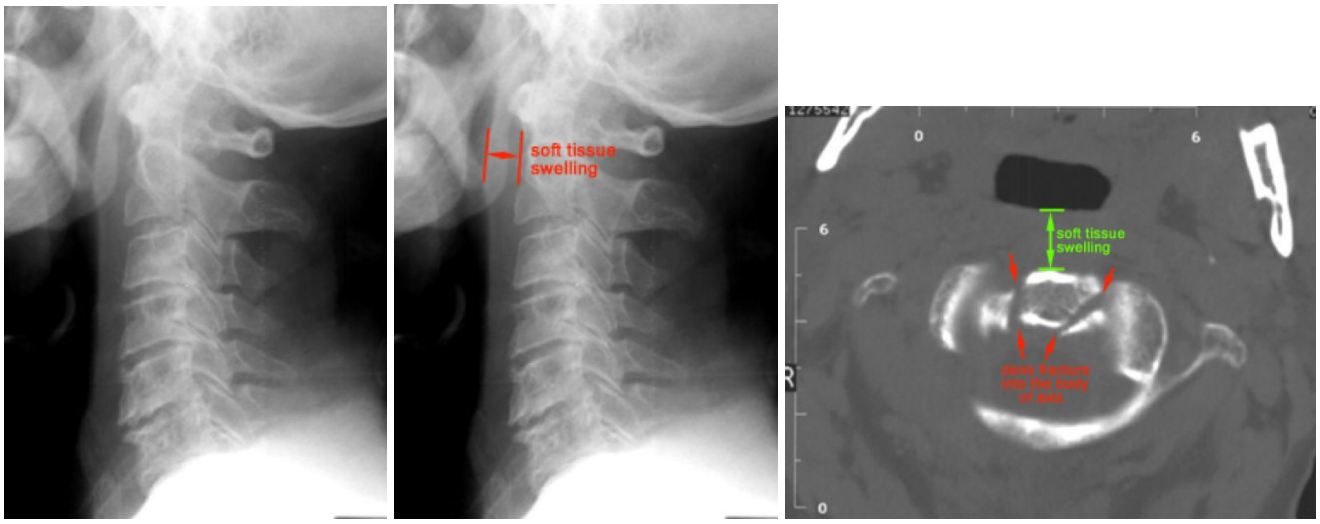
2) Trauma:

- Plain film is the first imaging modality in assessment of trauma
- All vertebrae were developed from notochord.
- Cervical vertebrae are at the most risk for fractures
- Upper cervical space (<5mm) should be thinner than retrotracheal space (less than vertebral body in diameter)
- Cervical spine trauma 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 and thoracic spine is more fixed, so in the RTA The mobile part tries to move while the fixed part doesn't which leads to injury, so if we do not use this maneuver we will miss the injury.
- To assess trauma, usually we do plain films, unless the patient is severely traumatized (head injury, skull laceration or multiple bone fracture) we do CT trauma survey from head to thigh.





