MRI FINDINGS IN PATIENTS WITH SPINAL CORD SYMPTOMS.

Michael G Kawooya

ECUREI &
Kampala MRI Centre

INTRODUCTION

- Patients with spinal cord symptoms present a diagnostic dilemma.
- Imaging helps in diagnosis, localization & assessing extent.
- MRI is the imaging of choice.

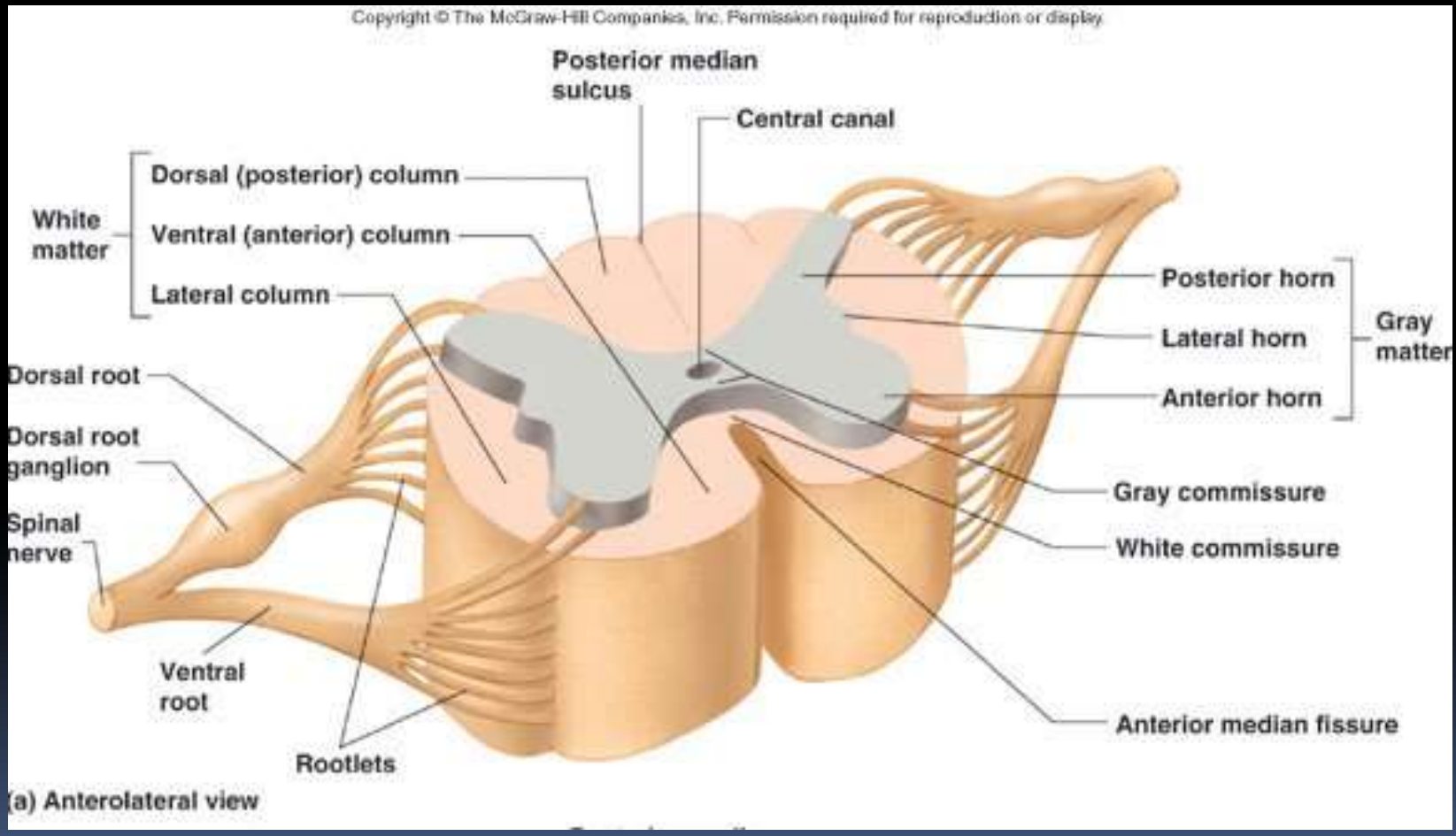
