Radiology Team 429

RADIOLOGY OF SPINE DISEASES

Dr. Sajjad Hussain

Assistant Professor of Radiology
King Saud University

Consultant Radiologist
King Khalid University Hospital

Radiology Team 429

In this team we used the outlines from the:

Doctor's slides

Lecture notes are in red boxes

427 Radiology team

Diagnostic Imaging –PETER ARMSTRONG – 6Th Edition

Sorry we don't hold responsibility for any missing information or perhaps – perhaps -wrong material.

We tried our best to present this lecture in the best way, and we hope what we wrote is enough to cover the subjects.

Team Leaders:

Abdulmajeed Al-Sadhan, Ibrahem Al-Sadhan, Sarah Mahasin

Team Members:

Hala Muneef

Best Wishes :)

Imaging Methods to Evaluate Spine

1. Plain X-Ray Films
2. Myelogram – injection of contrast medium in CSF followed by x-ray images. Rarely performed now-a-days
3. Computed Tomography (CT Scan)
4. Magnetic Resonance Imaging (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.
9. DEXA – radionuclide scan for bone density (osteoporosis)

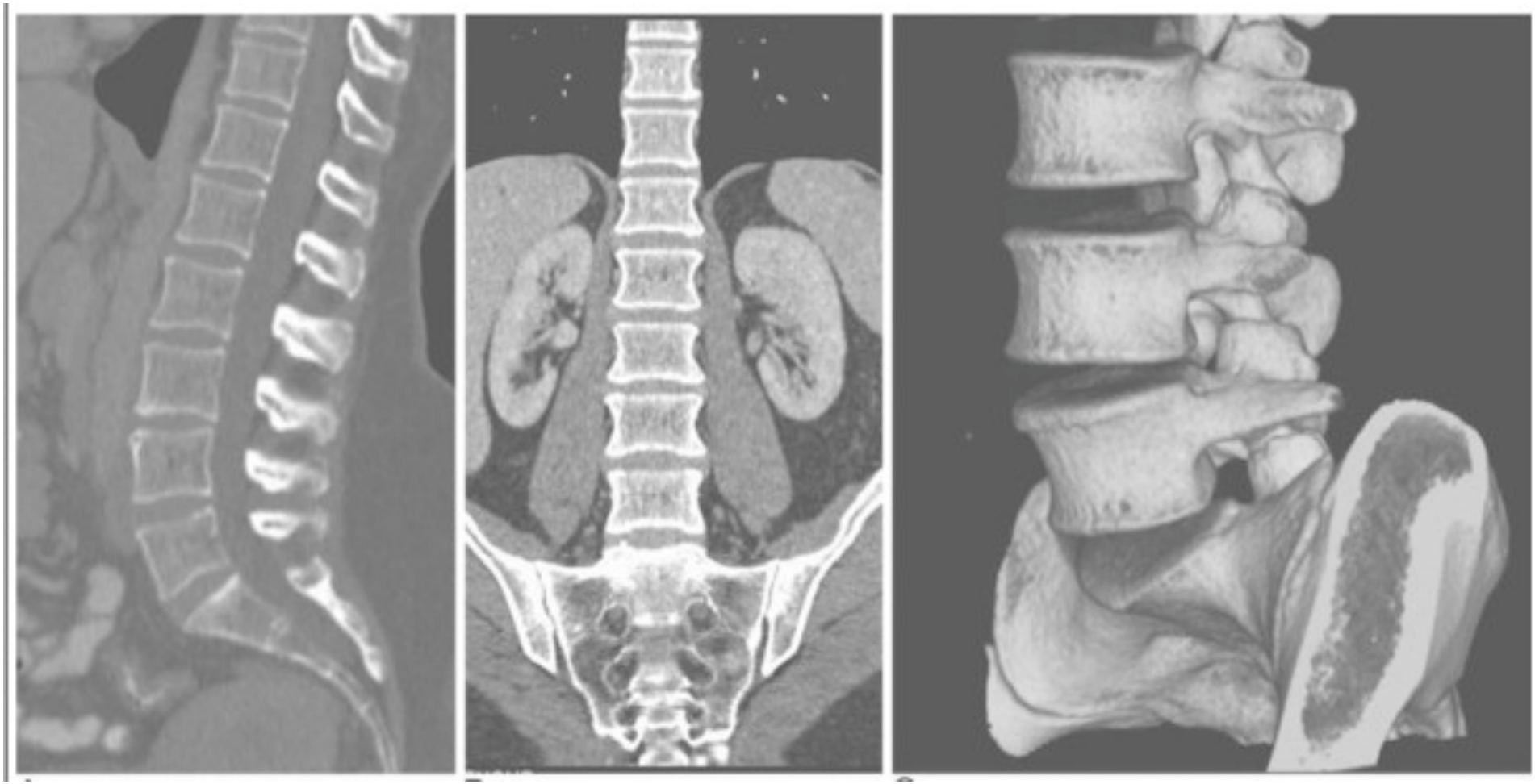
1. X-RAYS (RADIOGRAPHS)

- 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
  - Spinal instability
  - Congenital (birth) defects of the spinal column
  - Fractures caused by trauma
  - Osteoporosis (loss of calcium in the bone)
  - Infections
  - Tumors
- May be taken in different positions (ie; bending forward and backward) to assess for instability

2. 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
    1. Degenerative or aging changes
    2. Spinal alignment
    3. Fractures and fracture patterns
    4. Congenital/ childhood anomalies
    5. Herniated discs
    6. Areas of narrowing in spinal canal through which spinal cord and spinal nerve roots pass
- Entire spine can be imaged within a few minutes
- A contrast material may be injected intravenously or intrathecally to make some areas clear
- Problems imaging: patient is obese, patient I continuously moving

2. COMPUTERIZED TOMOGRAPHY (CT SCAN)



3. MYELOGRAM

A dye (contrast material) is injected into CSF to better identify areas where the 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
- Often a CT scan is also performed after this
- May be performed when MRI can not be performed

Replaced by MRI, used when MRI cannot be performed
See the nerves, spinal cord, tumors, some images of the brain
Introducing the needle may cause: potential hemorrhage, infection. Dye causes headache

4. Magnetic Resonance Imaging (MRI)

The gold standard of imaging for spinal disorders

- Does not use ionizing radiation
- Can identify abnormalities of bone, discs, muscles, ligaments and spinal cord
- Intravenous contrast is sometimes administered to better visualize certain structures or abnormalities
- Patient lies still in a tunnel like structure for about 25 minutes
- 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 SCANNER (closed type)

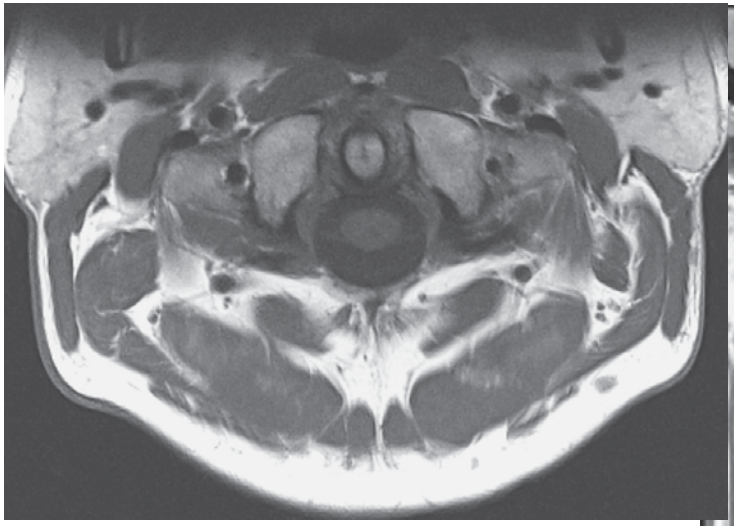
Note: Contrasts are given intravenously only in cases of MRI

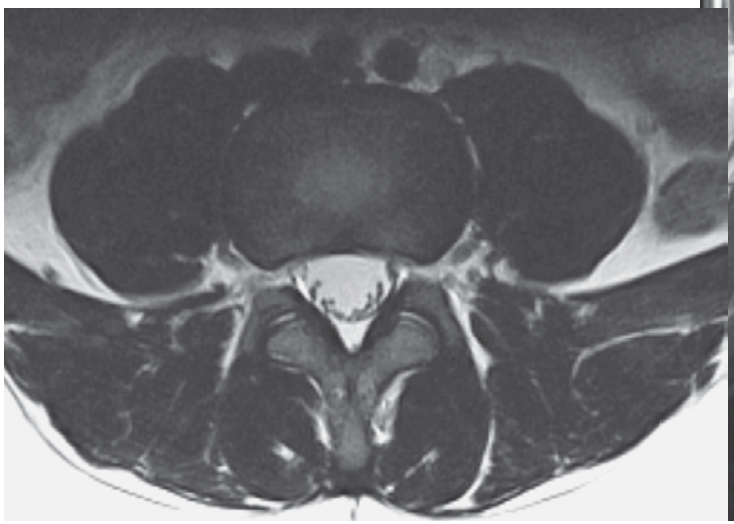
MRI SCANNER (open type)