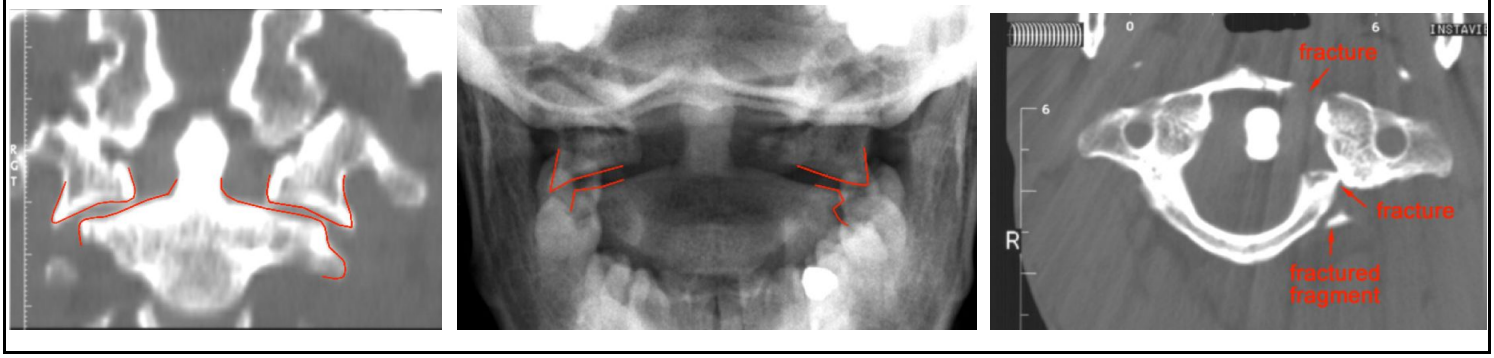


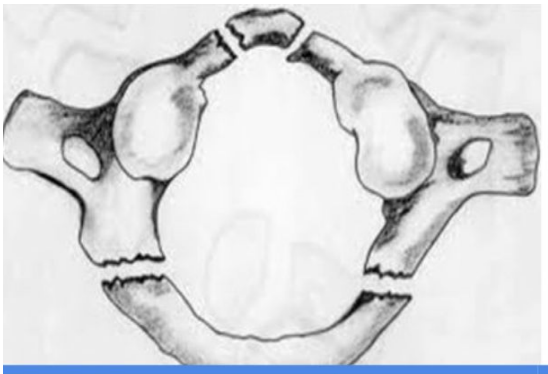


- (Soft tissue anterior to spine is very important): Increased soft tissue space anterior to upper cervical vertebrae indicates hemorrhage from fractures (hematoma). No need to repeat, just get the patient to CT scan to assess the site of injury.
Here in the picture there is no C8 and T1 but we don't need to repeat the image because the abnormality is already found, but; if image was normal we need to repeat the imaging to see the cervicothoracic junction.

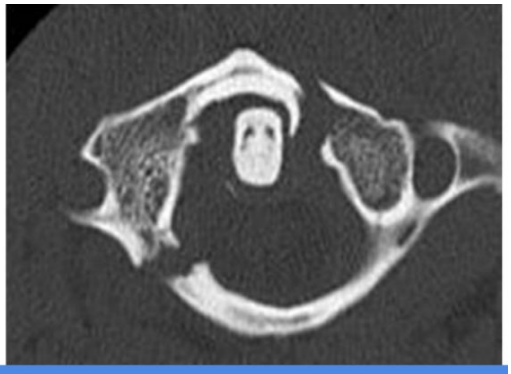
★3) Jeffereson Fracture (C1 fracture):

- Relatively lateral masses are thicker compared to anterior and posterior arches. If there is anything compressing from top and will slip laterally which will cause fractures in anterior and posterior arches 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.
- Axial CT clearly shows the location of the fractures of C1.
- 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.
Whenever it involves the anterior and posterior arch (it's called Jeffereson) should happen to both!
if it happens to a single arch this is not jefferson.

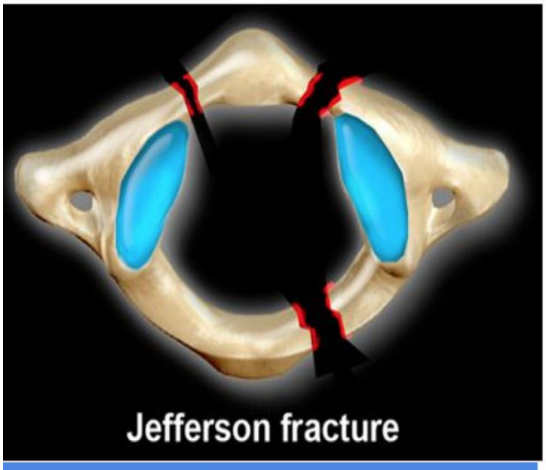




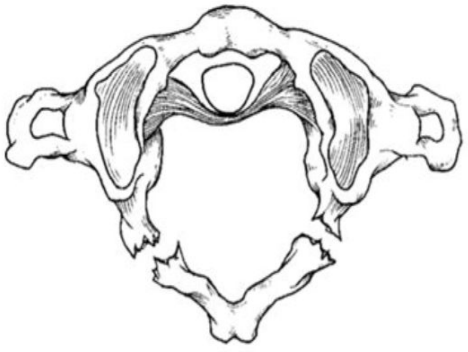
2Anterior and 2posterior fractures



1Anterior and 1posterior fractures



2Anterior and 1posterior fractures



Posterior arch fracture

this is not Jefferson Fracture

Mechanism of trauma is *Axial Loading*:

