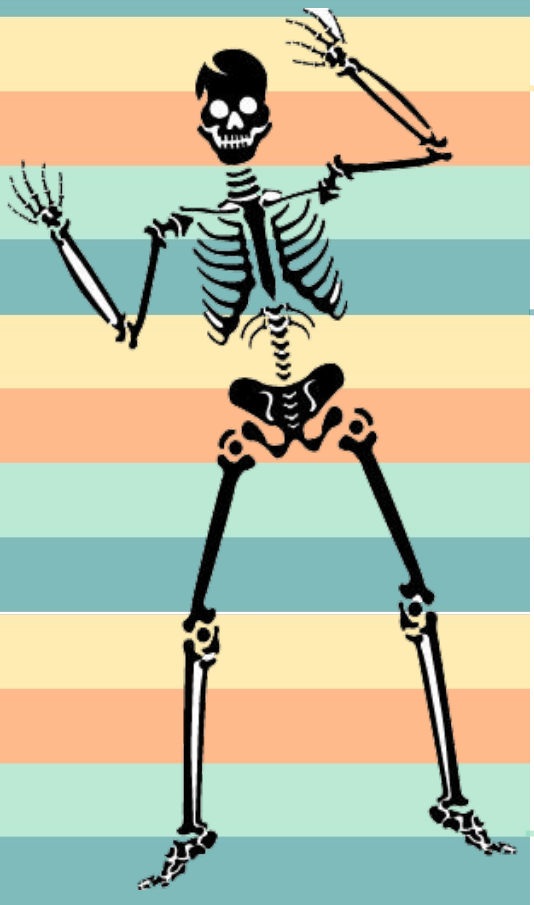
436 Teams

Radiology
Teams 436

Radiology of spinal diseases

Objectives

1. To understand basic mechanisms of trauma to cervical spine.
2. To evaluate findings on plain films of cervical spine trauma.
3. To know basic differences between spine infections, tumors and trauma.
4. To be able to localize spinal lesions in intramedullary, intramural and extra dural compartments.



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Color Coding

Important | Notes | Extra

Editing File

Imaging Methods to Evaluate the Spine

Imaging method	Explanation
Plain X-Ray Films	Bones (usually the first used imaging modality).
Myelogram	- Injection of contrast medium in CSF followed by an X-ray,to assess CSF surrounding space. - Rarely performed nowadays (because of risk of injury and infections. Only performed in selective cases that are contraindicated to MRI).
CT Scan	Best modality for bone, very poor information about spinal cord.
MRI	- For intraspinal content , spinal cord بالتحديد. - Preoperatively in spinal cases we do both CT and MRI.
Spinal angiography	To evaluate arteries and veins.
Ultrasound	More in children for example in congenital disease (Used in pediatrics because they have more cartilage unlike adults).
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.
DEXA (Dual-Energy X-ray Absorptiometry)	Radionuclide scan for bone density (Osteoporosis only).

X-Rays (Radiographs)

- Often the 1st diagnostic test, quick & cheap, request in the ER.
- Small dose of radiation to visualize the bony parts of the spine.
- May be taken in different positions (ie; bending forward & backward, flexion and extension) to assess for instability.

Can detect:

1) Spinal alignment and curvature (alignment means the vertebrae is aligned with the other vertebrae).
2) Spinal instability – with flexion & extension views, to assess displacement and subluxation.
3) Congenital (birth) defects of spinal column.
4) Fractures after trauma, Infections and Tumors.
5) Moderate osteoporosis (loss of Calcium from bone), but DEXA is better in osteoporosis.

Computerized Tomography (CT)

- Uses radiation to obtain 2D which can be processed to 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 structures, limited information about spinal cord 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). IMPORTANT
4) Congenital/childhood anomalies.
5) Areas of narrowing in spinal canal through which spinal cord and spinal nerve roots pass, like spinal stenosis.

Poor in visualizing:

Inner details of spinal cord (contents of spinal cord), the concentration is more on the bones.

3D Image

Sagittal Image

Axial Image

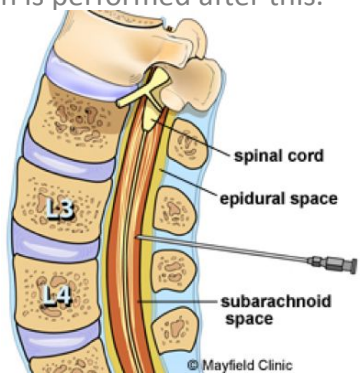
Coronal Image

Myelogram

A contrast material is injected into CSF to better identify areas where spinal cord or spinal nerves are compressed. Rarely used now, to assess the outline and not the cord itself.

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, the contrast is injected in the subarachnoid space.
Often a CT scan is performed after this.



*white arrows: nerve root

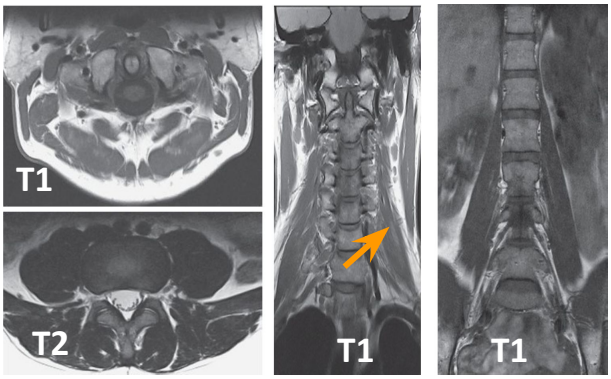
Magnetic Resonance Imaging

- 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. eg: infection, tumor but normally we do not use contrast.
- Patient lies still in a tunnel like structure for 25 mins.
- Claustrophobic patients may need sedation, and children often need general anesthesia.