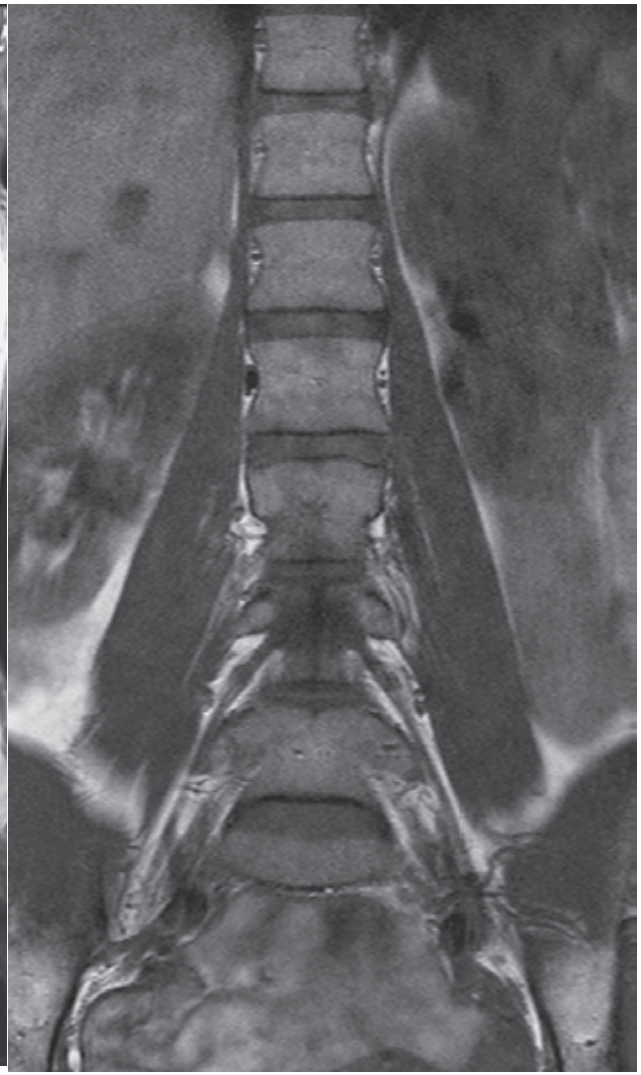
Open type: for claustrophobic patient, images aren’t clear as closed

