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)

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 – 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

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

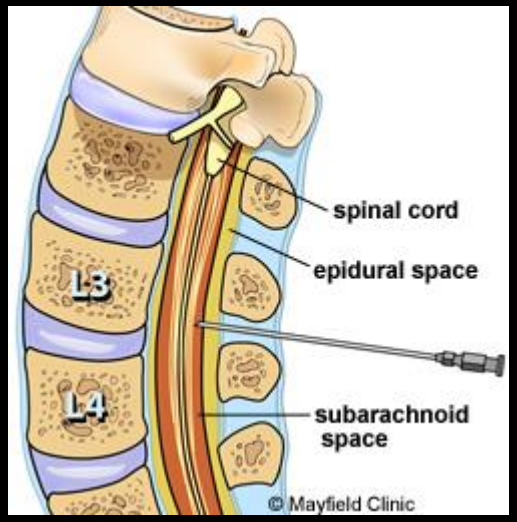
A contrast material is injected into CSF to better identify areas where spinal cord or spinal nerves may be compressed

PROCEDURE:

Under local anesthesia, a needle is placed into lower lumbar spinal canal, 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)

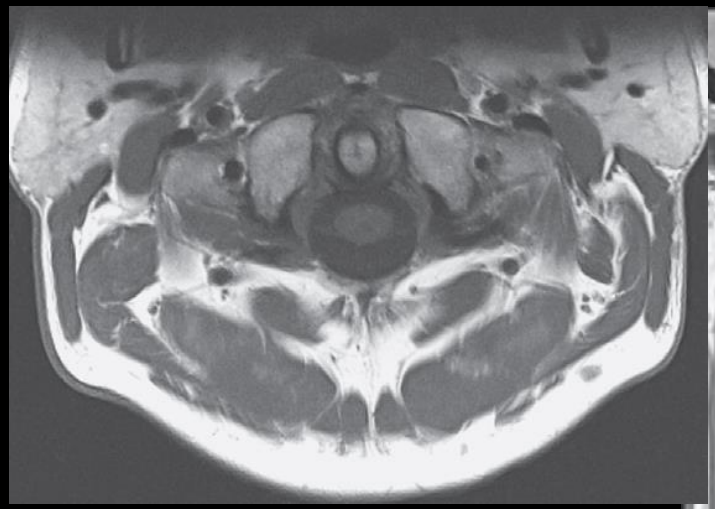
The gold standard of imaging for spinal disorders
Does not use ionizing radiation
Can identify abnormalities of bone, discs, muscles, ligaments and spinal cord
Intravenous contrast is sometimes administered to better visualize certain structures or abnormalities
Patient lies still in a tunnel like structure for about 25 minutes
Claustrophobic patients may need sedation, and children often need general anesthesia
Contraindications include
Implanted devices e.g. cardiac pacemakers

Artificial joints and spinal hardware may still have MRI scans

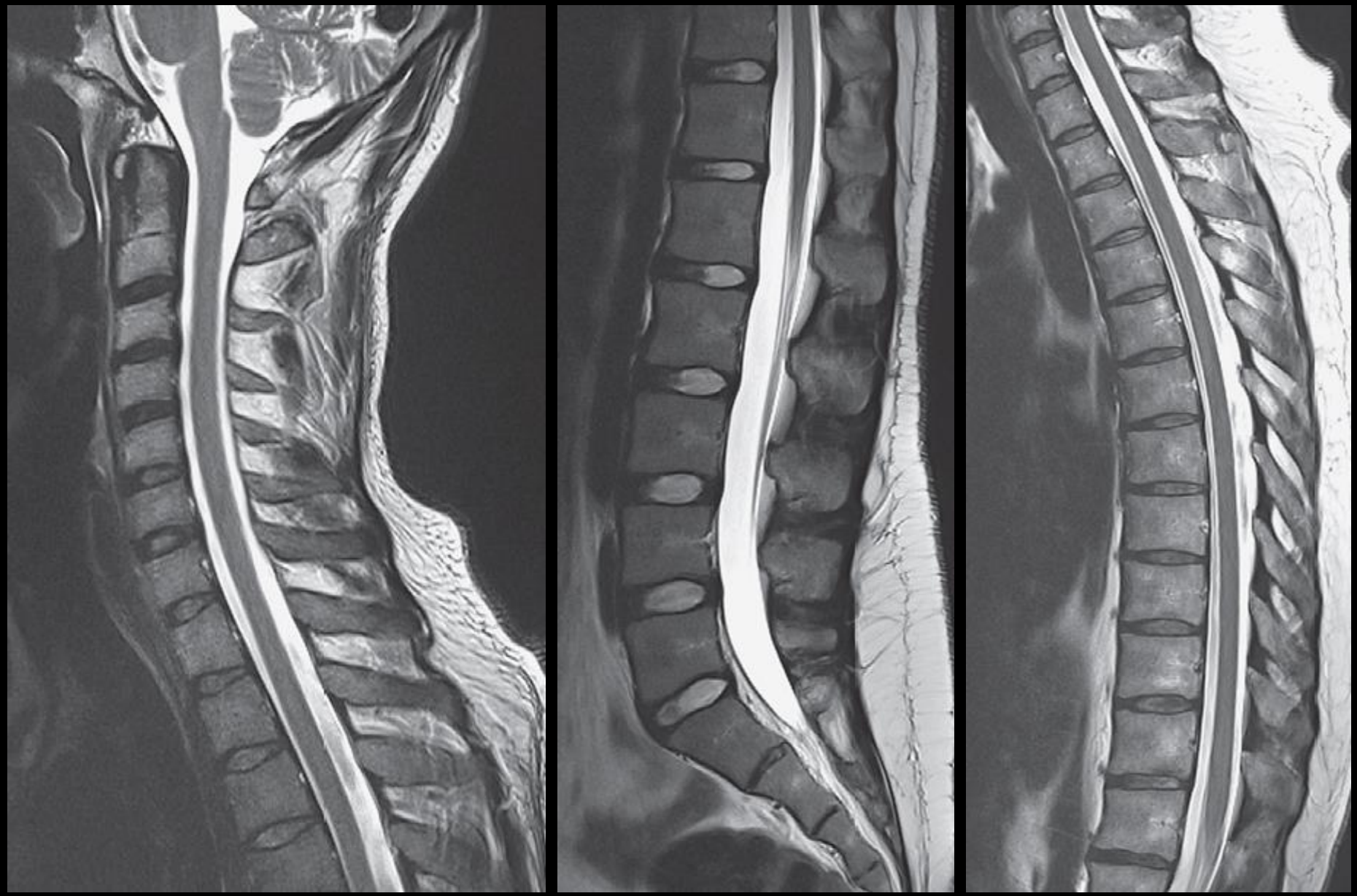
MRI SCANNER (closed type)

MRI SCANNER (open type)