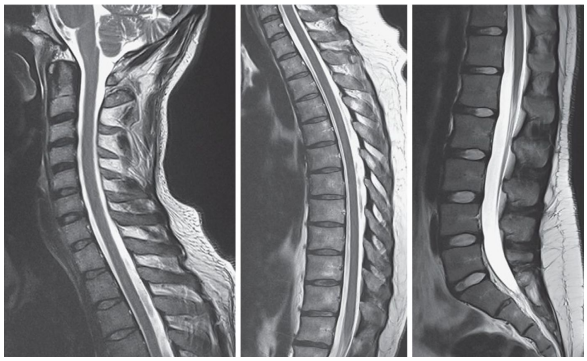
- **Contraindications include:**
 1) Implanted devices e.g. cardiac pacemakers and all other electromagnetic devices.
 2) Certain metal clips and stimulators (like aneurysmal clips, because if the clip moves it damages the artery).
- Artificial joints & spinal hardware may still have MRI scans "will not be pulled out, but the metal can get hard to the patient (they feel it)".

MRI features in contrast to CT

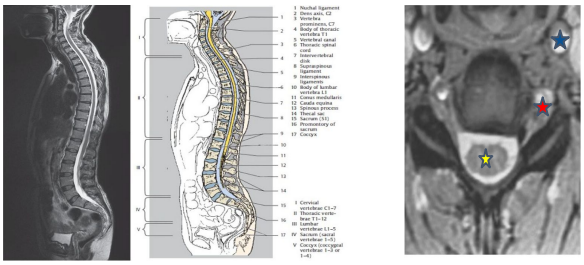
MR images are Multi-planer



MR images are very high resolution



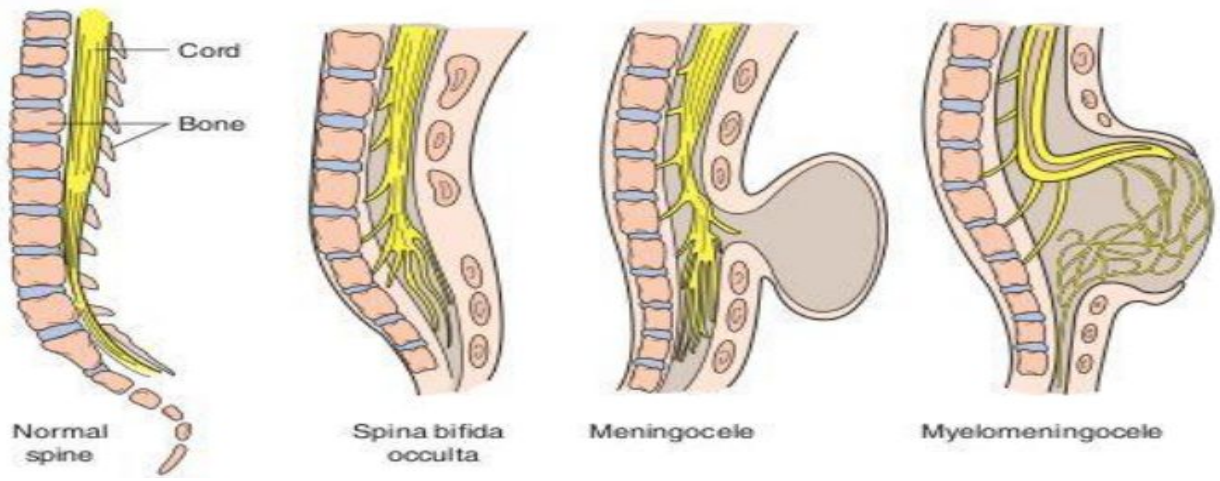
Cervical **Thoracic** **Lumbar**

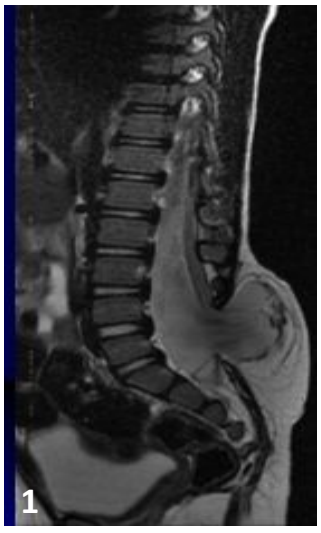


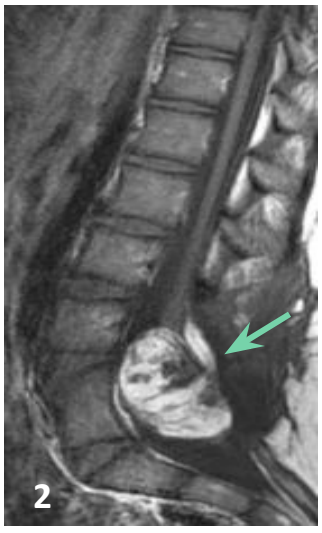
- **Orange arrow:** Psoas muscle.
- X-ray and CT show us only disc space.
- MRI not only shows us disc but the components of it.
- High signal intensity (bright disc) → T2 **Why?** due to collagenous water materials that why in degenerative disease the disc become hard and low water so it look little bit dark + narrow disc space.
- **Yellow star:** spinal cord.
- **Red star:** vertebral artery.
- **Blue star:** carotid artery.

1) Congenital Anomalies:

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







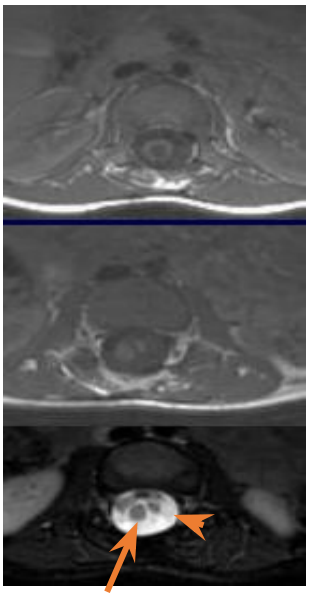
Meningocele

Low lying cord tethered to large lipoma

- **Pic1:** T2 because the disc is bright.
- **Pic 2&3:** Post meningocele repair, the spinal cord lower than the normal and it could be with free end or attached (tethered) to fat like this pic شالوا السيست وبقى الفات
- Fat bright in pic 2 while in pic 3 dark by using fat saturation technique which suppress the fat عشان نتأكد إذا هو فعلاً فات ولا لا.
- **Orange arrow:** Low lying cord.
- **Blue arrow**: Lipoma.