Learning objectives

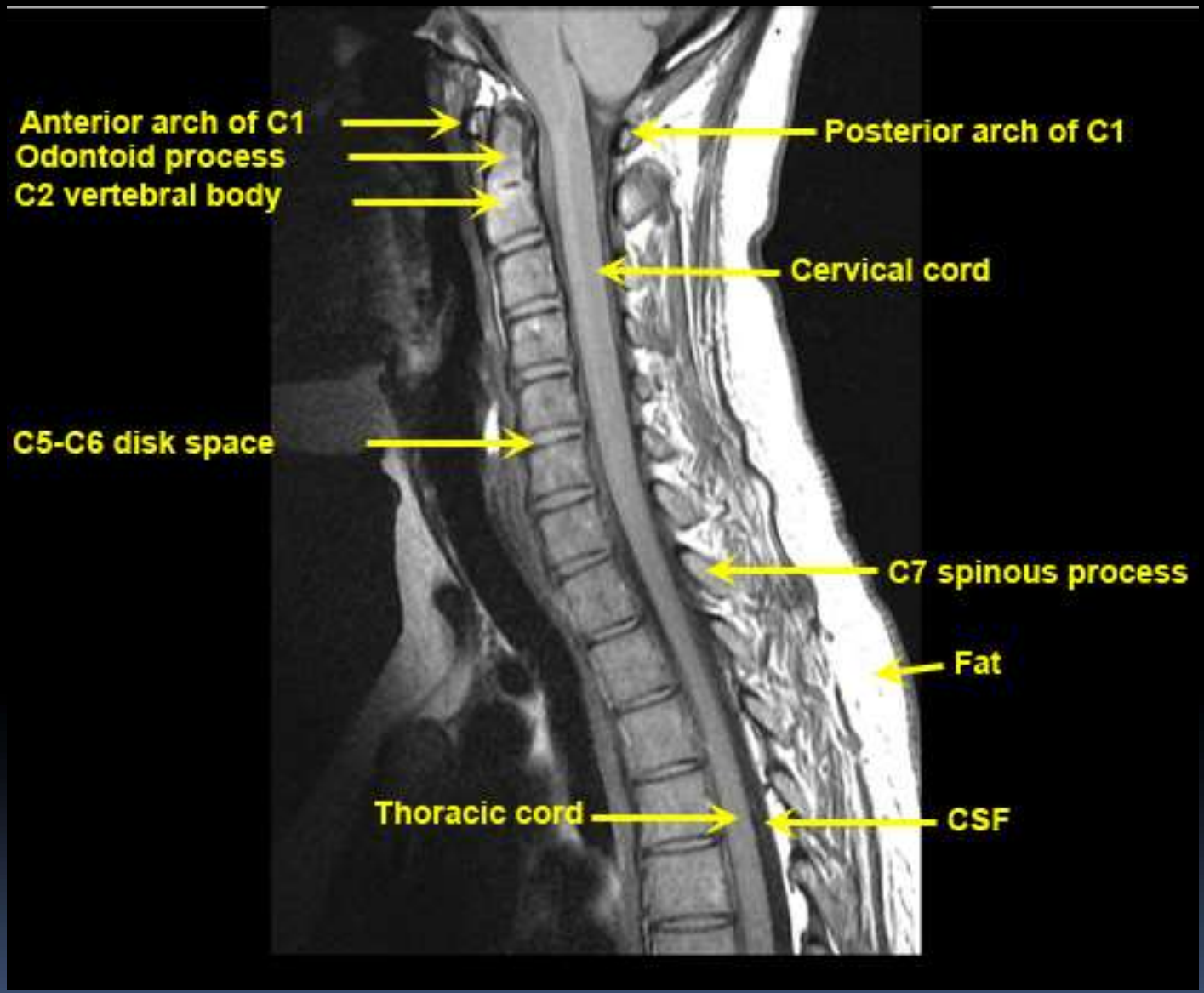
- Review anatomy relevant to spinal cord disease
- Review patho-physiology of spinal cord disease
- List the common diseases in our invironment.
- To list the salient clinical features
- Outline MRI technique
- Describe the MRI patterns