MR images are multi-planar



MR images are very high resolution



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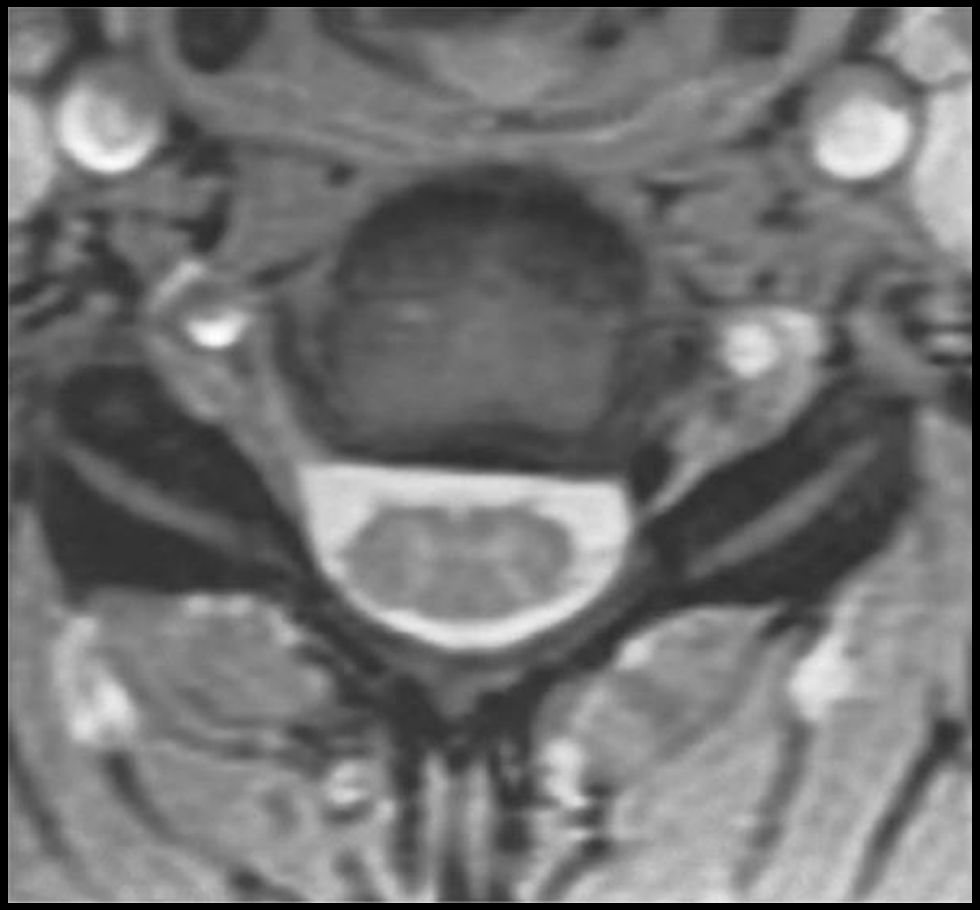
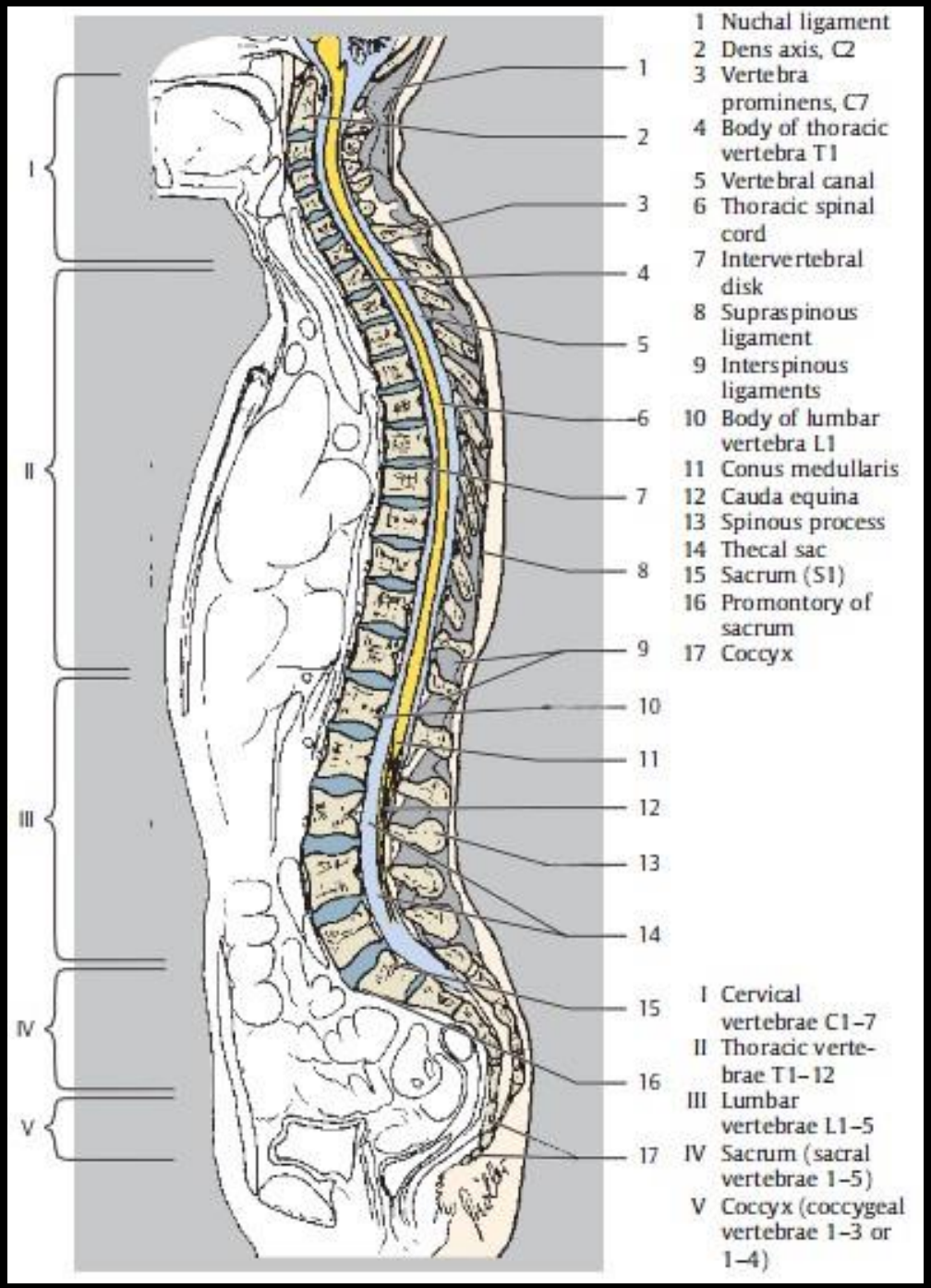



1 Nuchal ligament
2 Dens axis, C2
3 Vertebra prominens, C7
4 Body of thoracic vertebra T1
5 Vertebral canal
6 Thoracic spinal cord
7 Intervertebral disk
8 Supraspinous ligament
9 Interspinous ligaments
10 Body of lumbar vertebra L1
11 Conus medullaris
12 Cauda equina
13 Spinous process
14 Thecal sac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