Multiple fusion abnormalities of vertebra on plain film, loss of disc space.





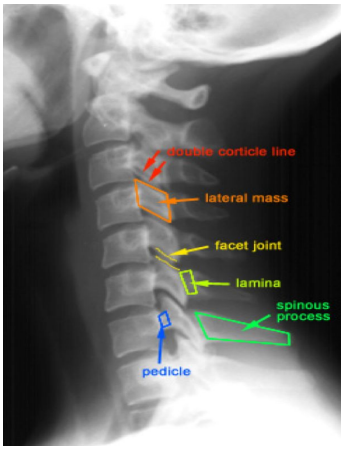
Arrows: represents the splitting cord into two part separated by bone element صعب نشوفه في sagittal view.
Circle: cyst.

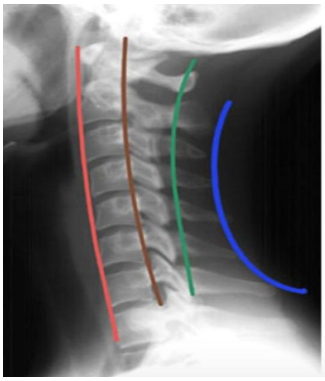
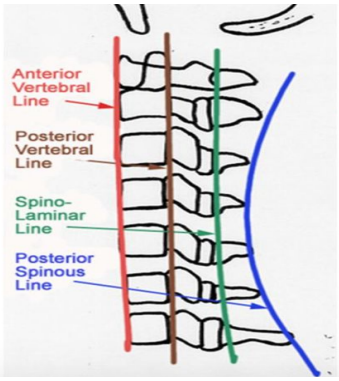
Split low lying cord (diastematomyelia)

2) Trauma:

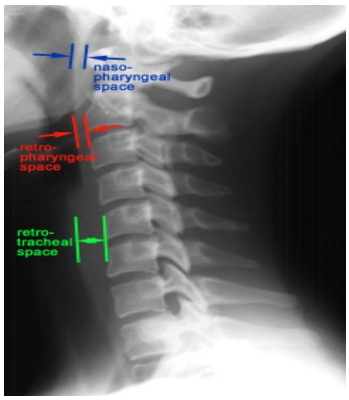
- Plain film is the first imaging modality in assessment of trauma.
- All vertebrae were developed from notochord.
- Cervical spine trauma is more likely to have fracture because it is uncovered part of the spine a little bit compared to thoracic and cervical.
- To assess trauma, usually we do plain films, unless the patient is severely traumatized (head injury, skull laceration or multiple bone fracture) we do CT trauma survey from head to thigh.



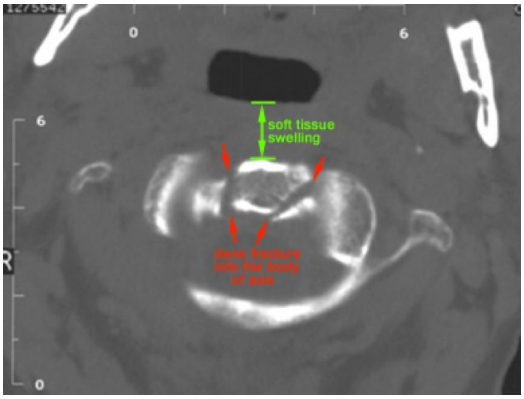


Alignment should be normal – check by drawing lines to assess displacement and subluxation.



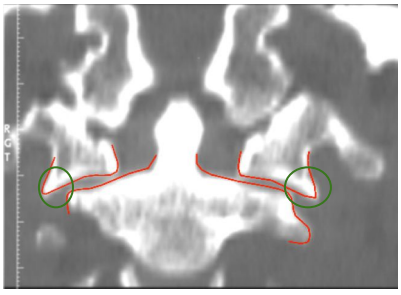
Normally the thickness increase when we go down from nasopharyngeal to retrotracheal but it should not exceed specific numbers.
Anterior soft tissue start from nasopharyngeal until C4 which is the level of retropharyngeal space the thickness of this area should not exceed 3-5 mm if it more than that it will be abnormal eg: hematoma, abscess, metastasis tumor, while the thickness of the anterior soft tissue below C4 which is the level of retrotracheal space should not exceed the width of the vertebral body.

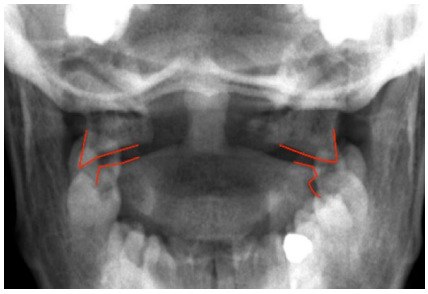


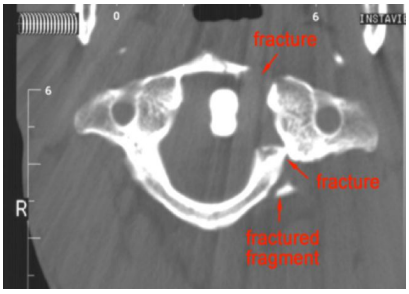
- Increased soft tissue space anterior to upper cervical vertebrae indicates hemorrhage from fractures (hematoma). No need to repeat, just get the patient to CT scan to assess the site of injury.

3) Jefferson Fracture (C1 fracture): (Important)

- 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, not jefferson.

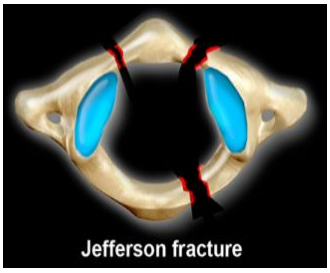




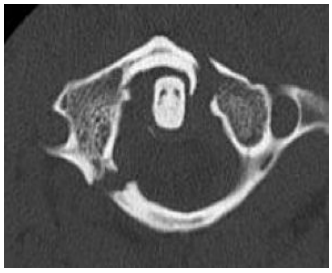


YOU SHOULD COMMENT ON DISPLACEMENT.
The green circles show lateral displacement and loss of the alignment.