Can be taken sagittal or axial

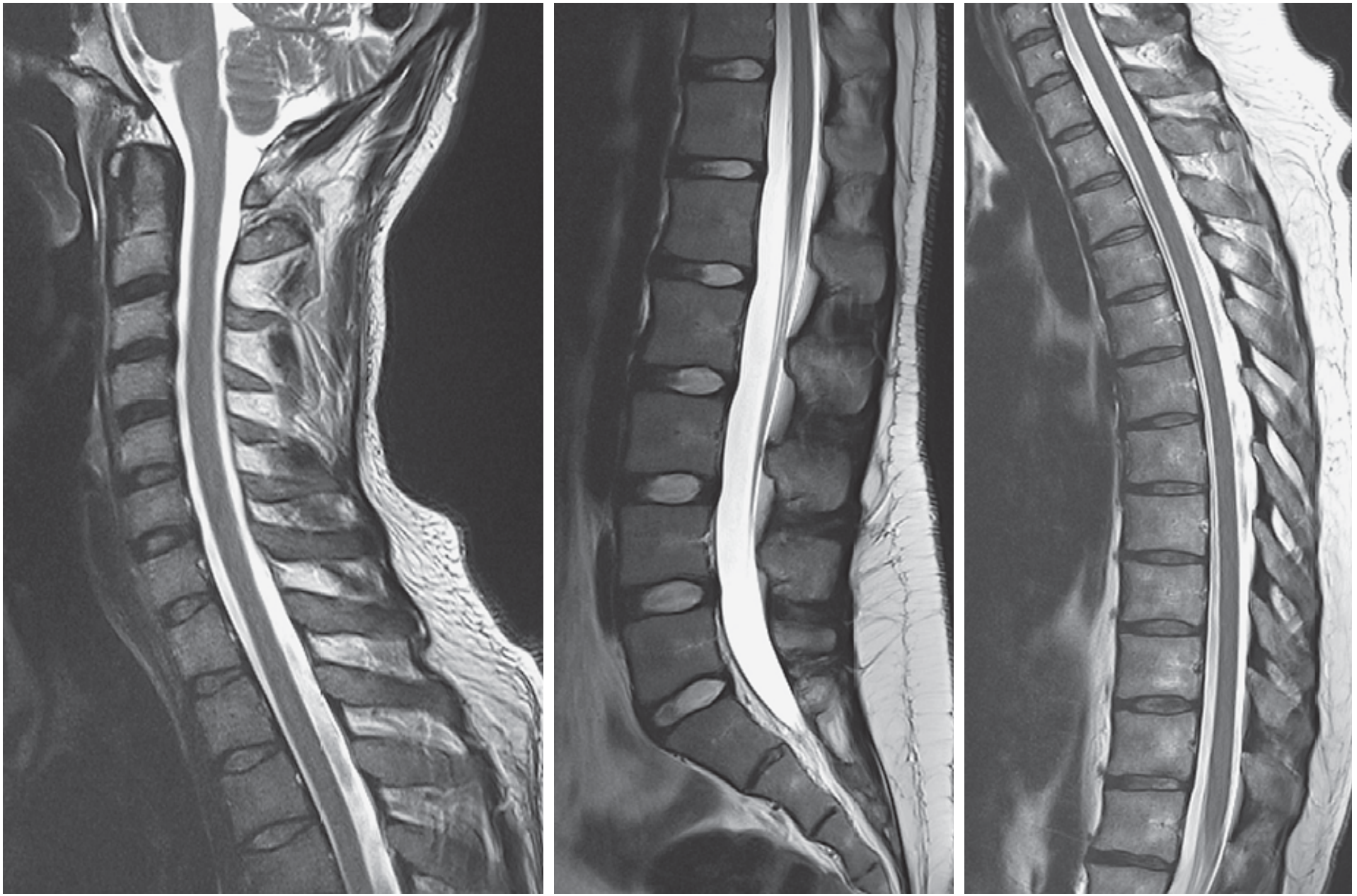
MR images are multi-planar



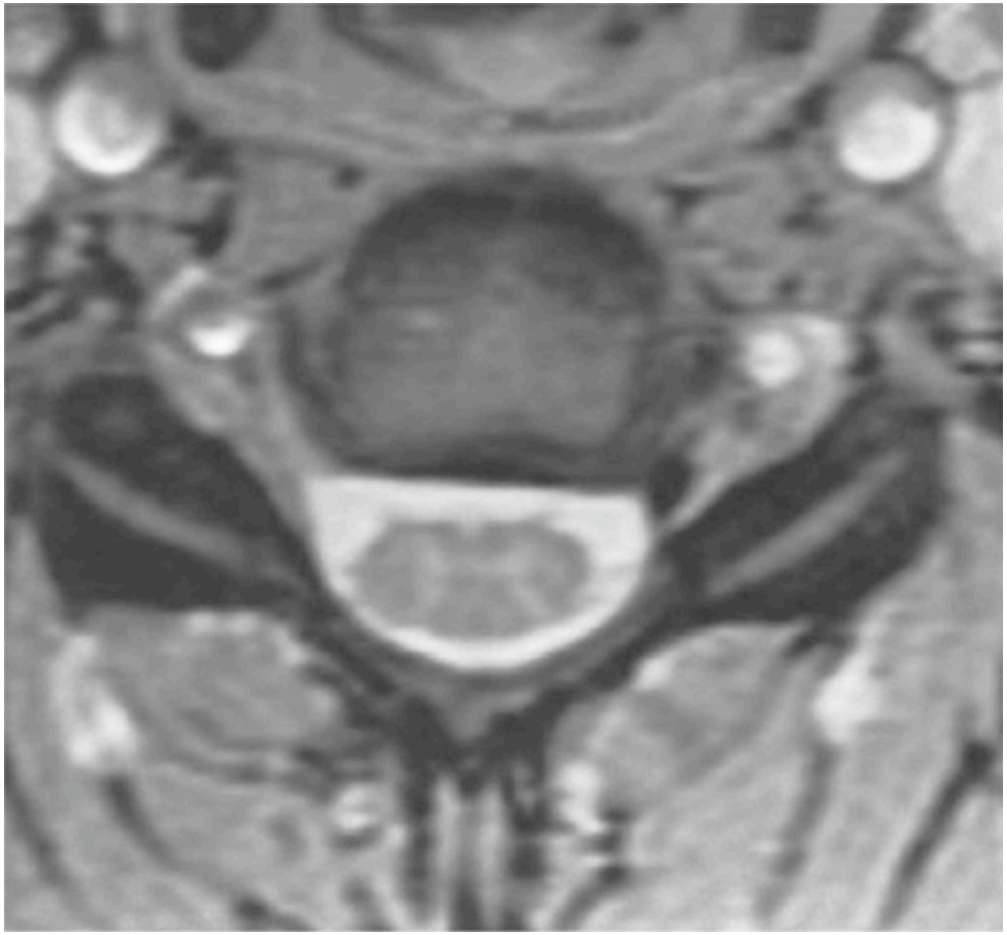


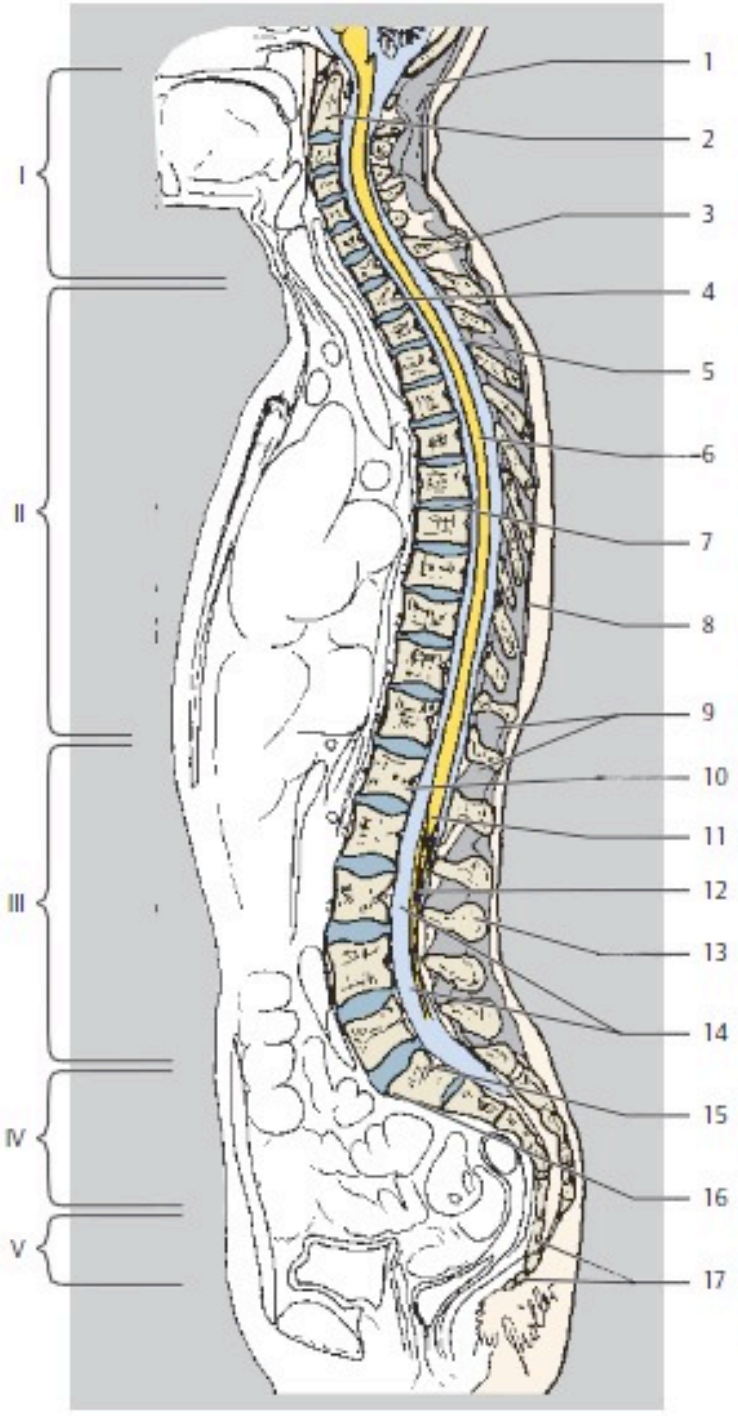


MR images are very high resolution



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)

5. 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

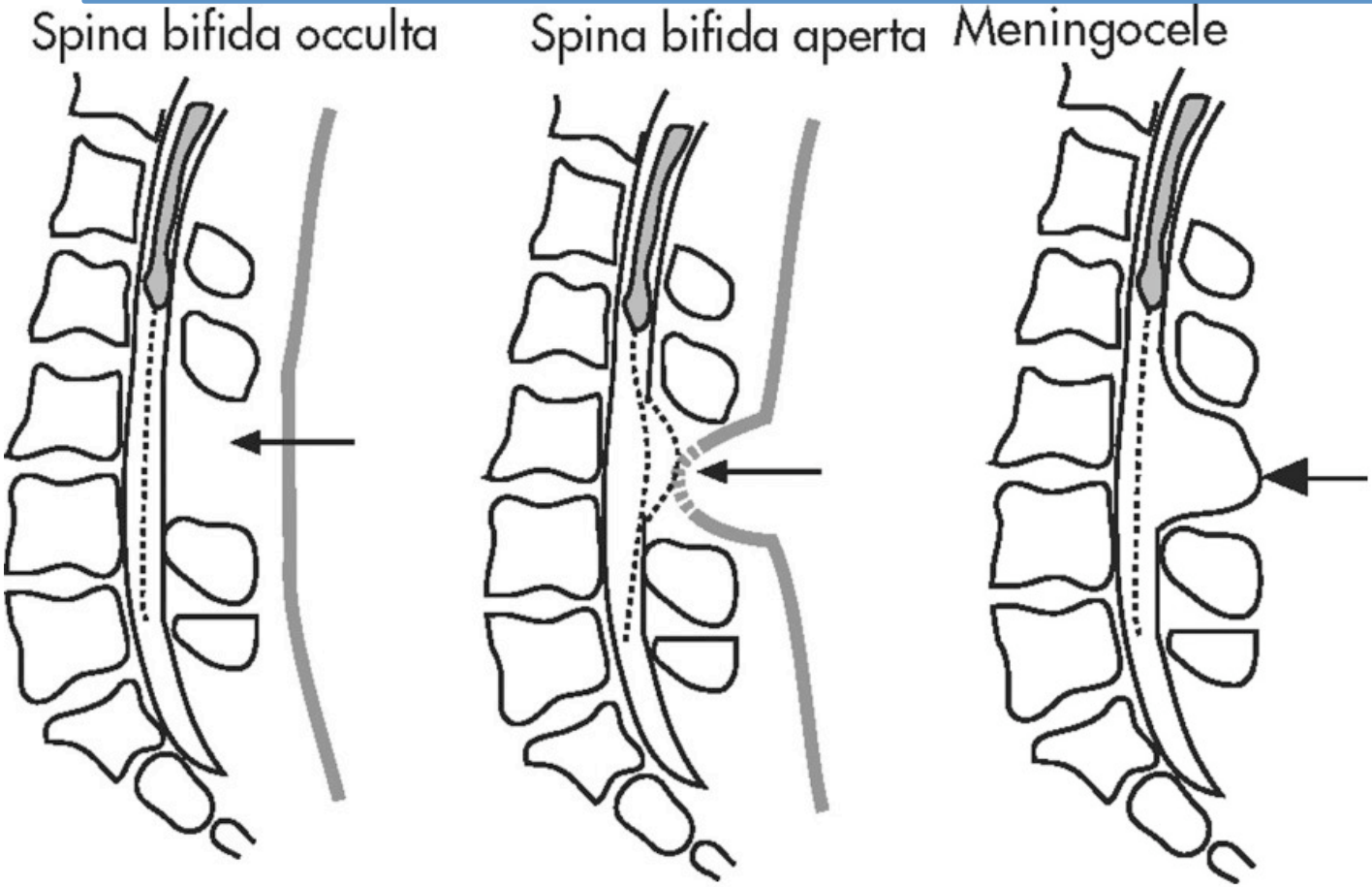
Congenital Anomalies

CONGENITAL ANOMALIES

- Skin covered defects and Open skin defects

- 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



SBOcculta: the defect in the bone. No herniation of the spinal cord or its meninges.

SBOperta: the skin is open

Meningocele: only the meninges are herniated out side>
Meningeomyelocele: Spinal cord and its meninges are herniated. Picture in the MRI

Multiple fusion abnormalities of vertebrae on plain film

Image: fused spinal process, partially fused disc

The vertebral bodies are fused together. No apparent intervertebral disc in the arrow-pointed location.
The spinous processes are also fused in the upper levels.