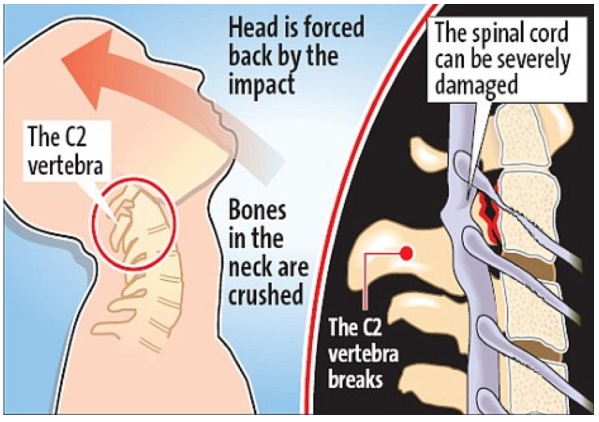
1) Object hitting the head.

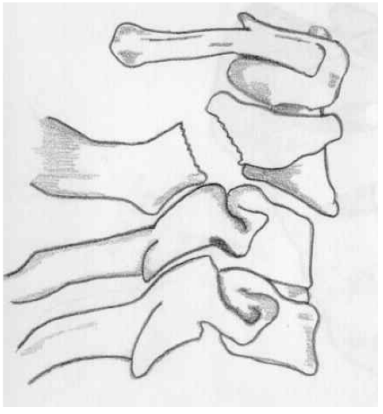
* E.g. when a hard brick falls on the head of a worker. (Workers should wear helmets, but they still aren't fully protected because the helmet protects against the direct head injury, but the ultimate weight will transmit to the whole craniocervical junction) but if the worker doesn't wear a helmet he will have a head injury, which is more lethal than cervical spine injury.

2) Head hitting a surface or object.

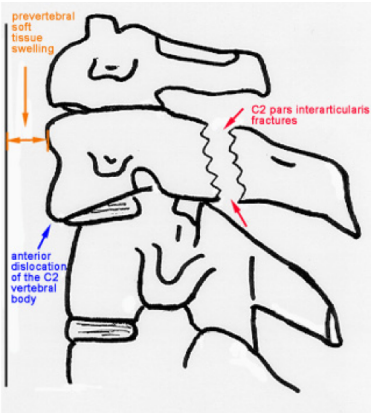
* E.g. Jumping into a swimming pool with shallow water will cause the head to hit the floor directly.

★4) Hangman's Fracture (C2 fracture):

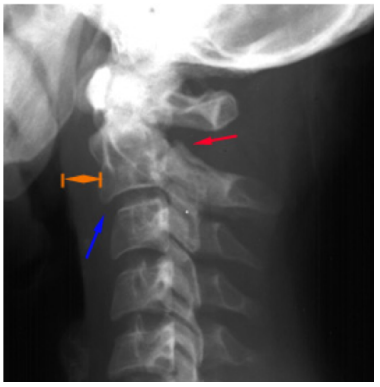




- Fractures through the pars interarticularis of C2 (between vertebral Body and posterior element) resulting from **hyperextension and distraction**.
- Sudden Hyperextension e.g. hanging (death sentence) or when chin hits dashboard in road accident.



- **Radiographic features**: (best seen on lateral view).
    1) Prevertebral soft tissue swelling
    2) Fracture(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.
    if injury is in C2 > hemiplegia.if below C5 > quadriplegia and breathing is intact. if C3 and below, pt can't breath bc the diaphragm is supplied by C3,C4,C5



5) Bilateral Facet Dislocation:

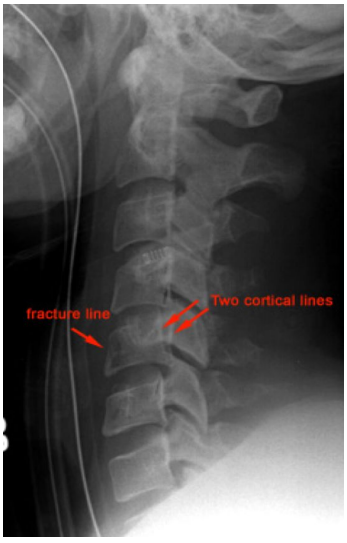
- aka Wedge fracture.
- Complete anterior dislocation of vertebral body resulting from sudden extreme hyperflexion injury. (not as dangerous as jefferson)
- Associated with a very high risk of cord damage.
- Happens in car accidents when the car suddenly stops causing dislocation.
- Called wedge, but if the fracture reaches the posterior cortex it's called **burst** fracture, which is more dangerous because it affects the spinal cord.