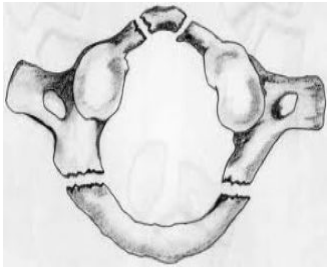
Mechanism of trauma is Axial Loading:
1) Object hitting the head.
* E.g. when a hard brick falls on the head of a worker. (Workers should wear helmets, but they still aren't fully protected because the helmet protects against the direct head injury, but the ultimate weight will transmit to the whole 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.



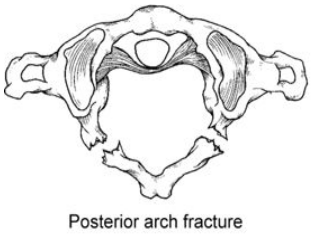
2 anterior and 1 posterior fracture



1 anterior and 1 posterior fracture

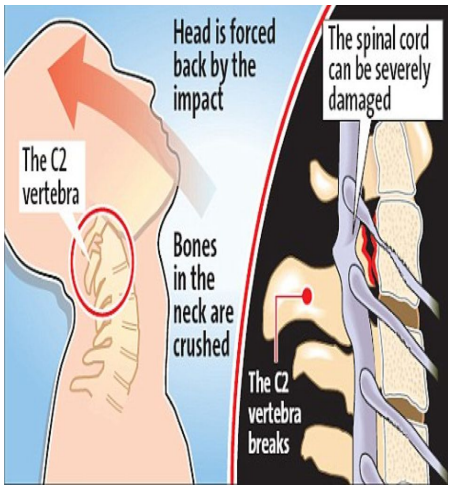


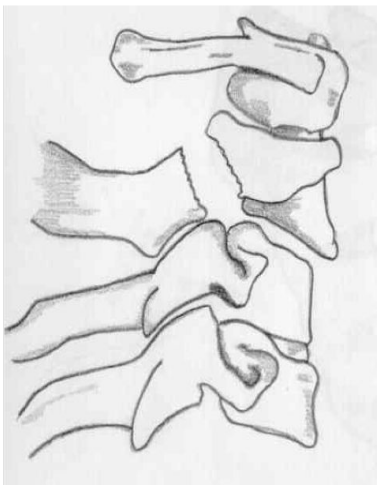
2 anterior and 2 posterior fracture

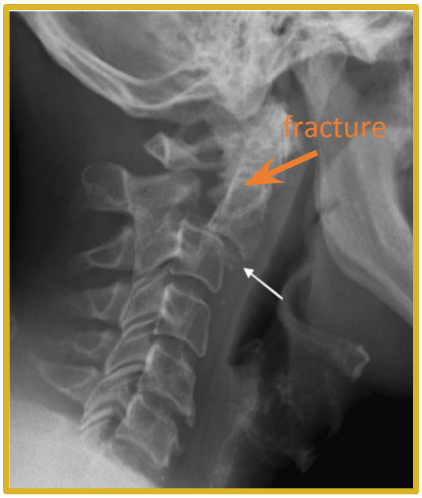


This is not Jefferson fracture

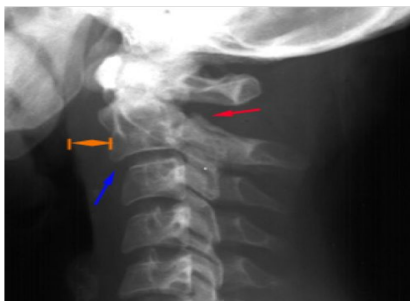
4) Hangman's Fracture (C2 fracture): (Important) can cause death



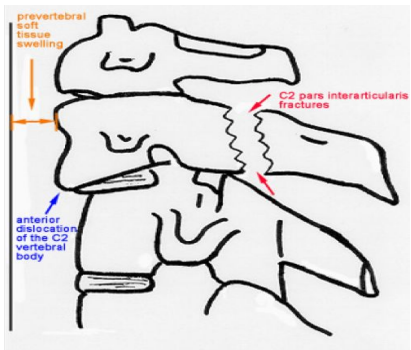




- Fractures through the pars interarticularis of C2 (between vertebral Body and posterior element) resulting from **hyperextension and distraction.**
- Sudden Hyperextension e.g. hanging (death sentence) or when chin hits dashboard in road accident.



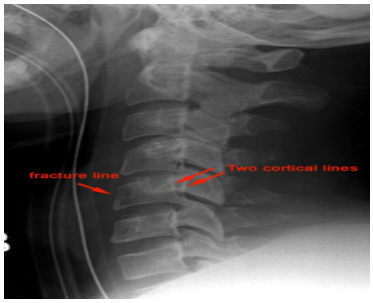
- Radiographic features: (best seen on lateral view).
1) Prevertebral soft tissue swelling
2) Fracture (Avulsion) of anterior inferior corner of C2 associated with rupture of anterior longitudinal ligament.
3) Anterior dislocation of C2 vertebral body. (white arrow)
4) Bilateral C2 pars interarticularis fractures.
if injury is in C2 > hemiplegia.
if below C5 > quadriplegia and breathing is intact.
if C3 and below, patient can't breathe because the diaphragm is supplied by C3,C4,C5.

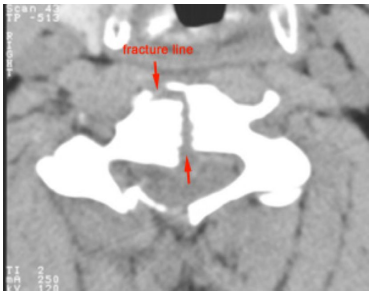


5) Burst Fracture: For more details, click HERE.

- Are 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.
- 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.