Very important

TRAUMA
Cervical Spine

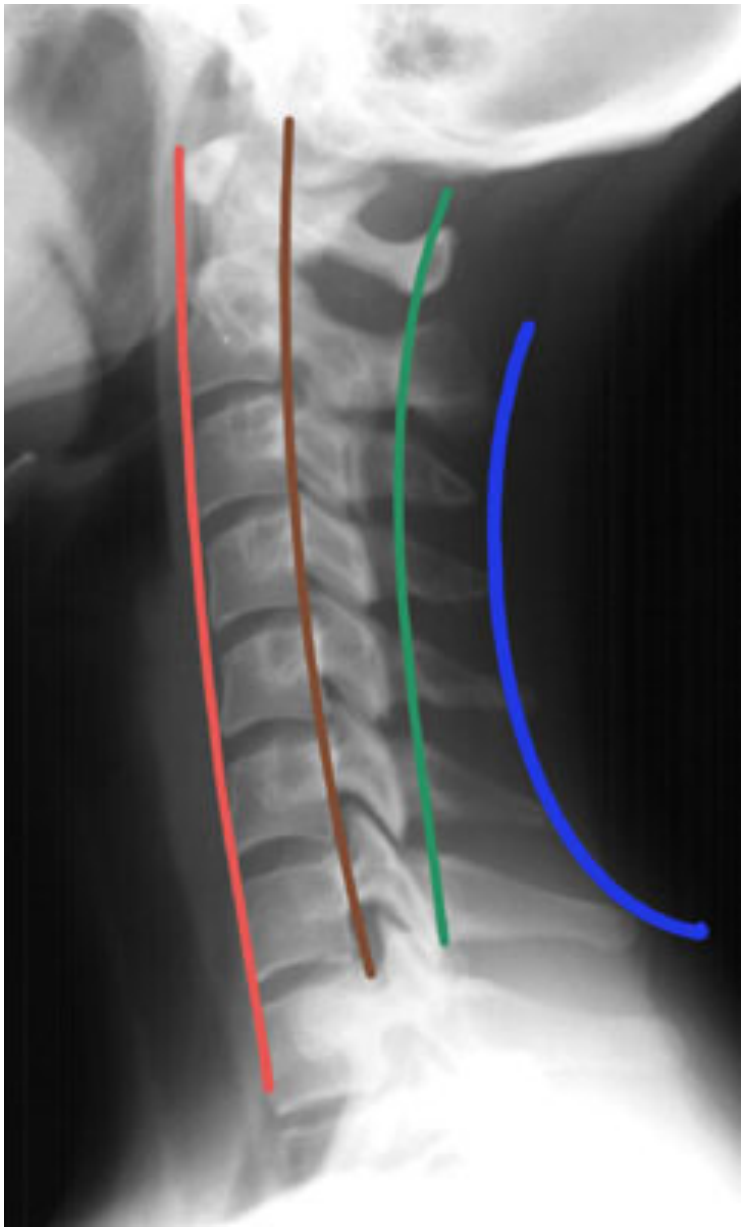
Trauma

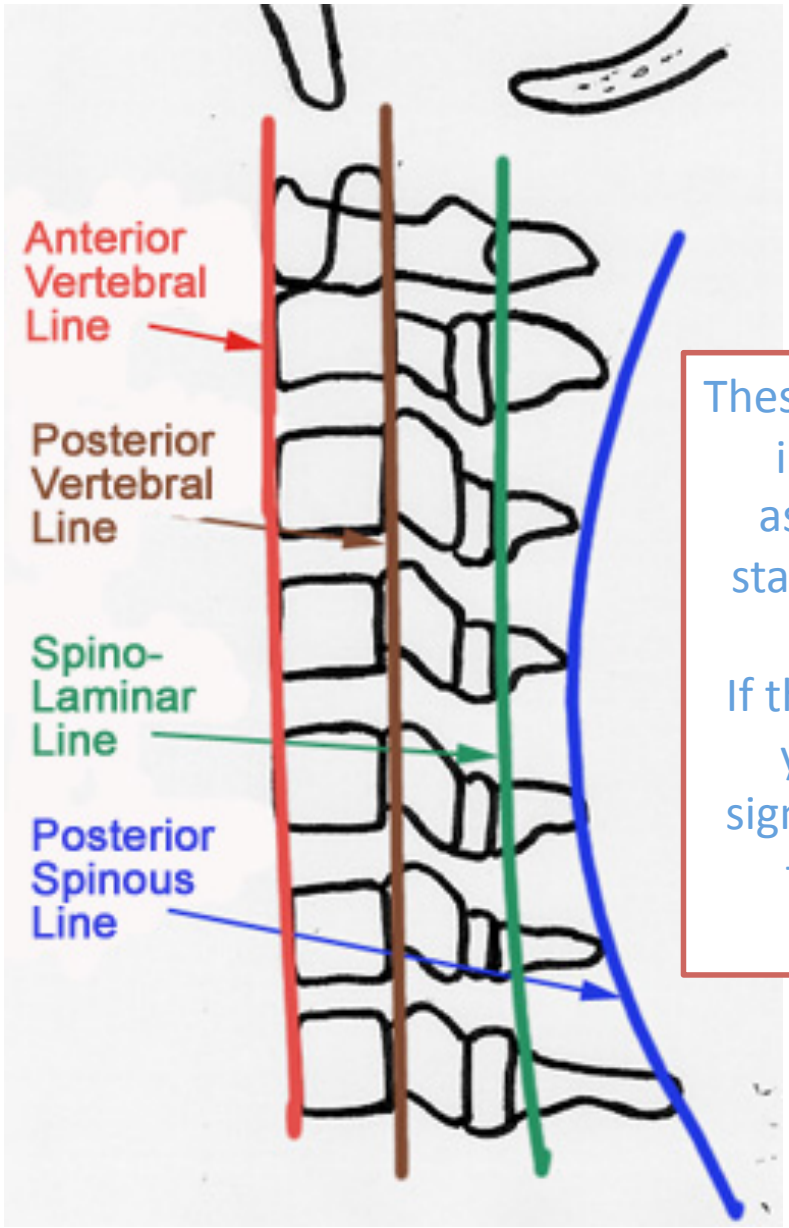
- Stabilize the patient, ABC
- X-ray/CT, Check for abnormal alignment:
  - Lateral view without touching the patient
  - Assess the alignment: 4 lines: anterior vertebral lines, posterior margin of spinal process, tip of spinous lines
  - All lines in the proper shape: good assurance of patient's condition
- Any damage to C3,4,5 could kill the patient (diaphragm)