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

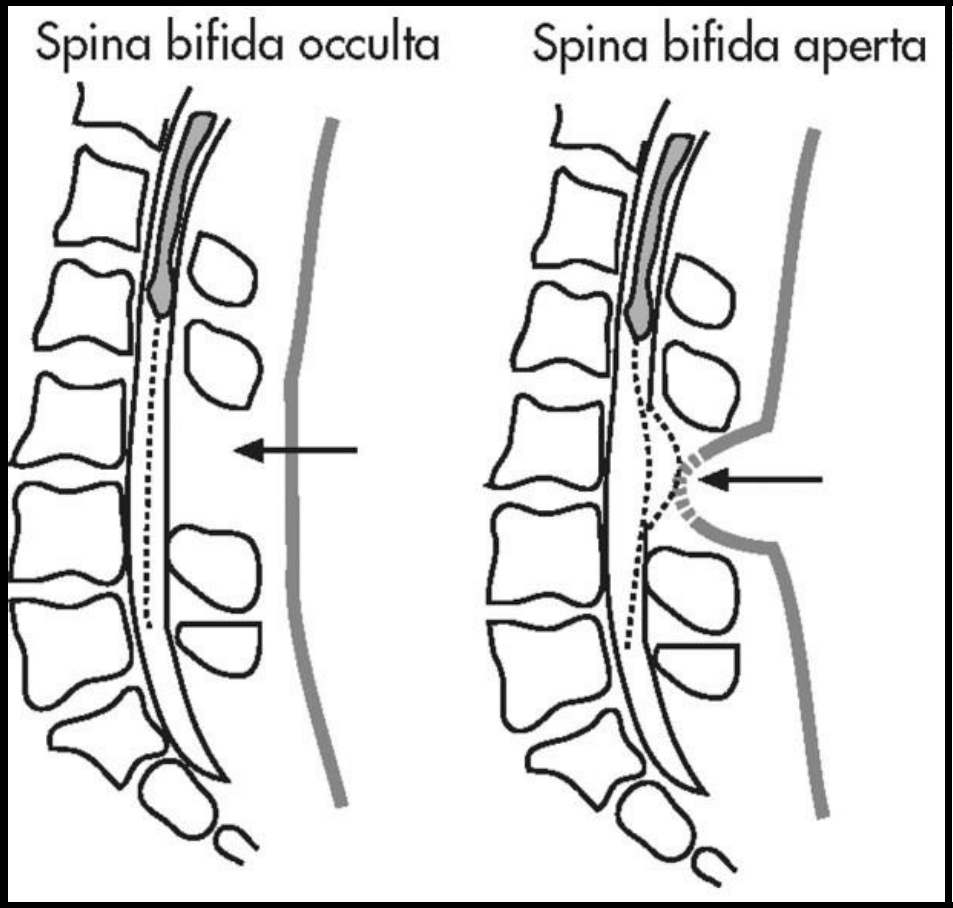
Congenital Anomalies

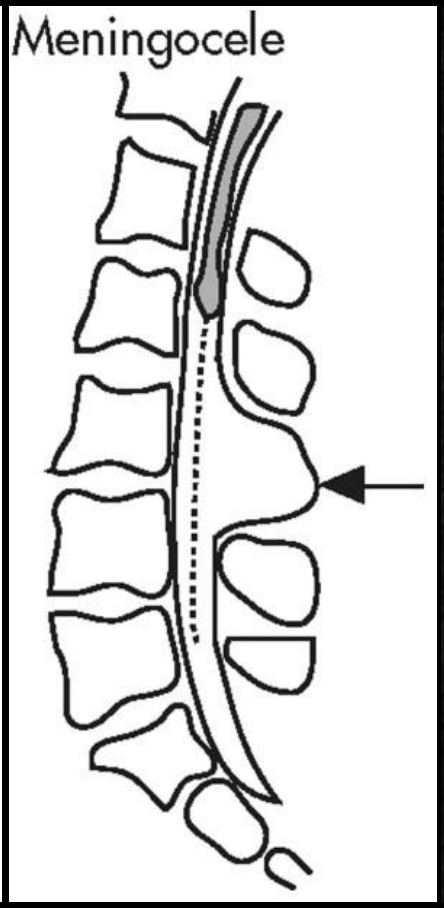
CONGENITAL ANOMALIES

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

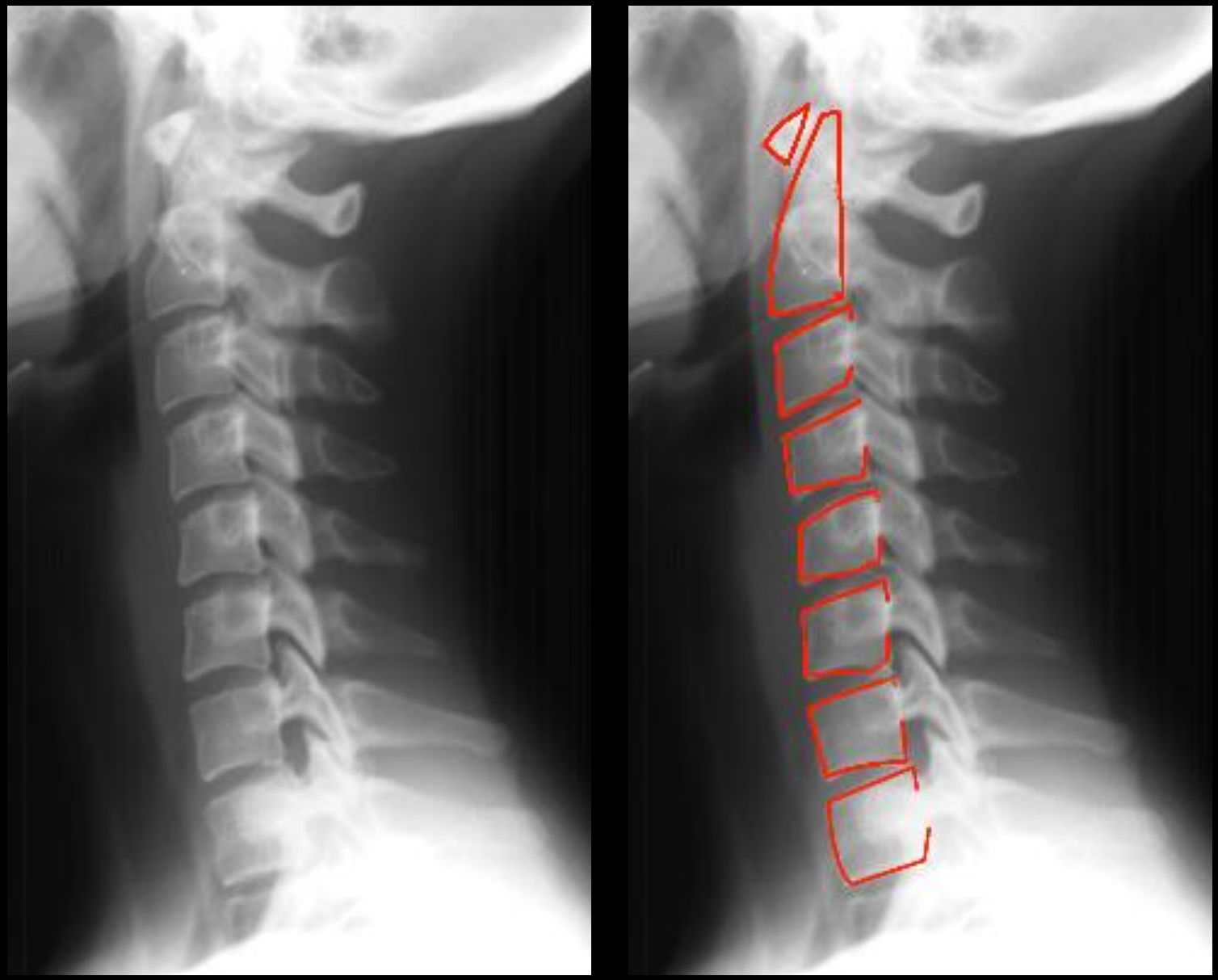




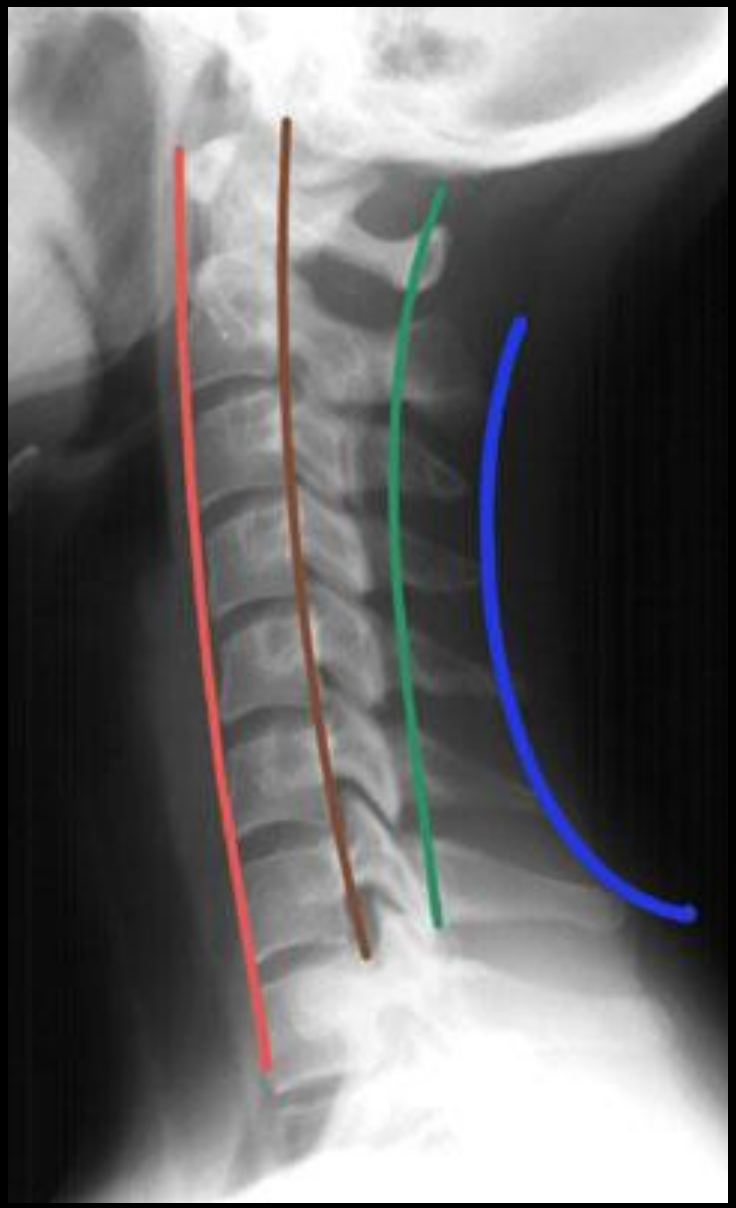
Multiple fusion abnormalities of vertebrae on plain film