(These two pictures from Dr. Hamdy's slides. Kindly, check slide 14 to see Dr. Fahad's Pictures).





Fracture of vertebral body + spinal cord compression.

Infections: Discitis & Osteomyelitis

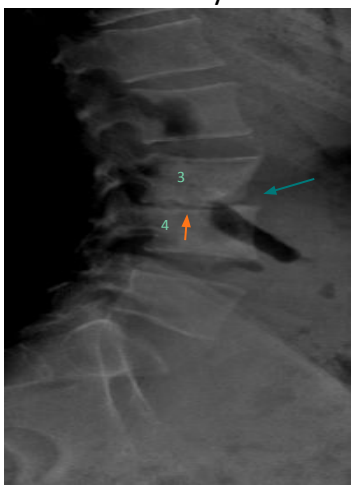
- **Usually the result of blood–borne agents** (hematogenous spread)**,** especially from the lungs and urinary tract.
- Most common pathogen is **staphylococcus**, Streptococcus is less common.
- Gram-negative rods in **IV drug abusers or immunocompromised patients:**
  1) E. Coli.
  2) Proteus.
  3) 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.
- Infection classically starts in vertebral body but it extend quickly to the disc, 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.

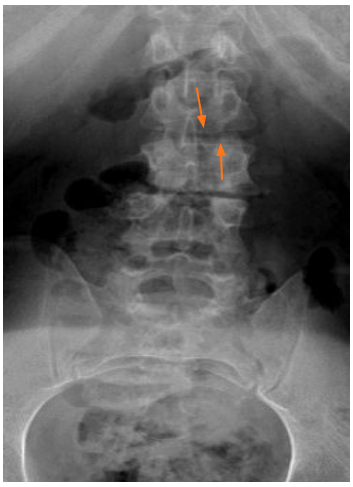
Imaging Findings:

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.

Spondylodiscitis

Spondylo = vertebral body , discitis = inflammation of disc so there is involvement of the disc and vertebral body.





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

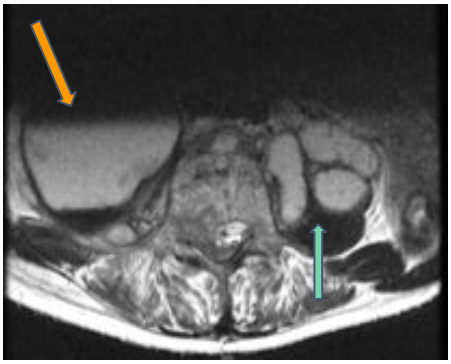
Blue arrow: loss of the corner > erosion

Sagittal T1WI shows decreased signal of vertebral bodies and disc with end plate destruction
lost L3-L4 infection materials inside the bone marrow.

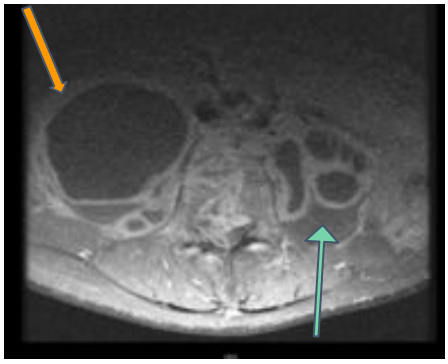
Sagittal T2WI shows increased signal in corresponding areas with anterior subligamentous and intraspinal epidural abscess.
we can see also paravertebral component + compression of spinal cord (arrow).

Sagittal contrast-enhanced T1-fat sat shows intense enhancement the involved area.
there is erosion of the endplate.

Axial T2WI and axial contrast-enhanced T1 fat sat show the paraspinal large abscesses.
there is multi abcesses in the left side in both pics
Treatment:
drainage + antibiotic.
symptom:
fever + back pain + urinary incontinence.



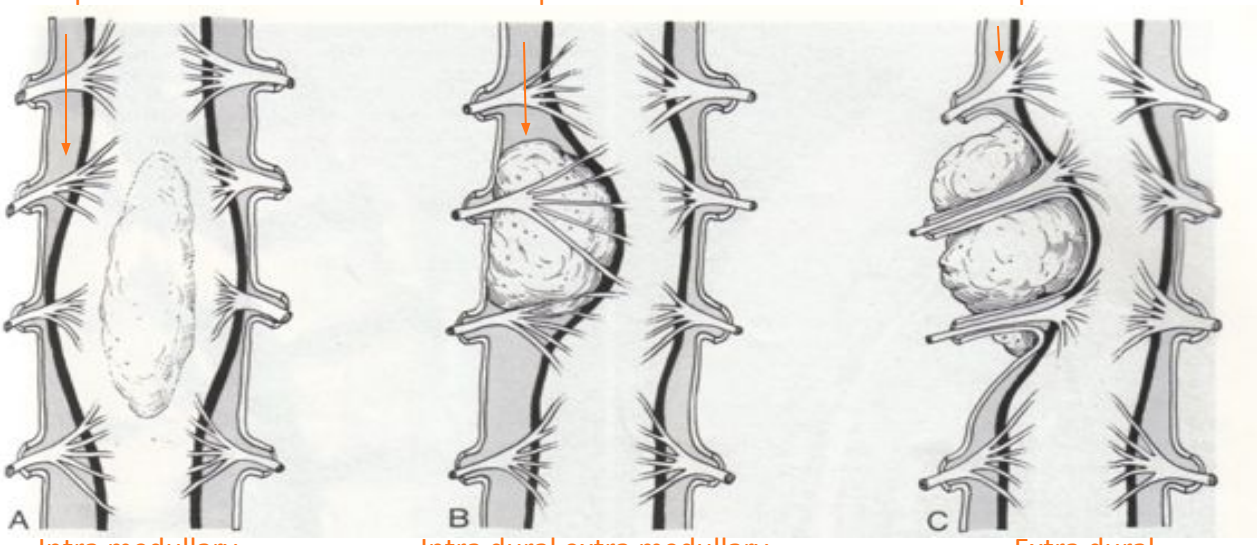
Orange arrows: Large abscess.