Plain film assessment of trauma – the first imaging method

normal

a) Alignment should be normal – check by drawing lines

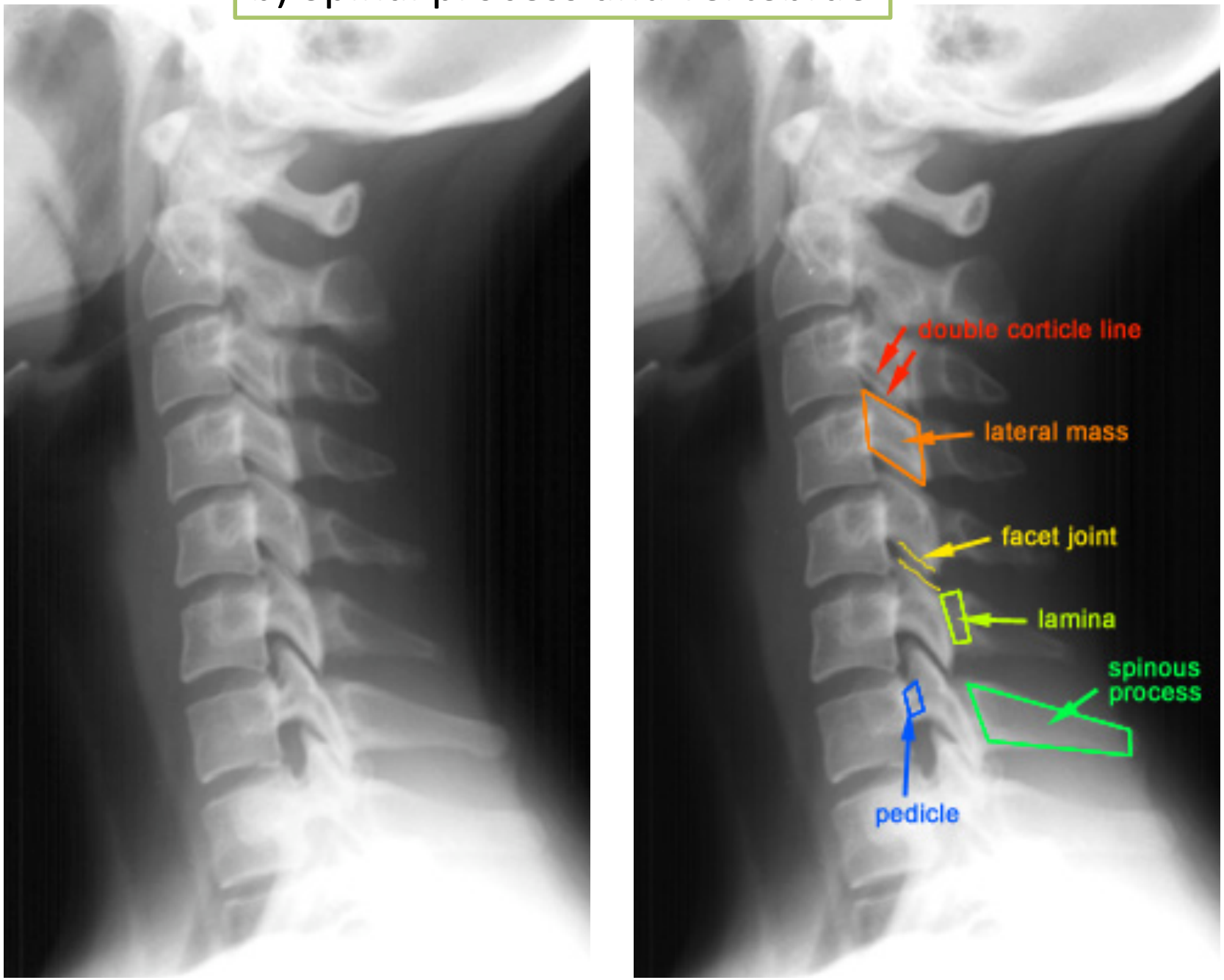




These are lines are very important in the assessment of the stability of the spinal cord.
If they are align, then you can exclude significant damage to the spinal cord.