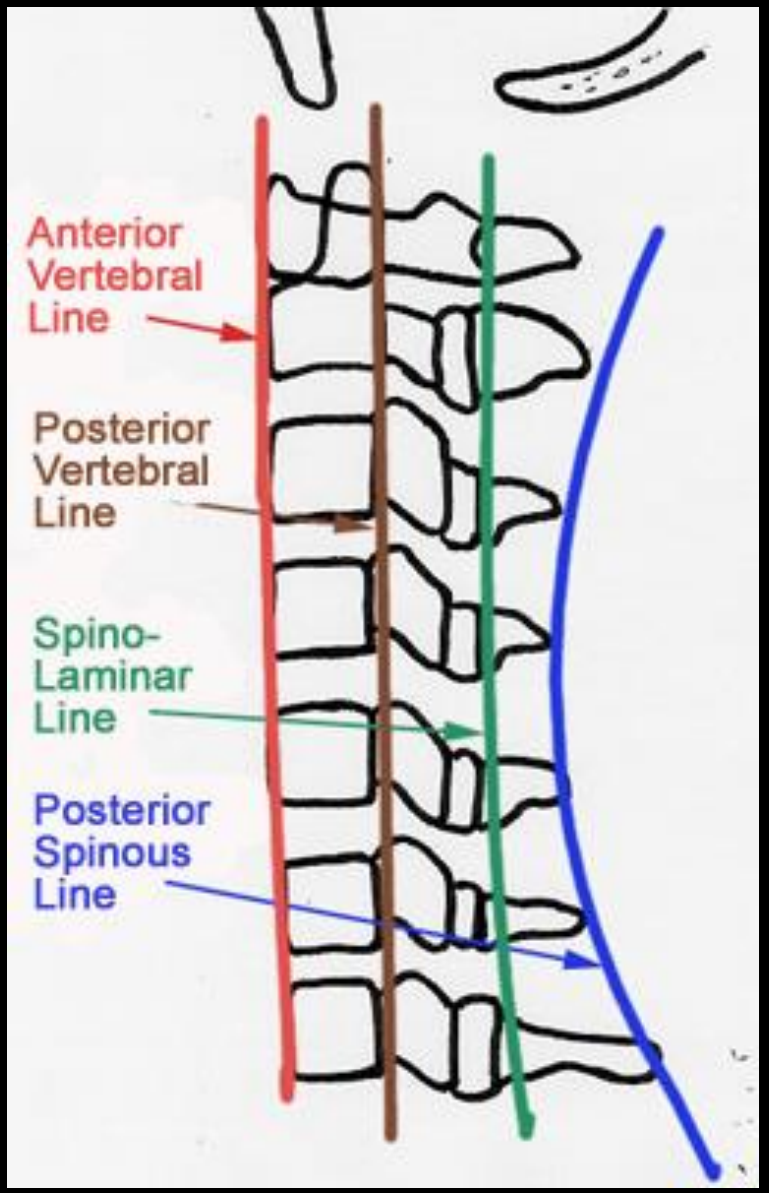
TRAUMA

Plain film assessment of trauma – the first imaging method



Alignment should be normal – check by drawing lines

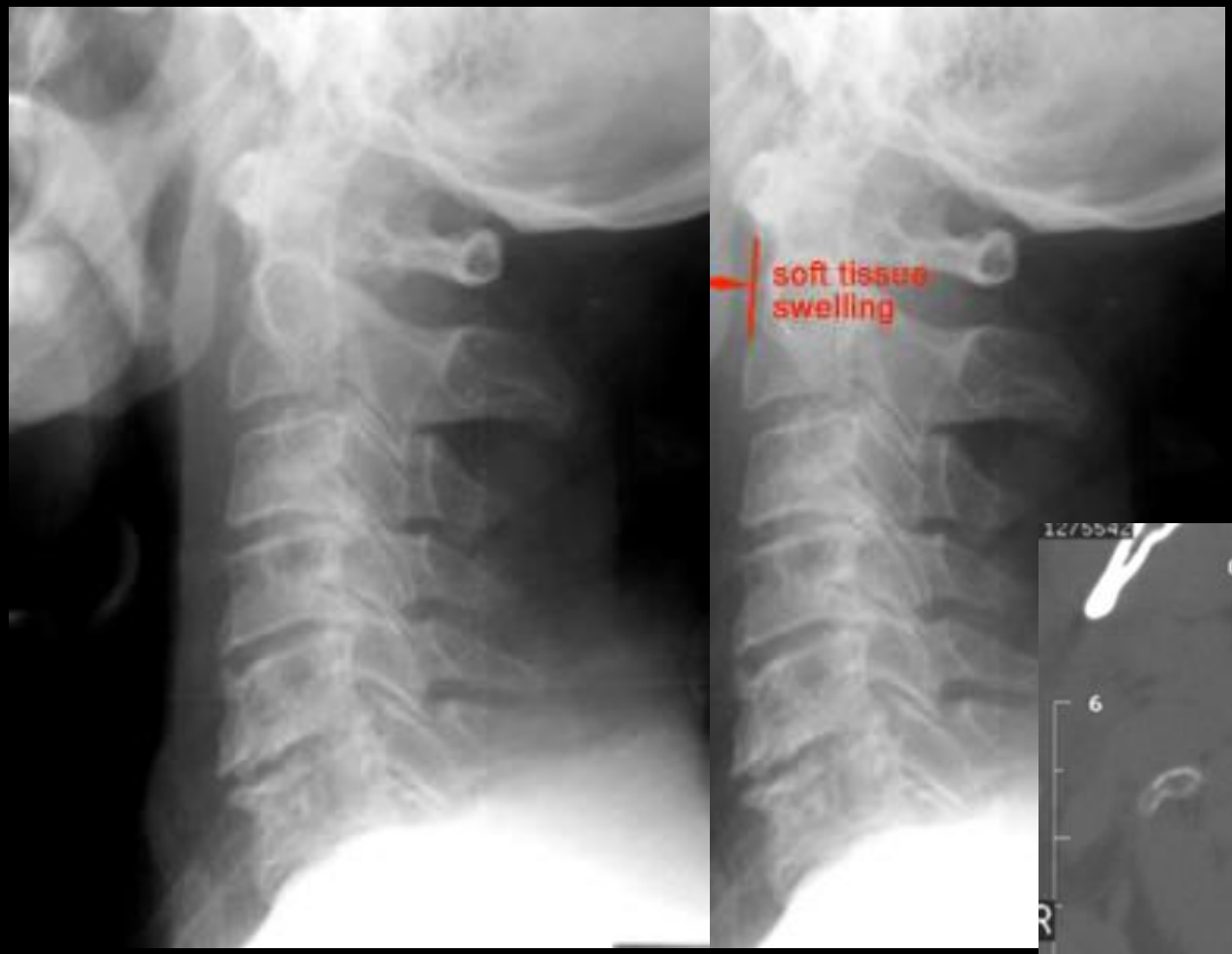


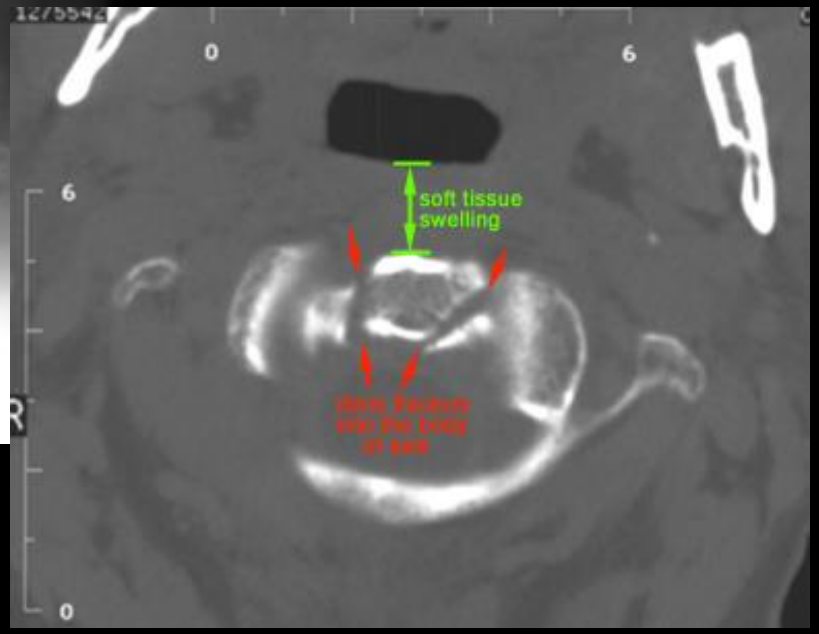



double corticle line
lateral mass
facet joint
lamina
spinous process
pedicle


naso-
pharyngeal
space
retro-
pharyngeal
space
retro-
tracheal
space

Soft tissue anterior to spine is very important