Blue arrows: Multi abscesses.

Tumors

CSF Space CSF Space CSF Space



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.

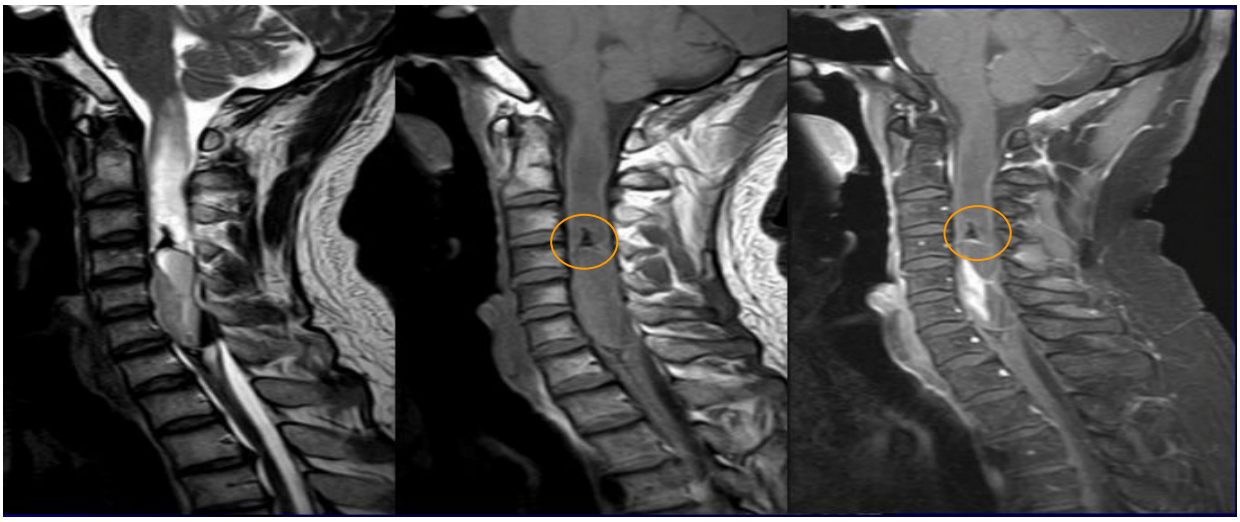
- If the CSF space is narrowed and the spinal cord diameter becomes big > this is intramedullary tumor. (very limited treatment options) (we can't do surgery)
- If the CSF space is larger and the spinal cord diameter becomes small > this is Intradural extramedullary eg: meningioma , schwannomas.
- If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

Intraspinal intramedullary tumor > expansion of the spinal cord

Intraspinal Intradural extramedullary

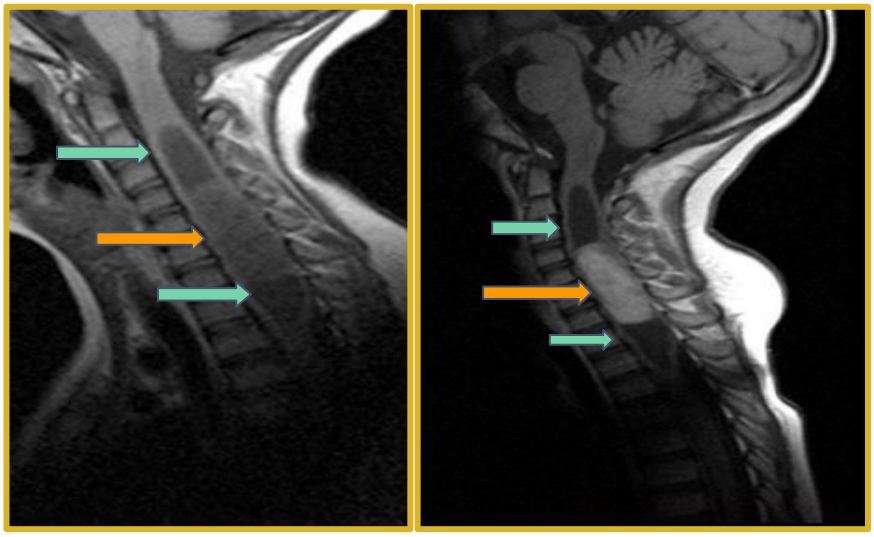
Extra dural

a) Ependymoma:



1- intraspinal intramedullary mass > spinal cord expansion.
2- hemosiderin deposition (orange circle) indicate blood component (hemosiderin cap) by it self good sign to tell you this is ependymoma.

b) Astrocytoma:



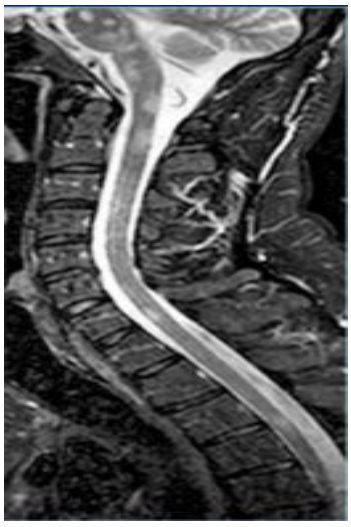
- Intraspinal intramedullary > expansion of the cord.
- There is solid tumor (orange arrow) which is enhanced in the second picture and cystic component (blue arrows).
*Syringomyelia means cyst inside the spinal cord.
These are two pictures of the same patient with different MRI windows.