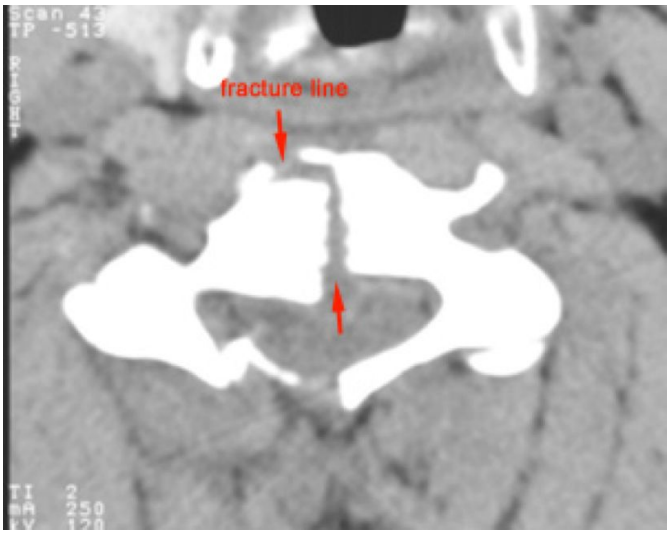
6) Unilateral Facet Dislocation:

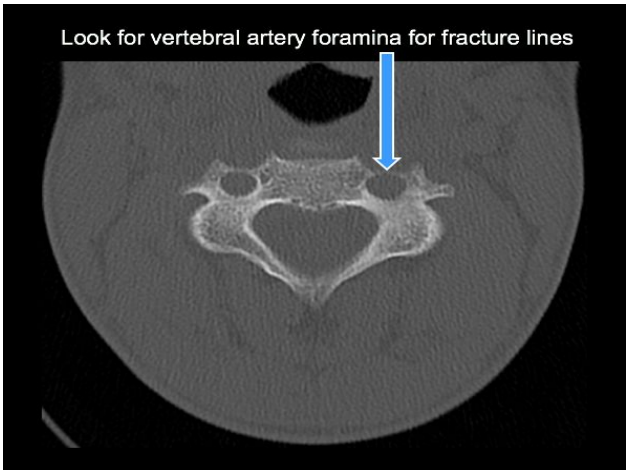
- Facet joint dislocation and rupture of the apophyseal joint ligaments resulting from rotatory injury.
- **Mechanism**: simultaneous flexion and rotation.

7) Burst Fracture:

- Results from axial compression.
- Injury to spinal cord is common due to displacement of posterior fragments. (if it reaches to the posterior cortex of vertebra, its called burst fracture.)
- CT is required for all patient to evaluate extent of injury.
- Occurs due to hyperflexion and axial compression.
- Hyperflexion is more stable than hyperextension injuries.

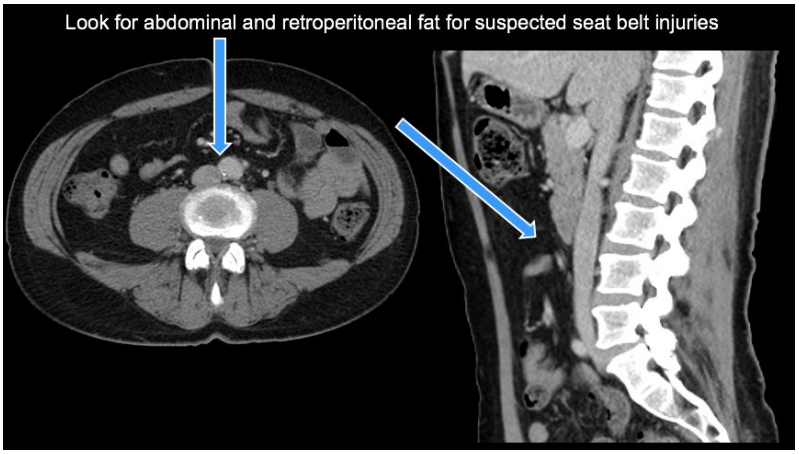






→ It happens with lateral flexion

→ The broken bone edges can injure the vertebral artery which might cause it to thrombose or even rupture, so the patient might present with stroke.