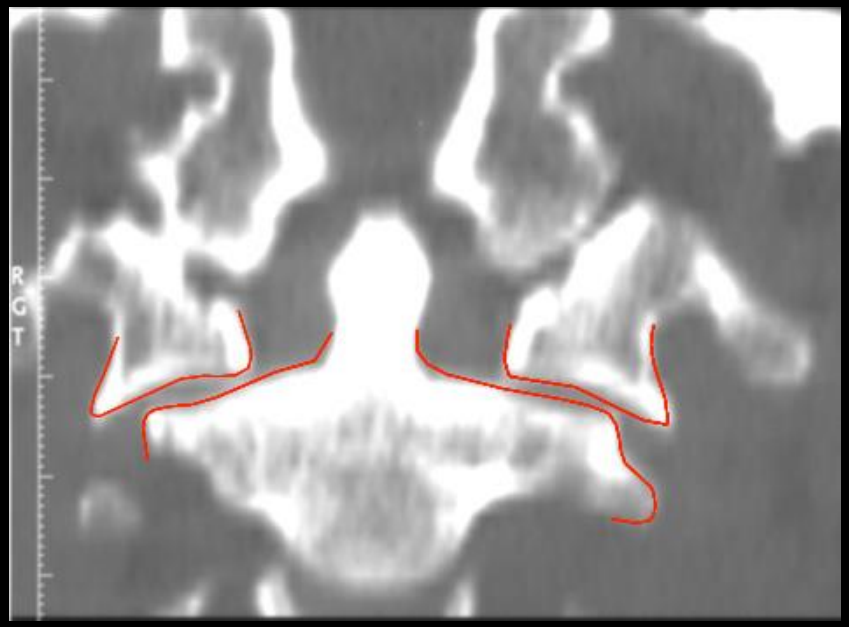


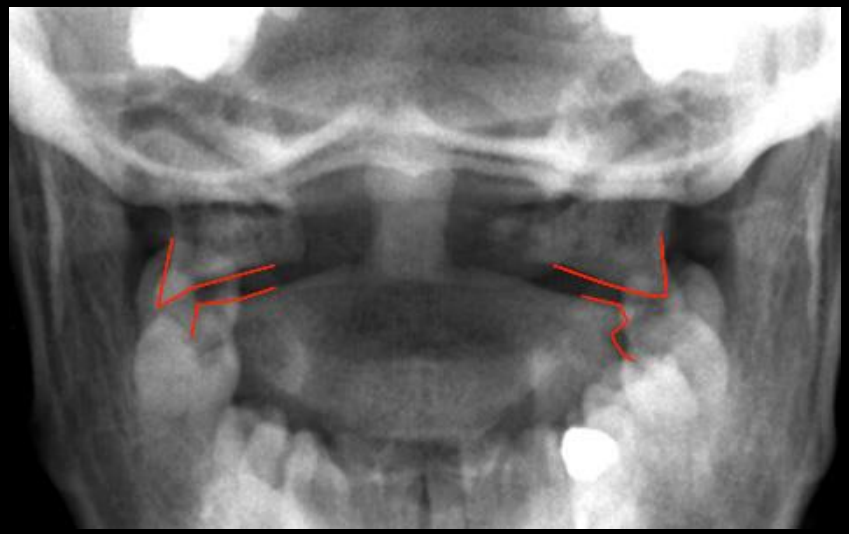
Jefferson Fracture

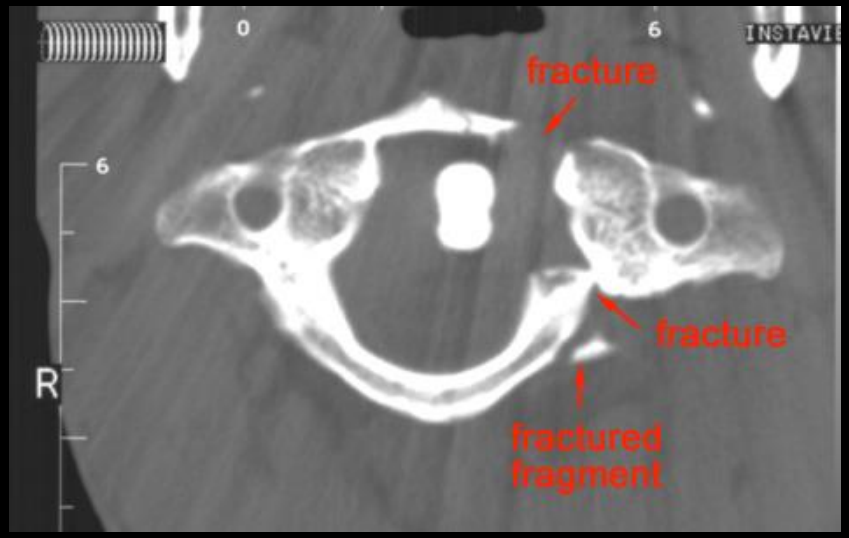
Lateral displacement of C1 in plain film (A)

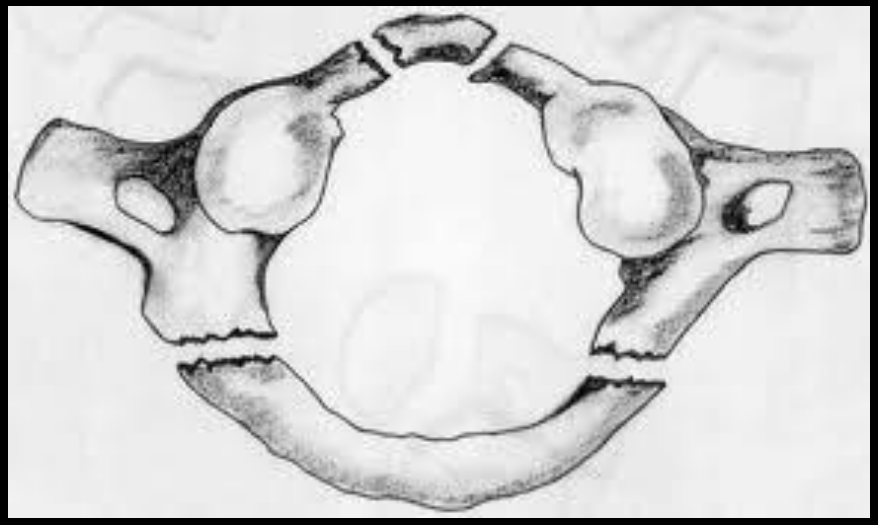
Coronal reconstruction from a CT confirms the findings from the odontoid view

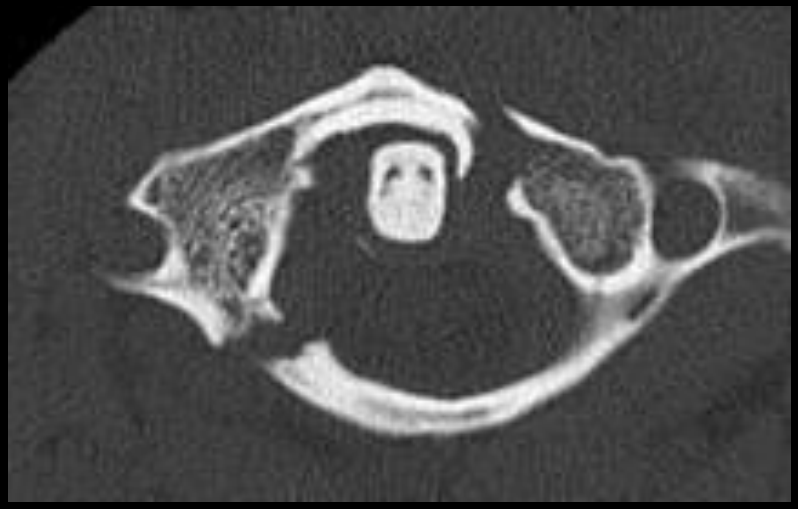
Axial CT clearly shows the location of the fractures of C1