Inflammatory

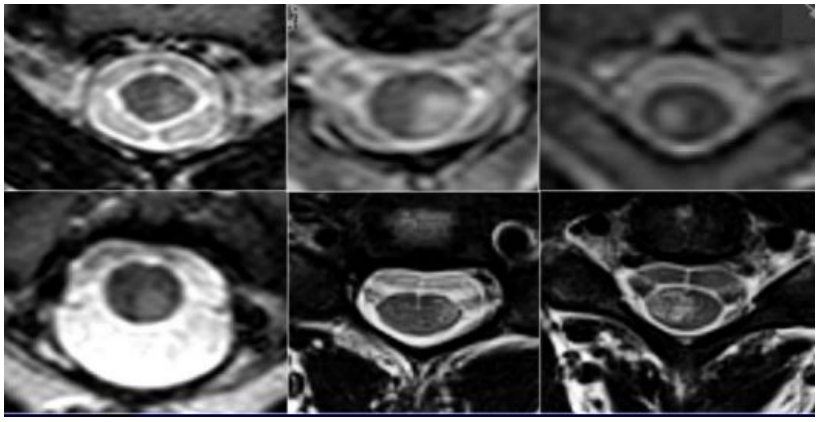
1a) Multiple Sclerosis:

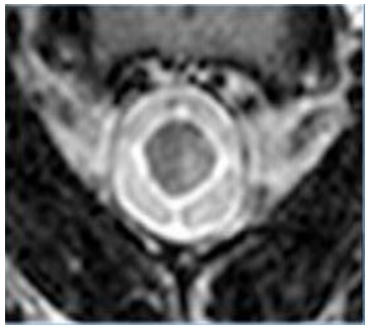
MS is an immune-mediated inflammatory demyelinating disease of the brain and the spinal cord.
MS is the most common demyelinating disease and there is overlap between these diseases:
- NMO (Neuromyelitis optica) was first thought to be a form of MS, but is now considered to be a distinct form.
- ADEM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

1b) Spinal cord lesions:



- Mostly in cervical cord (60%) and conus.
- Less commonly in thoracic region.
- More than 1 lesion in 55%
- <2 segments (2-60 mm) in craniocaudal length (short segments).
- Eccentric in the posterior or lateral, not midline because the white matter is posterior or lateral and MS is a disease of the white matter.
- No or very little mass effect or cord swelling.
- Lesions only in spinal cord in 5-24%.
- May result in cord atrophy disability.

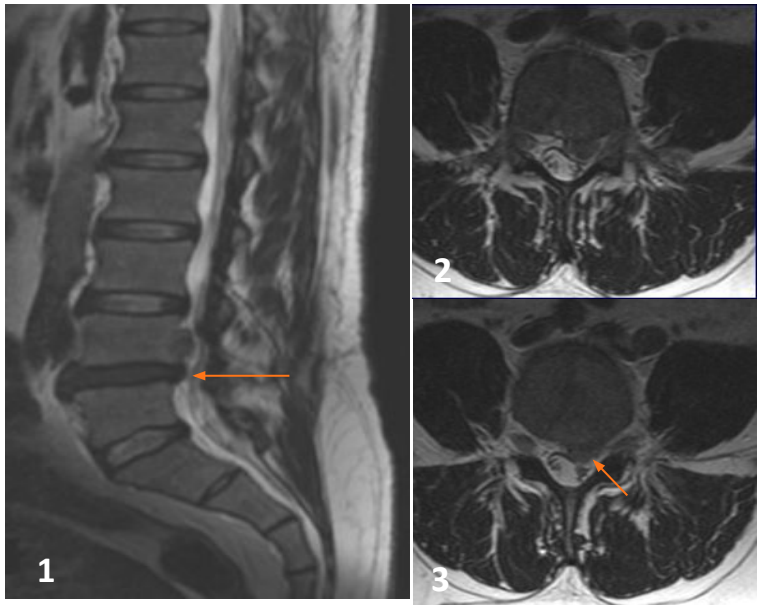




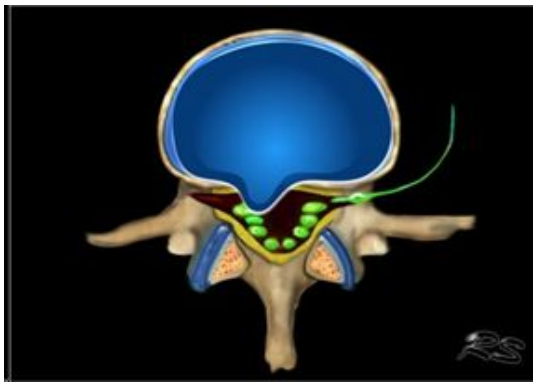
On transverse images MS lesions typically have a round or triangular shape and are located posteriorly or laterally.

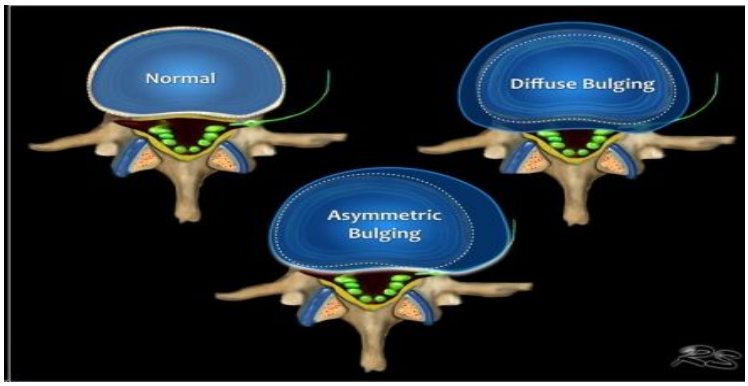
2) Disc disease:

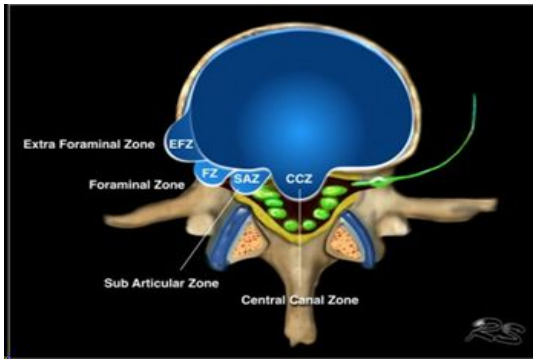
Disc herniation with sequestered disc fragment.
-**Pic1:** space between L3-L4 there is loss of signal intensity.
- We call it disc dehydration if it was in young person instead of degenerative diseases.
- **Pic3:** shows compression on the cord and nerve number 3 and 4.