→ It can cause extensive visceral abdominal injury (usually with sparing of liver and spleen) and can cause lumbar vertebral injury, so we have to check if the abdomen and viscera are injured or not.

→ Lumbar injury not only happens with seat belt injury but also with hyperflexion and hyperextension.

Infections: Discitis & Osteomyelitis

❖ Introduction:

- Usually the result of blood–borne agents (hematogenous spread), especially from the lungs and urinary tract.

- Most common pathogen is **staphylococcus**, Streptococcus is less common.

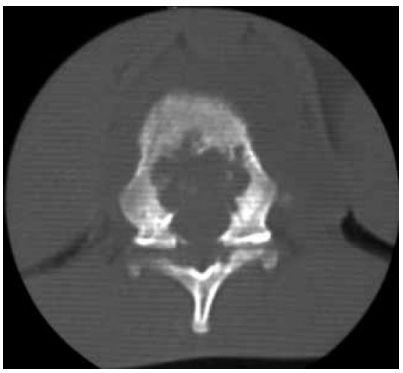
- Gram-negative rods in **IV drug abusers or immunocompromised patients:**
  1) E. Coli
  2) Proteus
  3) Non-pyogenic (Tuberculosis, Coccidioidomycosis)

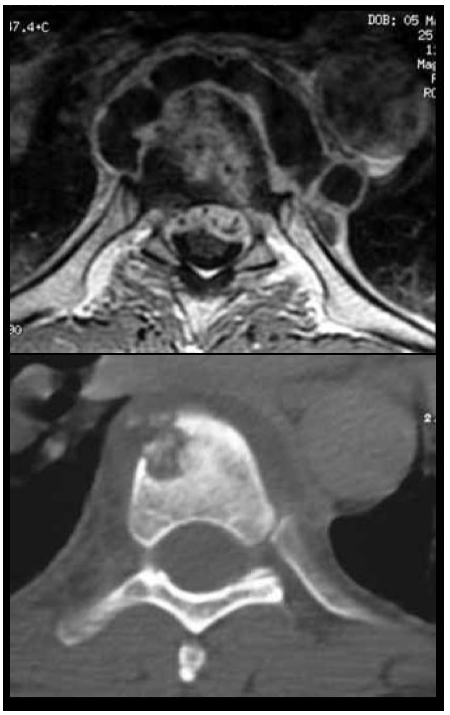
- **May occur after invasive procedure like Surgery, Discography, Myelography.**
- In children, infection begins in vascularized disc.
- In adults, in anterior inferior corner of vertebral body with spread across disk to adjacent vertebral endplate.
- **Site of involvement:**
  - L3/4
  - L4/5
  - Unusual 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 infected , if it is only in the vertebra it is usually tumor because tumor needs blood to survive and the disc has no blood supply.
- Infection from UTI can go to the spine.