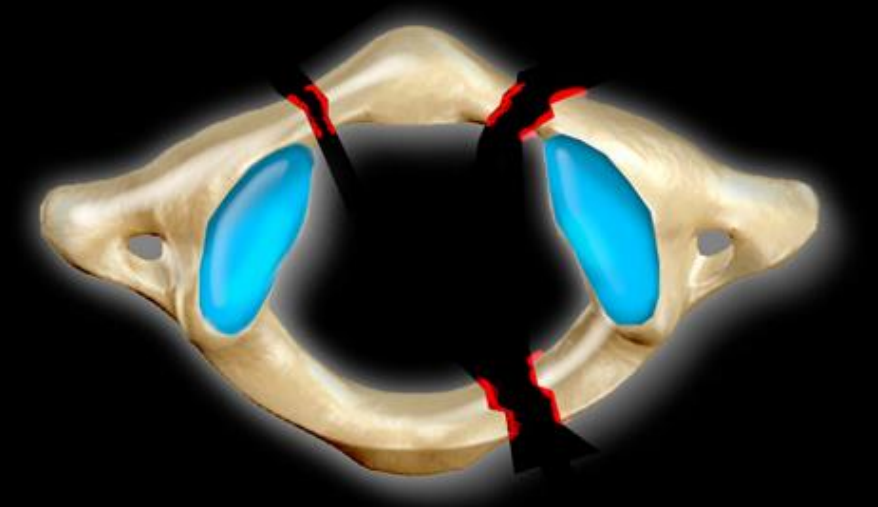




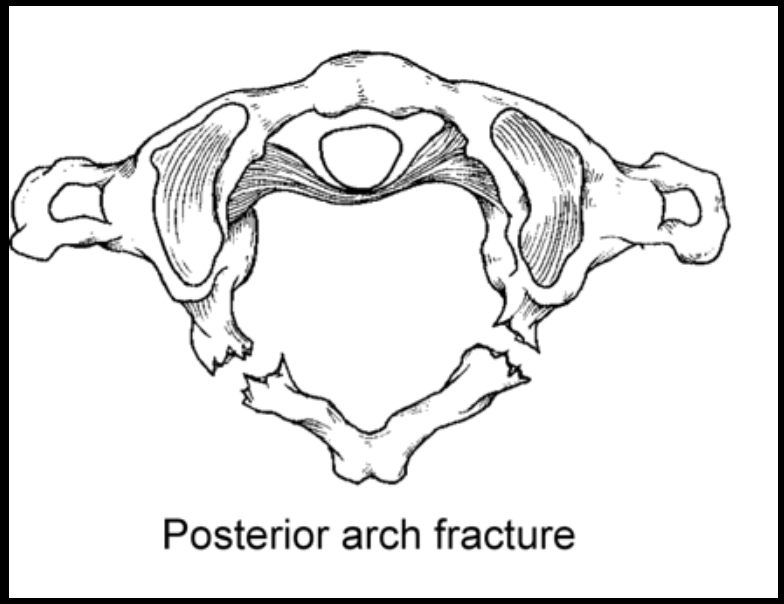




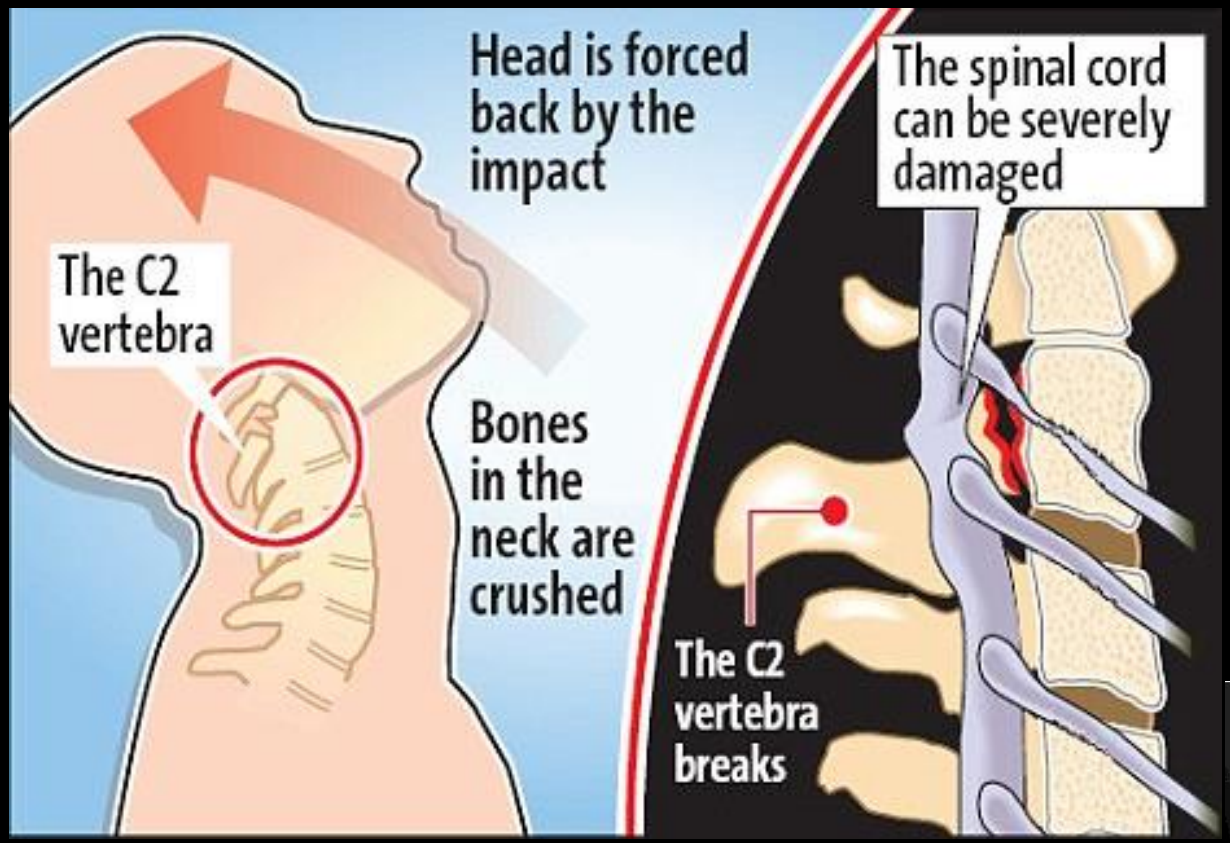


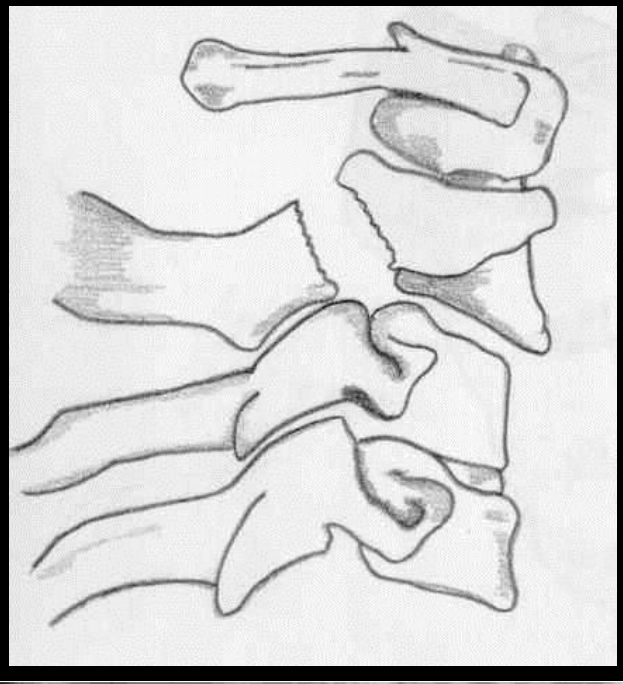


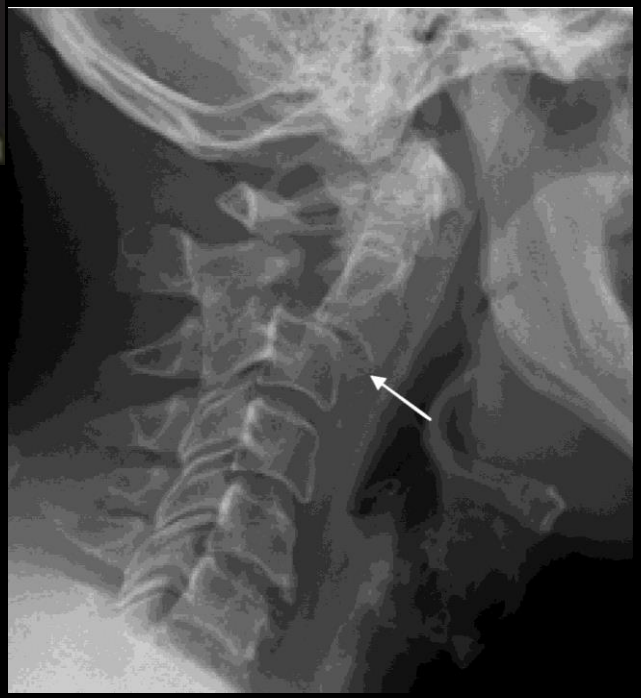
Jefferson fracture



Posterior arch fracture


Head is forced back by the impact
The C2 vertebra
Bones in the neck are crushed
The spinal cord can be severely damaged
The C2 vertebra breaks