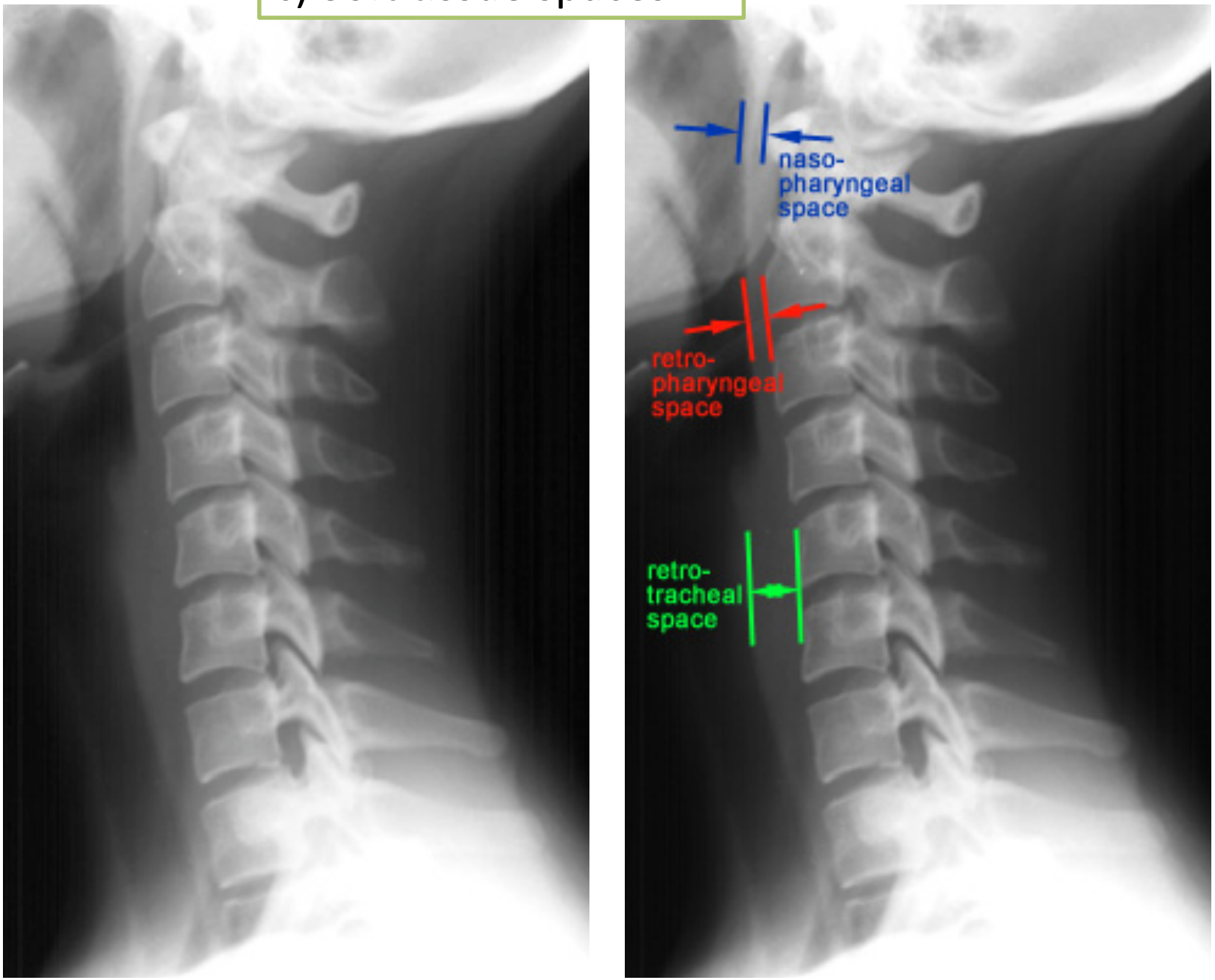
b) Spinal process and vertebrae

Facet joint is important, as it will be related in the next few slides



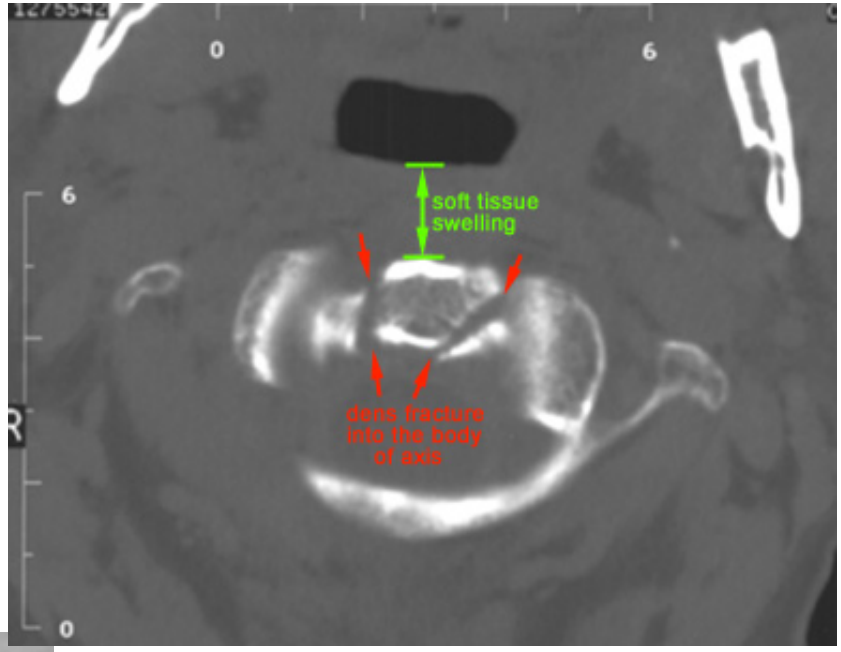
c) Soft tissue spaces

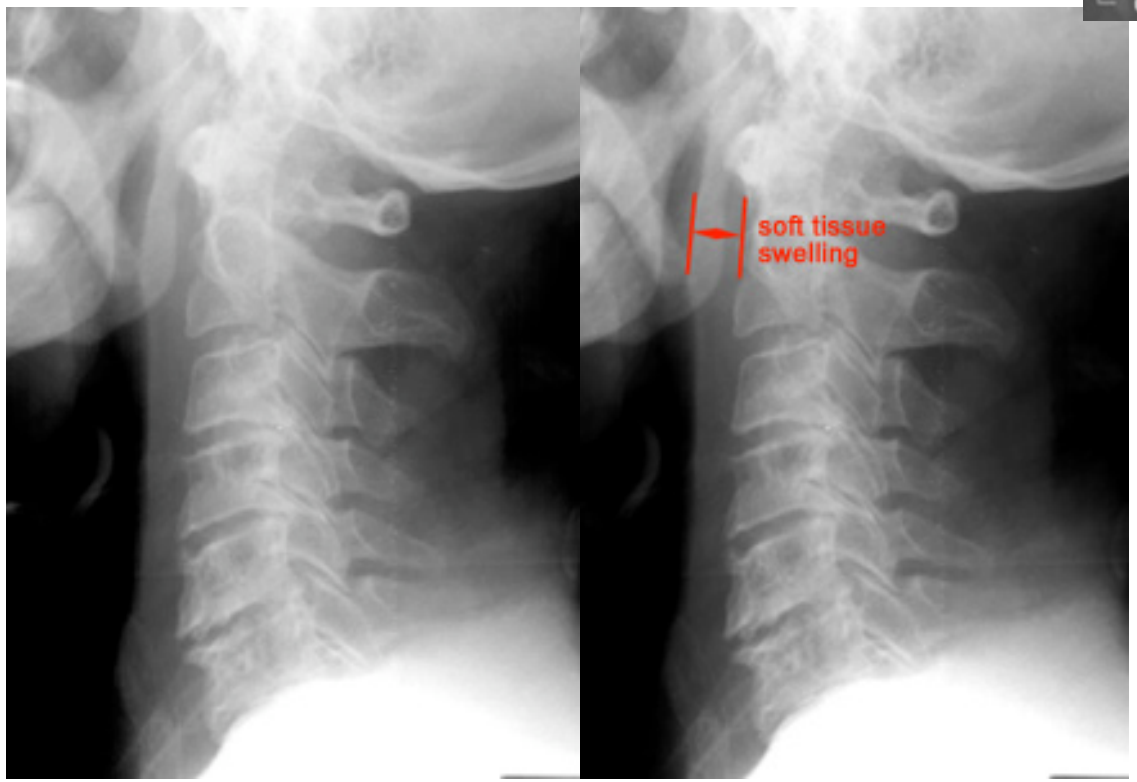
These spaces are prevertebral soft tissue. The thickness of each level should be in mind as some types of hematomas can fill up these spaces at any level. e.g. next slide Retropharun geal space is till the level of the larynx.



Soft tissue anterior to spine is very important

Swelling could be due to hematoma



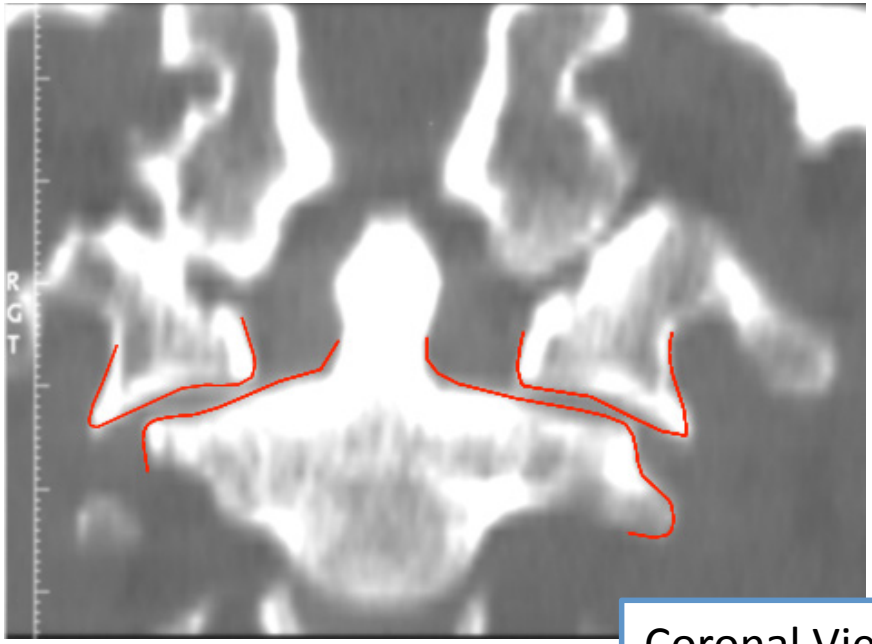


Hemorrhage causing hematoma in the retropharyngeal space, causing it to swell.

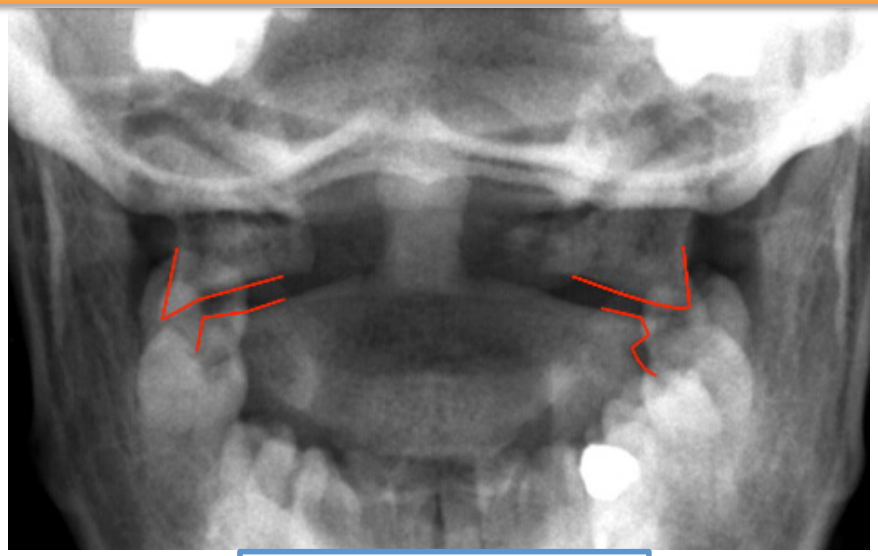
1. Jefferson Fracture

- Lateral displacement of C1 in plain film(A)
- Coronal reconstruction from a CT confirms the findings from the odontoid view
- Axial CT clearly shows the location of the fractures of C1

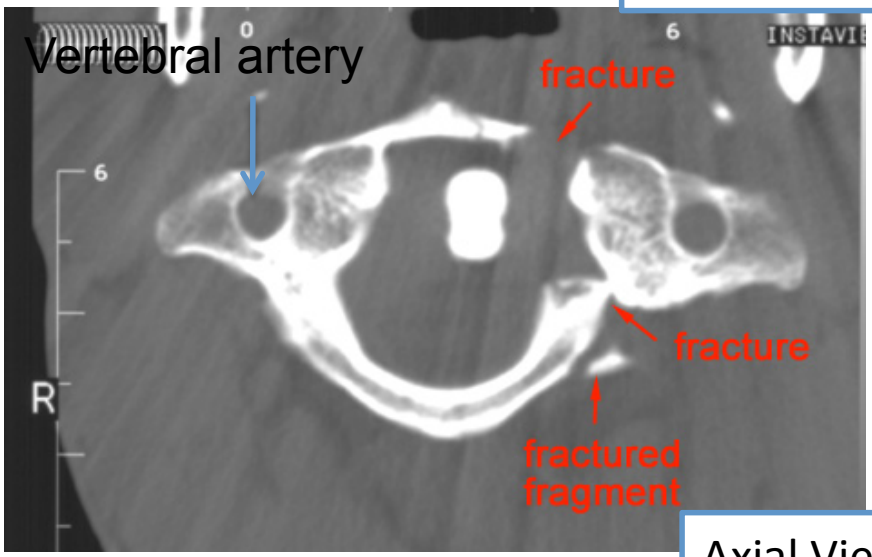
Usually caused by a strong force on the head. The force creates pressure which causes the fracture ex. heavy object falling on a worker's head, swimmer diving in a shallow pool and hitting his head



Coronal View



Frontal View X-ray



Axial View

Note : The red lined structure is C1, while the structure in the middle is the odontoid process. When the space between C1 and odontoid process increases, suspect Jefferson Fracture.

Left pic X-ray. Right pics CT. Diagnosed only by C.T., while X-ray just gives you a hint.

Result from an object hitting the head, or the head hitting an object.