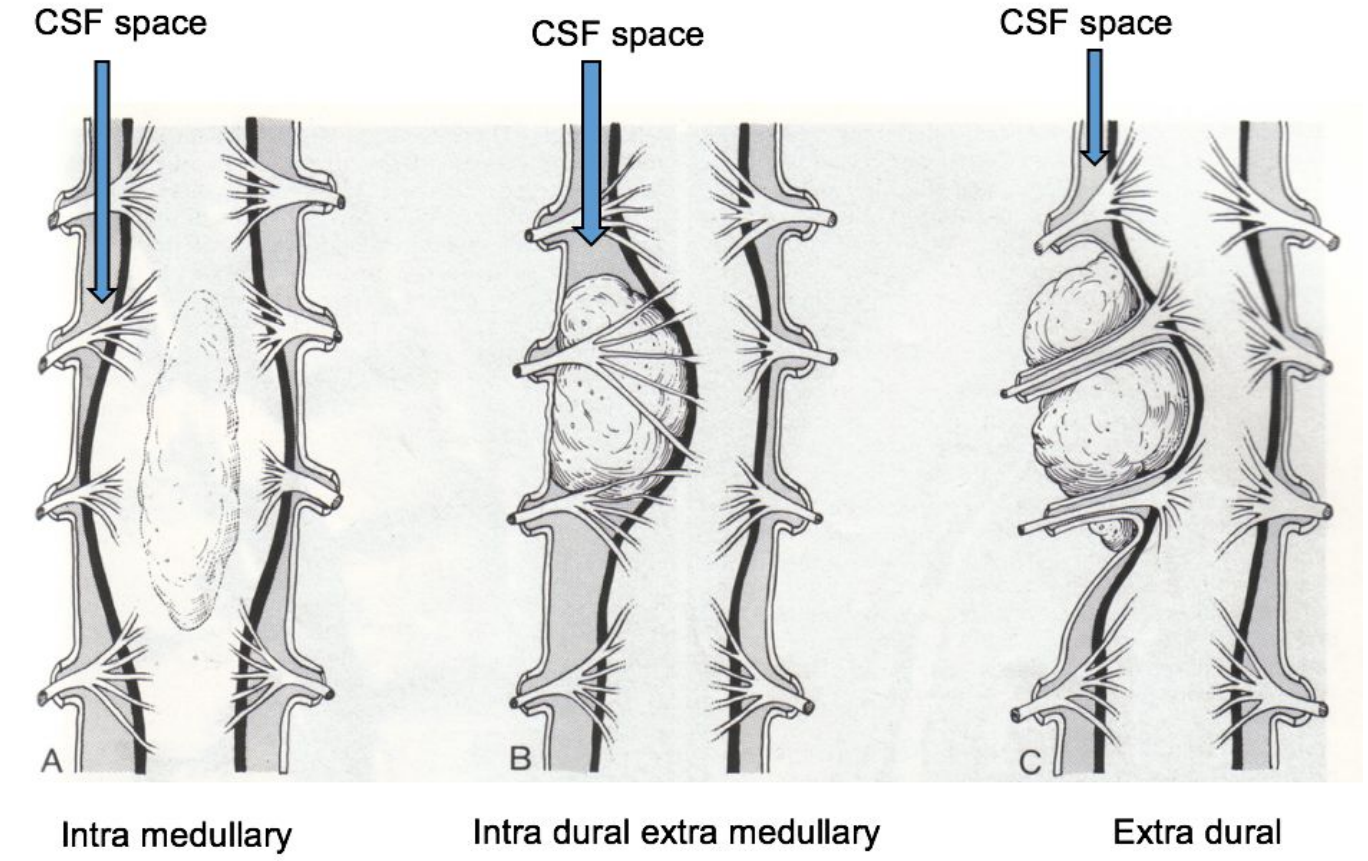
❖ Imaging Findings:

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



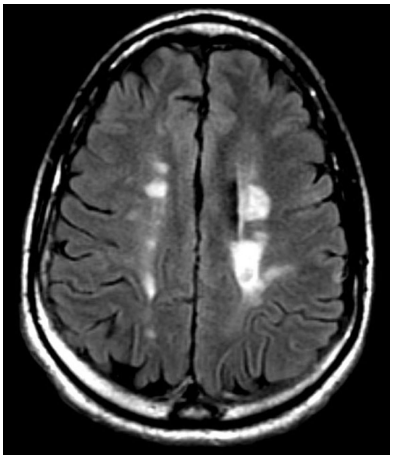
		
Sagittal T1 MRI shows decreased signal of vertebral bodies and disc with end plate destruction.	Sagittal T2 MRI shows increased signal in corresponding to areas with anterior subligamentous abscess, epidural involvement and extension of inflammation in T6 with preserved endplate.	**Upper Picture:** Axial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

Tumors



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 > this is intramedullary tumor. (very limited treatment options) (we can't do surgery)
- If the CSF space is larger and the spinal cord diameter becomes small > this is Intradural extramedullary.
- If the CSF space is narrowed and the spinal cord diameter becomes small > this is extra dural.

		 
Intradural Extramedullary	**IntraMedullary**	This is intramedullary but it is not a tumor, we did a brain MRI and it shows multiple lesions so this is Multiple Sclerosis. How to differentiate between MS and Intramedullary tumor ? 1- MS: Spinal cord has same size proximal to lesion as distal 2- Intramedullary tumor: Spinal cord becomes bigger