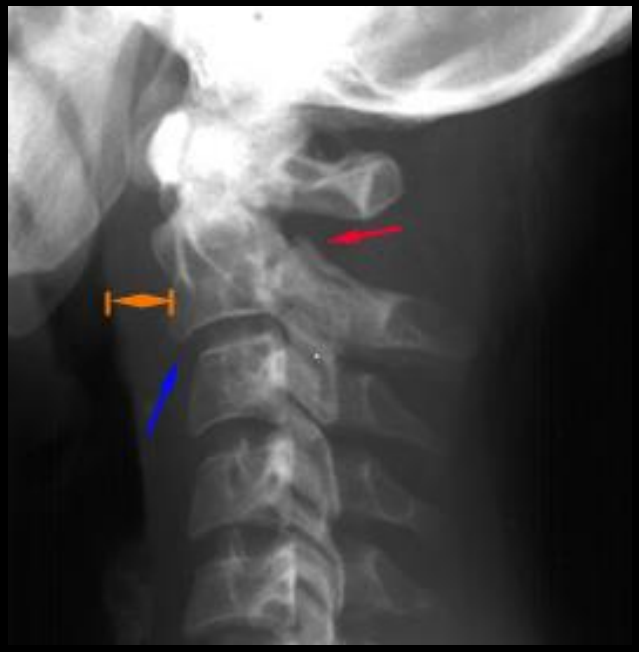
Hangman's Fracture

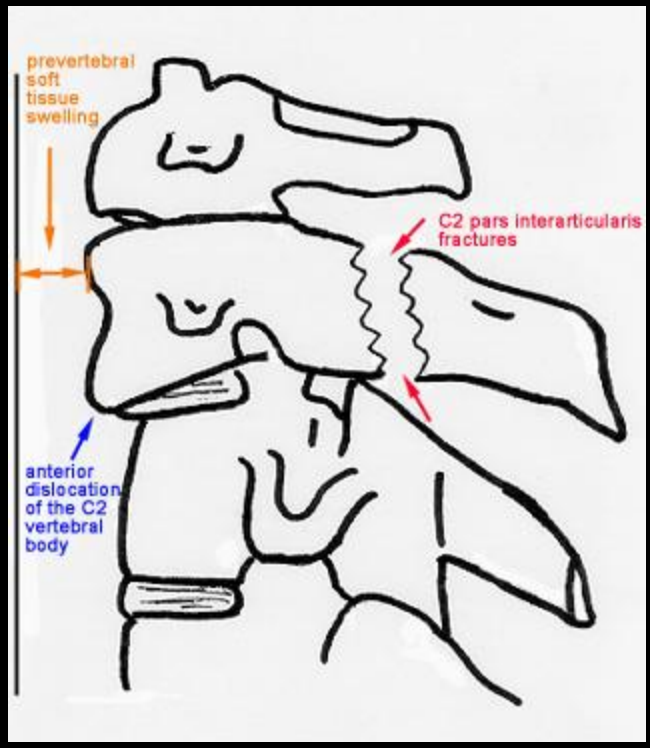
Fractures through the pars interaticularis of C2 resulting from hyperextension and distraction

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

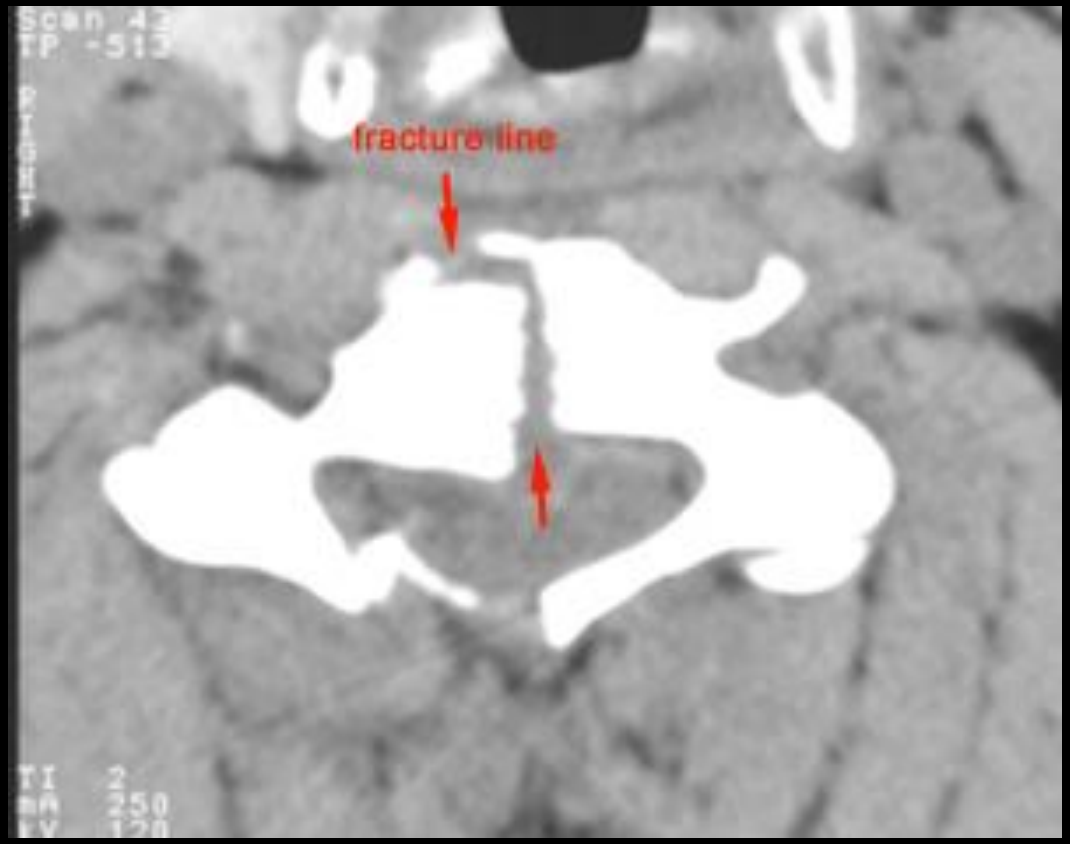
Mechanism: simultaneous flexion and rotation

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



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

Site of involvement

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

Discitis and Osteomyelitis

IMAGING FINDINGS

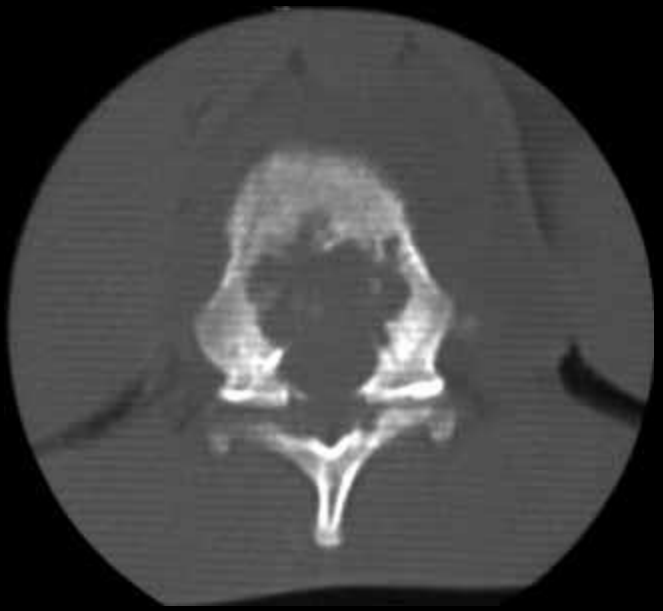
PLAIN FILMS

- 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

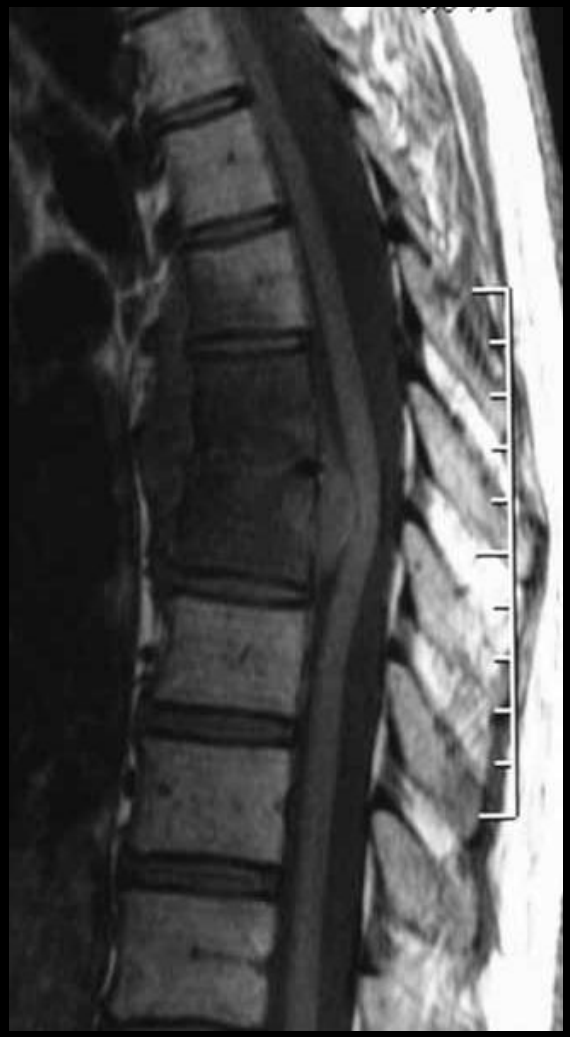
MRI

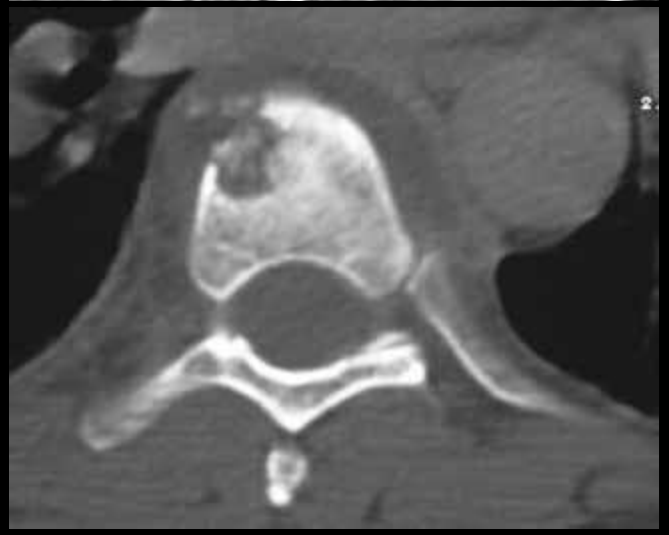
- Bone marrow edema in infected vertebrae, discs and paraspinal soft tissues
  - Dark on T1 and bright on T2 images
- Enhancement of inflammed tissues after contrast
- Fluid collections (abscesses) are common