2. Hangman's Fracture

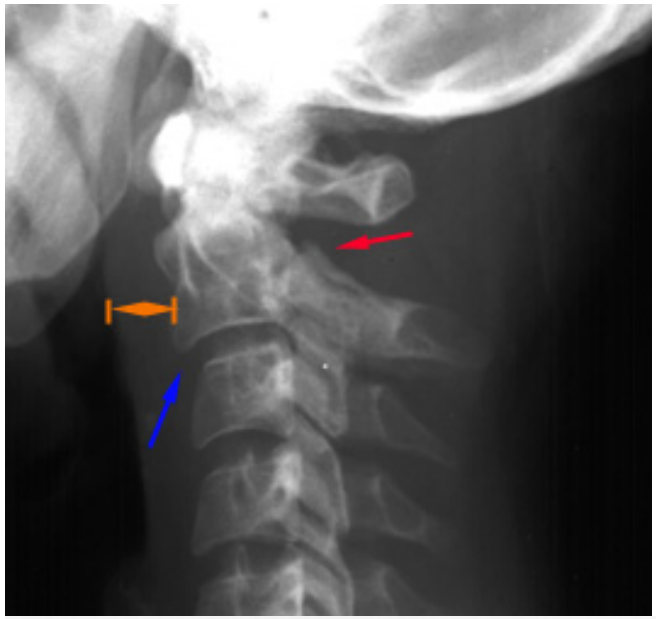
• Fractures through the pars interaticularis of C2 resulting from hyperextension and distraction (pulling head away from the neck)

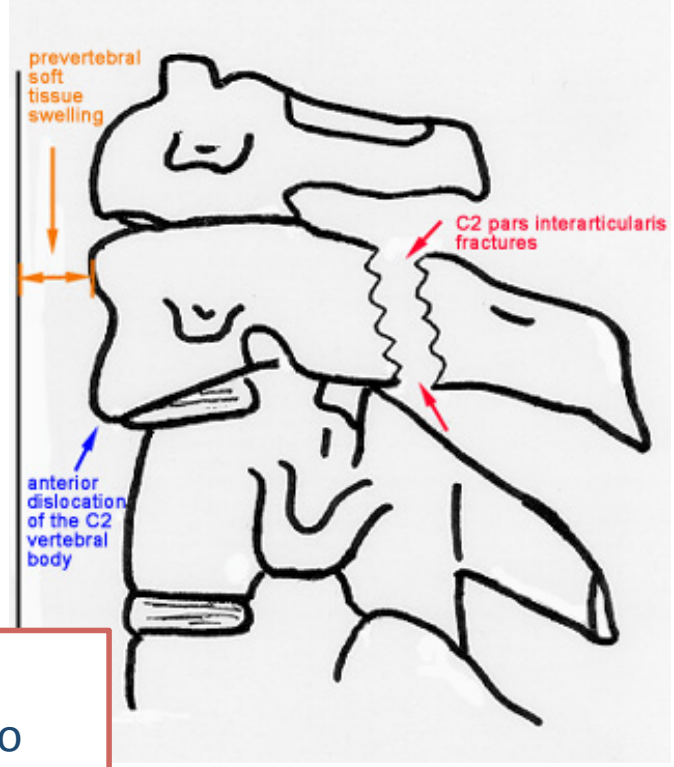
• Hyperextension (e.g. hanging, chin hits dashboard in road accident)

• In RTA, passenger more likely than driver to have Hangman's Fracture

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





Note :Injury to the spinal cord from C5 and lower will lead to quadriplegia. However the respiration will be still intact, due to the salvage of phrenic nerve, which comes out from C2,3 and 4.

3. Bilateral Facet Dislocation

• Complete anterior dislocation of vertebral body resulting from extreme hyperflexion injury

• Associated with a very high risk of cord damage

• Disc joint is not intact, whole vertebrae moves anteriorly, hyperflexion injury, unstable injury

Facet joint connect the articular processes of the vertebrae.