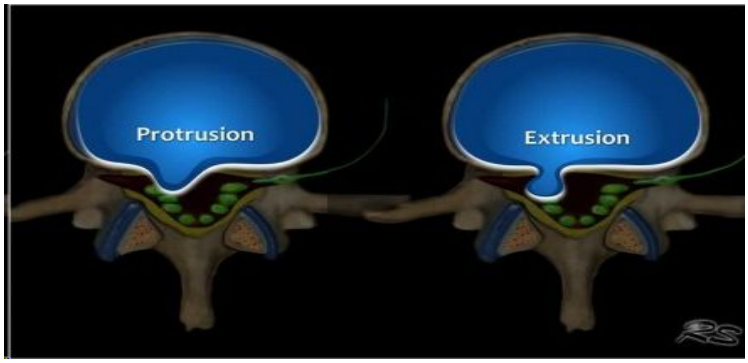


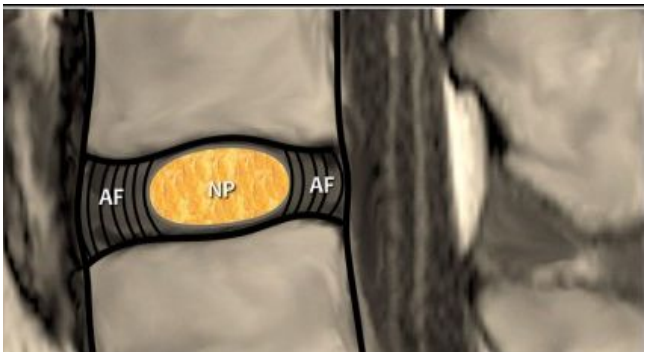
How to differentiate between MS and Intramedullary tumor?
1- MS: Spinal cord has same size proximal to lesion as distal.
2- Intramedullary tumor: Spinal cord becomes bigger.

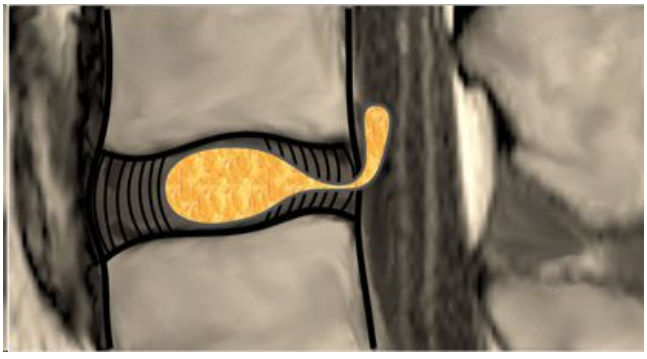








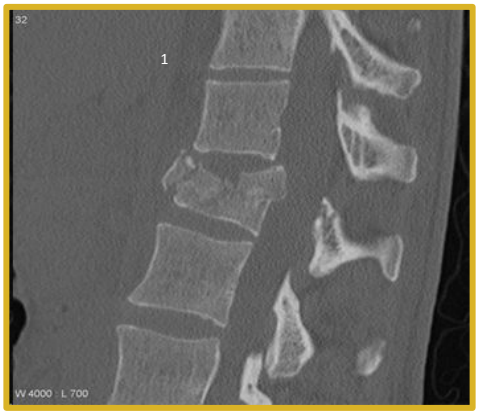




Burst fracture (Check slide 9)

These pictures are from Dr.Fahad's slides.
Dr.Hamdy's pictures are in slide 9.
Please check out ALL 5 pictures and try to understand the concept of the fracture.

Pic 1: Retropulsed fragments.
Pic 2: Cord edema.



Summary

Soft tissue anterior to spine	- anterior soft tissue start from nasopharyngeal until C4 thickness of this area should not exceed 3-5 mm - below C4 which is the level of retrotracheal space should not exceed the width of the vertebral body .
Jeffereson Fracture	-There is a lateral displacement of C1 in plain film -involves the anterior and posterior arch should happen to both
Hangman's Fracture	-Fractures through the pars interarticularis of C2 - Anterior dislocation of C2 vertebral body
Burst Fracture	- Results from axial compression -fracture of vertebral body+spinal cord compression
Spondylo-discitis	- infection involve the disc and vertebral body
Ependymoma	-intraspinal intramedullary mass > spinal cord expansion -hemosiderin deposition
Astrocytoma	-intraspinal intramedullary> expansion of the cord - there is solid component and cystic component

Questions

Q1) What do you see in the X-Ray:

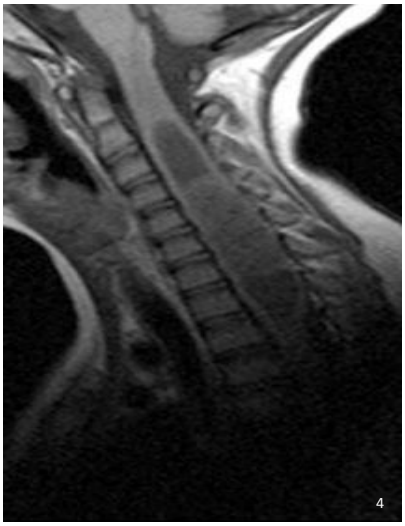
A. Normal spine.
B. Increased soft tissue space anterior to upper cervical vertebrae.
C. Jefferson Fracture.
D. Multiple fusion abnormalities.

Q2) What is the name of fracture seen in the X-Ray:

A. Hangman's Fracture.
B. Jefferson Fracture.
C. Burst Fracture.

Q3) Which of the following imaging finding is true regarding spondylodiscitis:

A. widening and swelling of an intervertebral disk.
B. Bone fusion after 6 weeks to 2 months on plain film.
C. Enhancement of inflamed tissue after contrast on MRI.
D. Most common pathogen is staphylococcus.



Q4) What is seen in MRI:

A. Astrocytoma.
B. Ependymoma.
C. schwannomas.
D. diastematomyelia.

Answers:
1- D.
2- A.
3- C.
4- A.