Discitis and Osteomyelitis

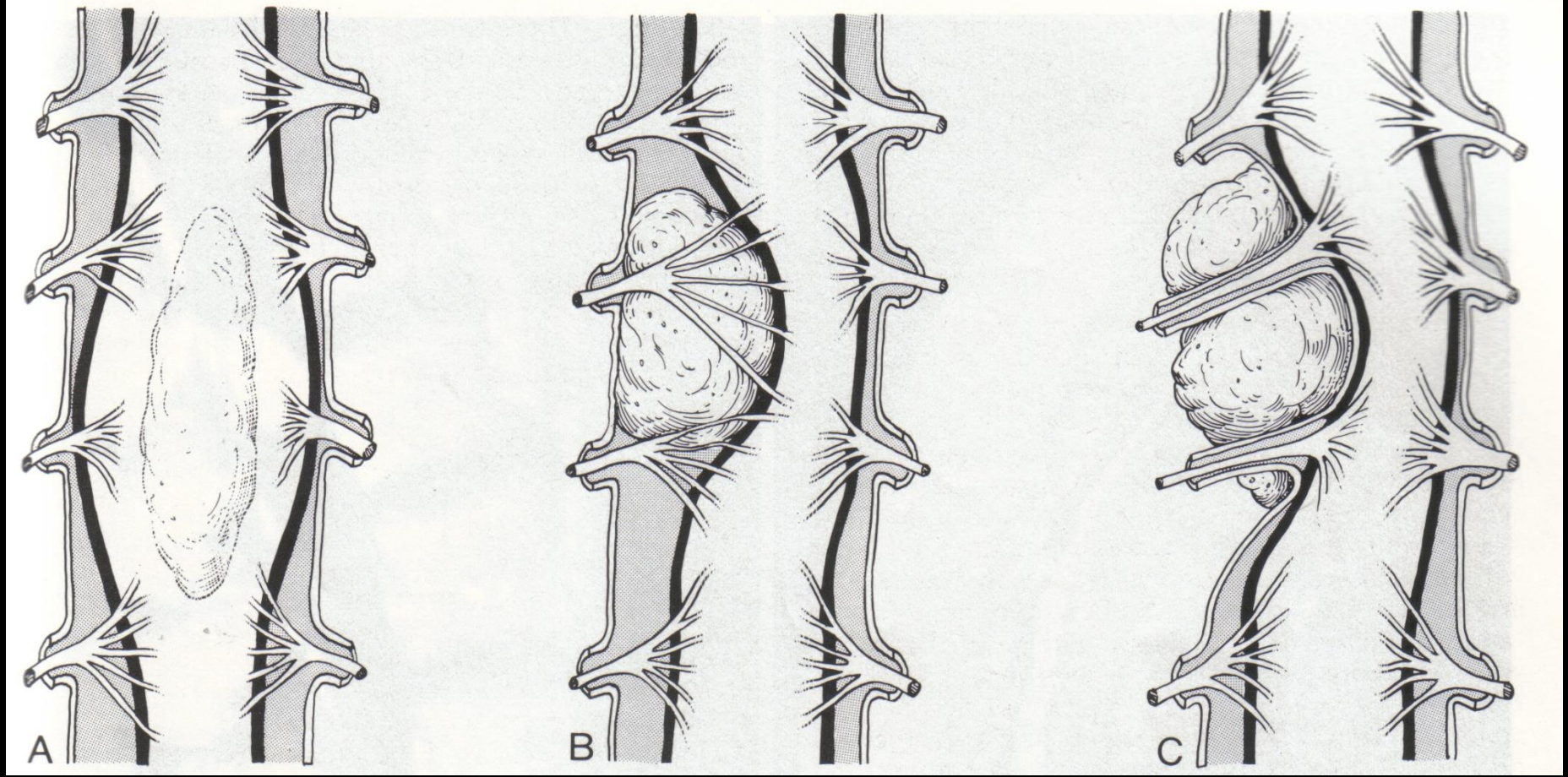


A. Sagittal T1 MRI shows decreased signal of vertebral bodies and disc with end plate destruction
B. Sagittal T2 MRI shows increased signal in corresponding areas with anterior subligamentous abscess, epidural involvement and extension of inflammation in T6 with preserved endplate
C. Axial contrast-enhanced 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

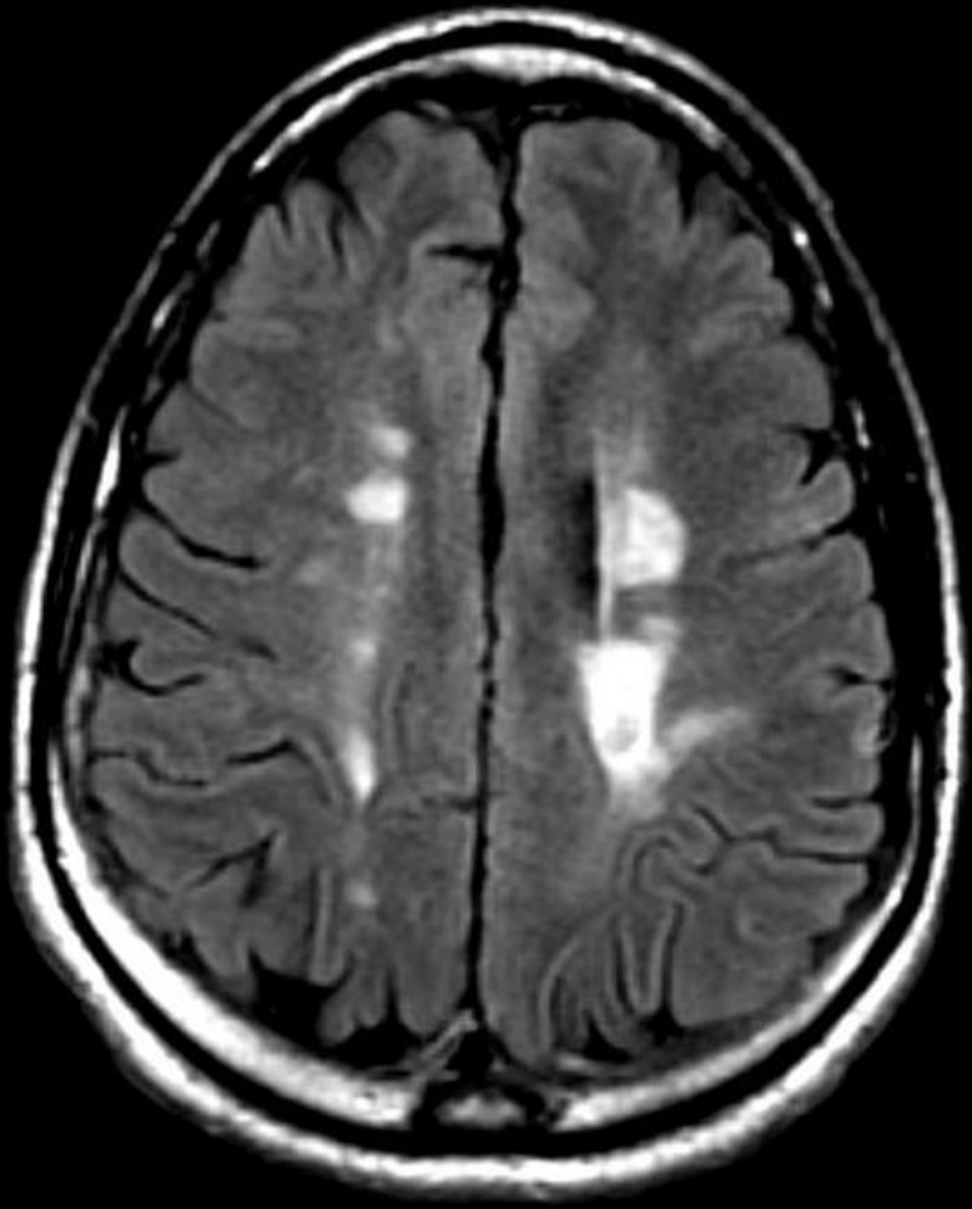




TUMORS


A
B
C

AJNR



THANKS