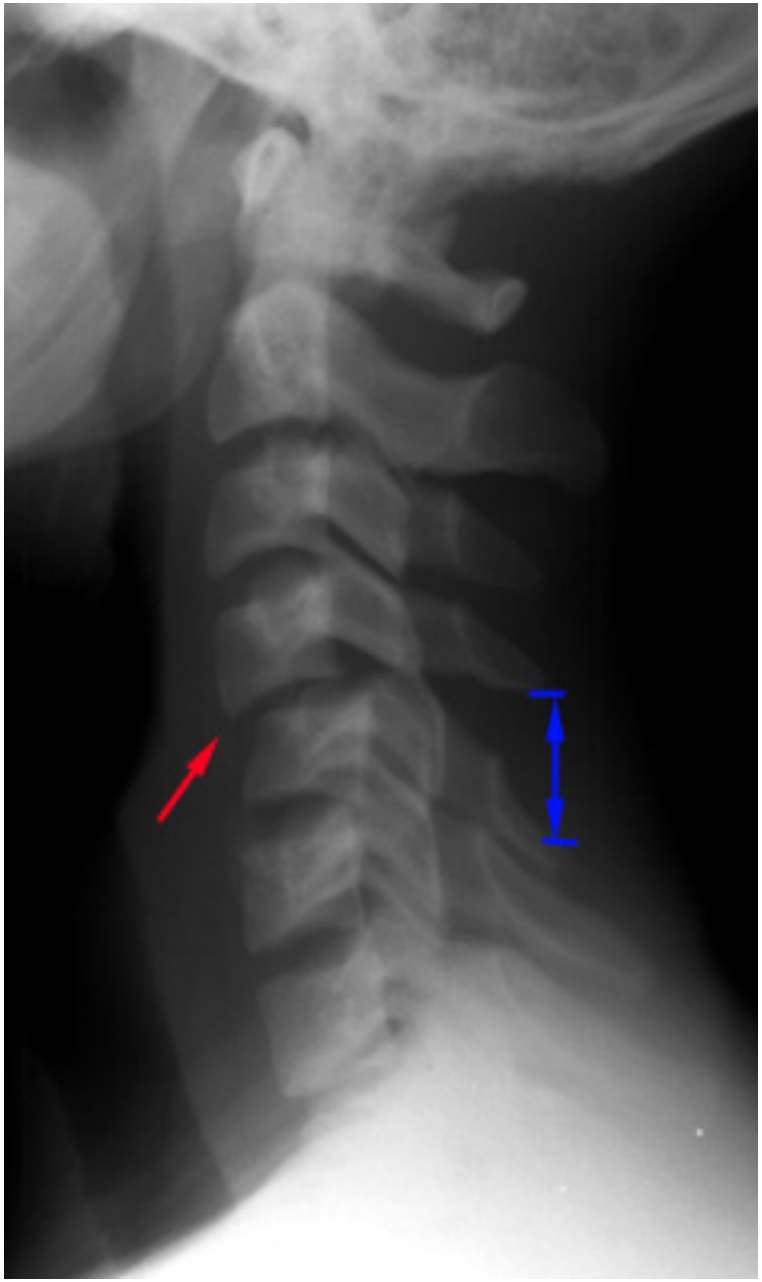
4. Unilateral Facet Dislocation

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

• **Mechanism**: simultaneous flexion and rotation

• Rotation injuries, one facet slips

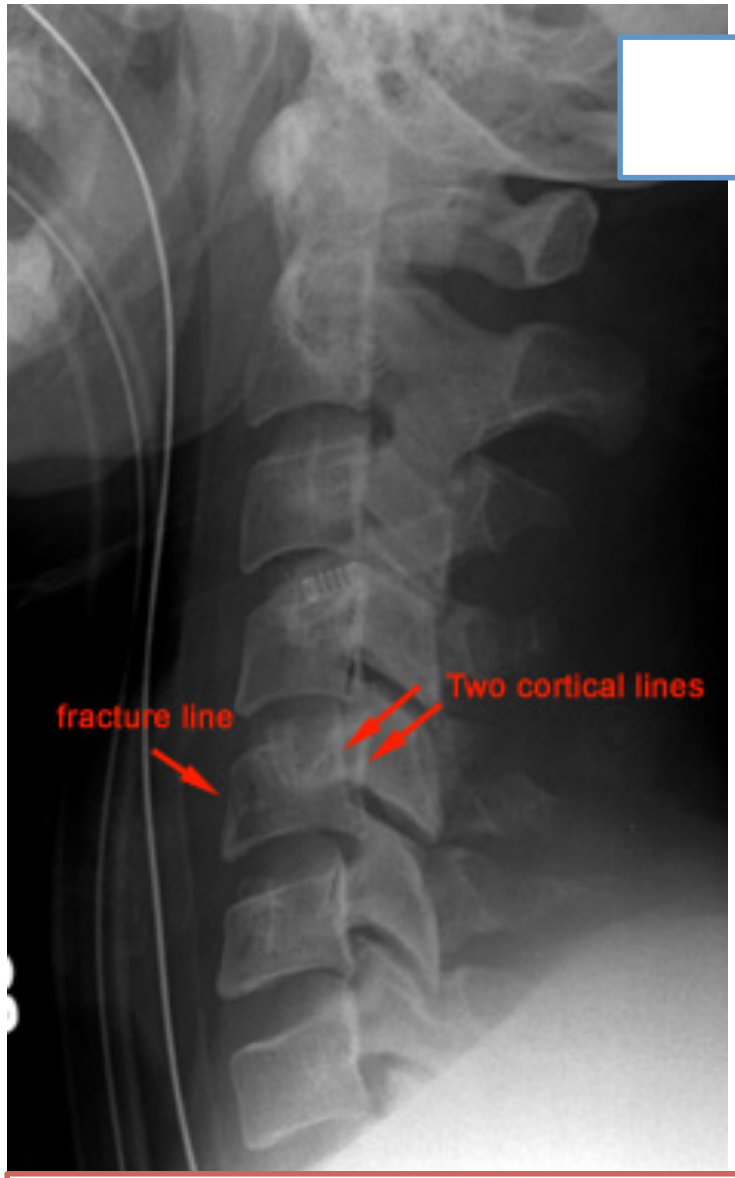
Even more severe tan bilateral

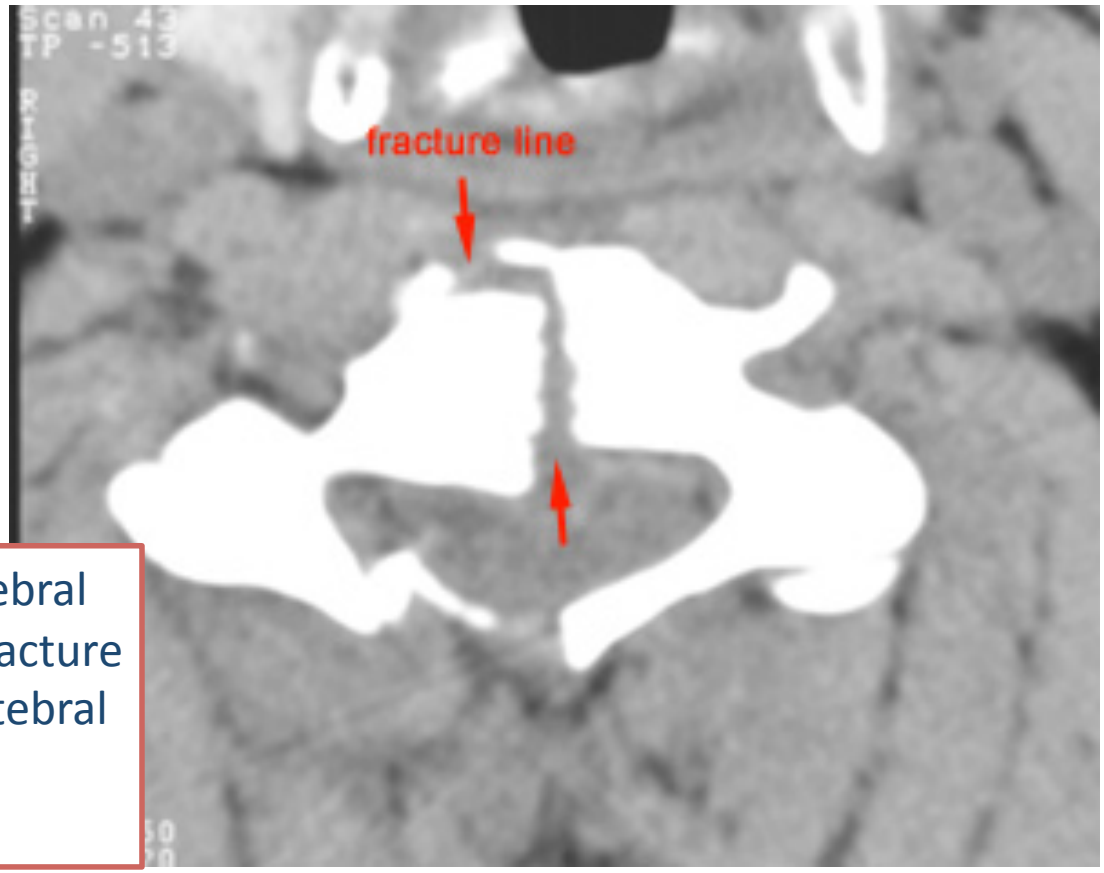


5. Burst Fracture

- 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

Extreme flexion, intraspinous process has ligaments in between usually. Disc acts like a cushion, but with more pressure the vertebrae will compress and bulges posteriorly, anteriorly compression. Further injury the posterior cortex of the body will break (ligamentous injury, compression injury)





Burst fracture is when the whole vertebral body is fractured. While compression fracture is when the posterior cortex of the vertebral body is still intact.

INFECTIONS

Discitis and Osteomyelitis

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
- 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 (the discs are not vascularized so the infection started elsewhere in the body and then travels to the disc)

Site of involvement

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

Discitis and Osteomyelitis

IMAGING FINDINGS

Plain Films:

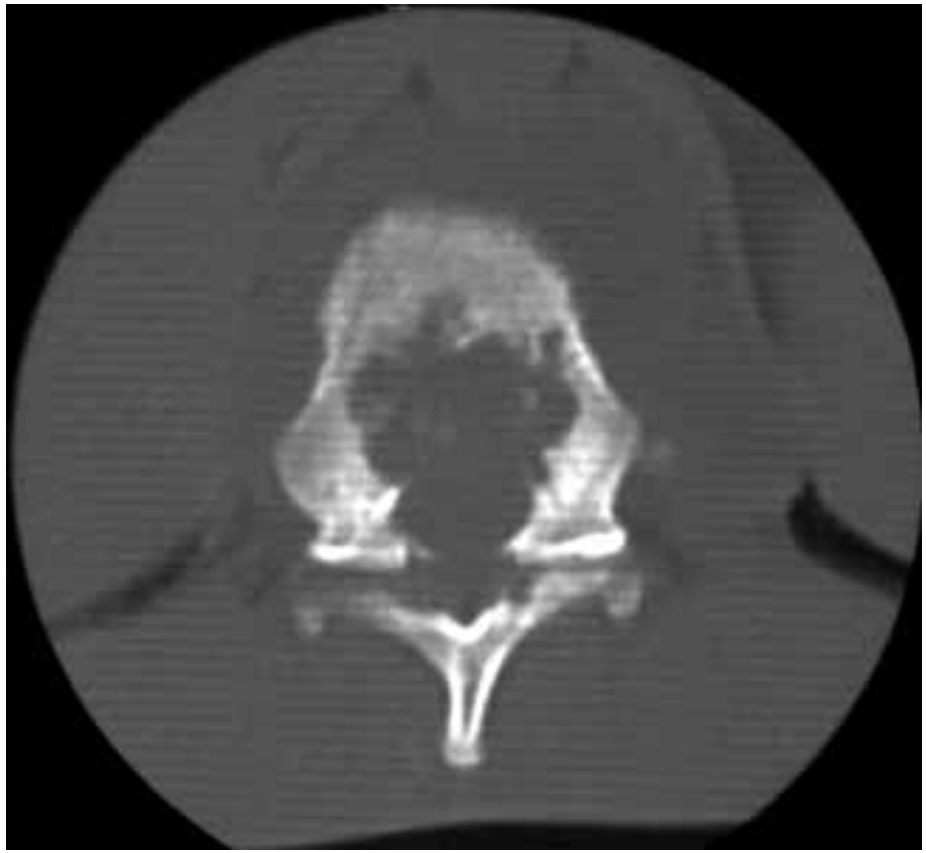
- Narrowing and destruction of an intervertebral disk
  - Earliest plain film sign
- Indistinct adjacent endplates with destruction
- Often associated with bony sclerosis of the two contiguous vertebral bodies
- Paravertebral soft tissue mass
- Endplate sclerosis (during healing phase beginning anywhere 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

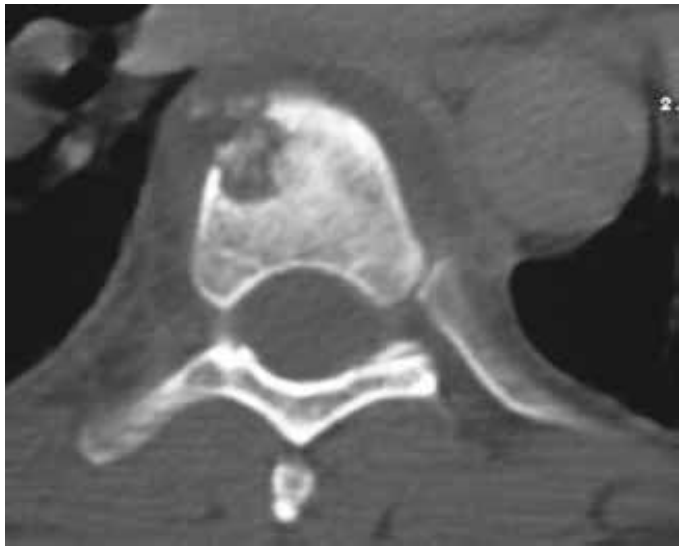
Discitis and Osteomyelitis

Normally discs are black and grey, abnormality in , pus



Disc is abnormal and abscess is on the side compressing the spinal cord

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 sub-ligamentous 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



Good Learning Resources
(Please visit the websites)

- http://www.knowyourback.org/Pages/Treatments/AssessmentTools/RadiologicalAssessment_SD.aspx

- http://www.rbrs.org/dbfiles/journalarticle_0256.pdf

- http://my.clevelandclinic.org/services/x-ray/hic_spine_x-ray.aspx

- http://www.learningradiology.com/archives05/COW%20140-Discitis/discitiscorrect.htm

- http://www.med-ed.virginia.edu/courses/rad/cspine/