MRI SEQUENCES

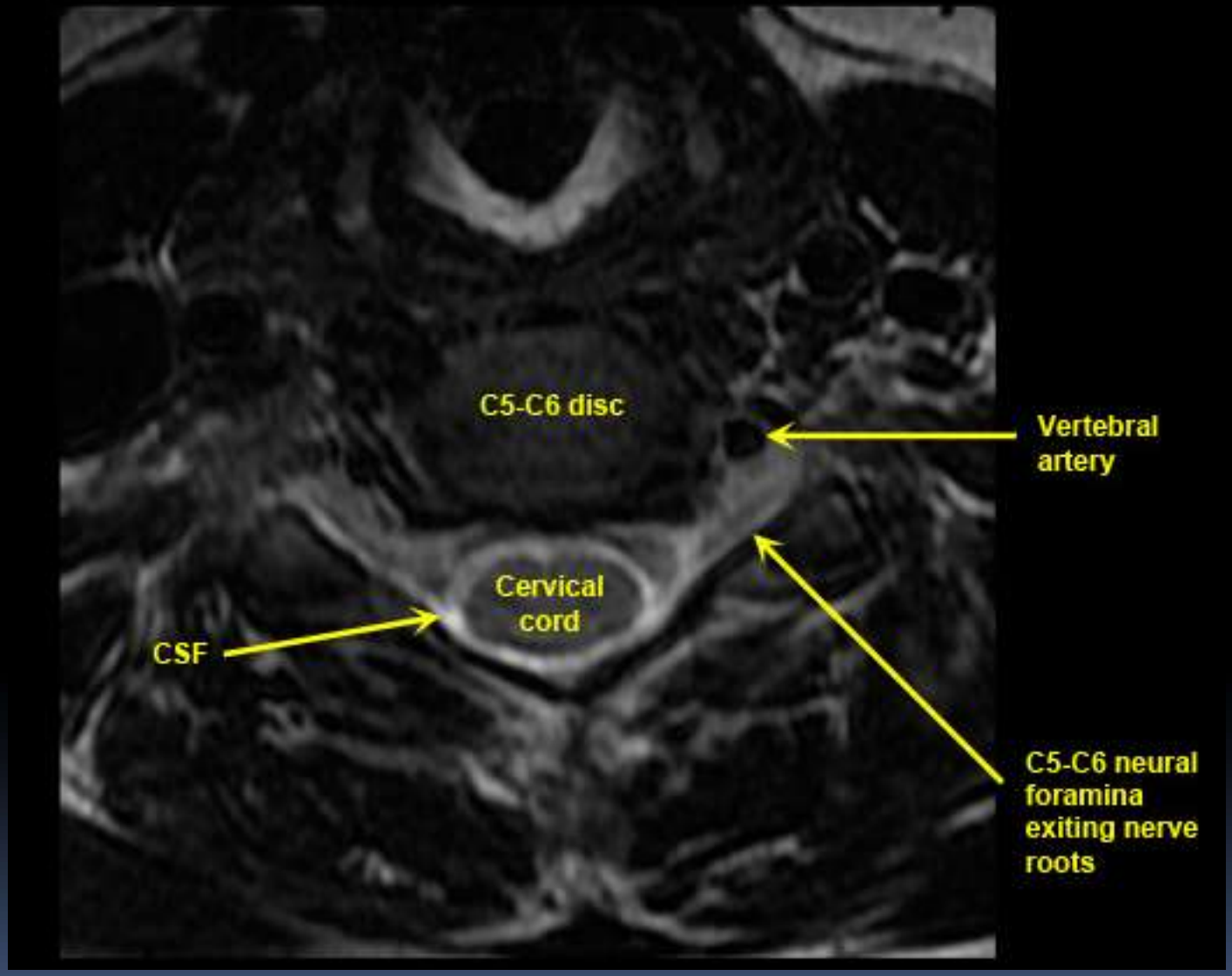
- T1W , T2W, STIR , T1W TSE+gado, DWI??

Cross sectional anatomy

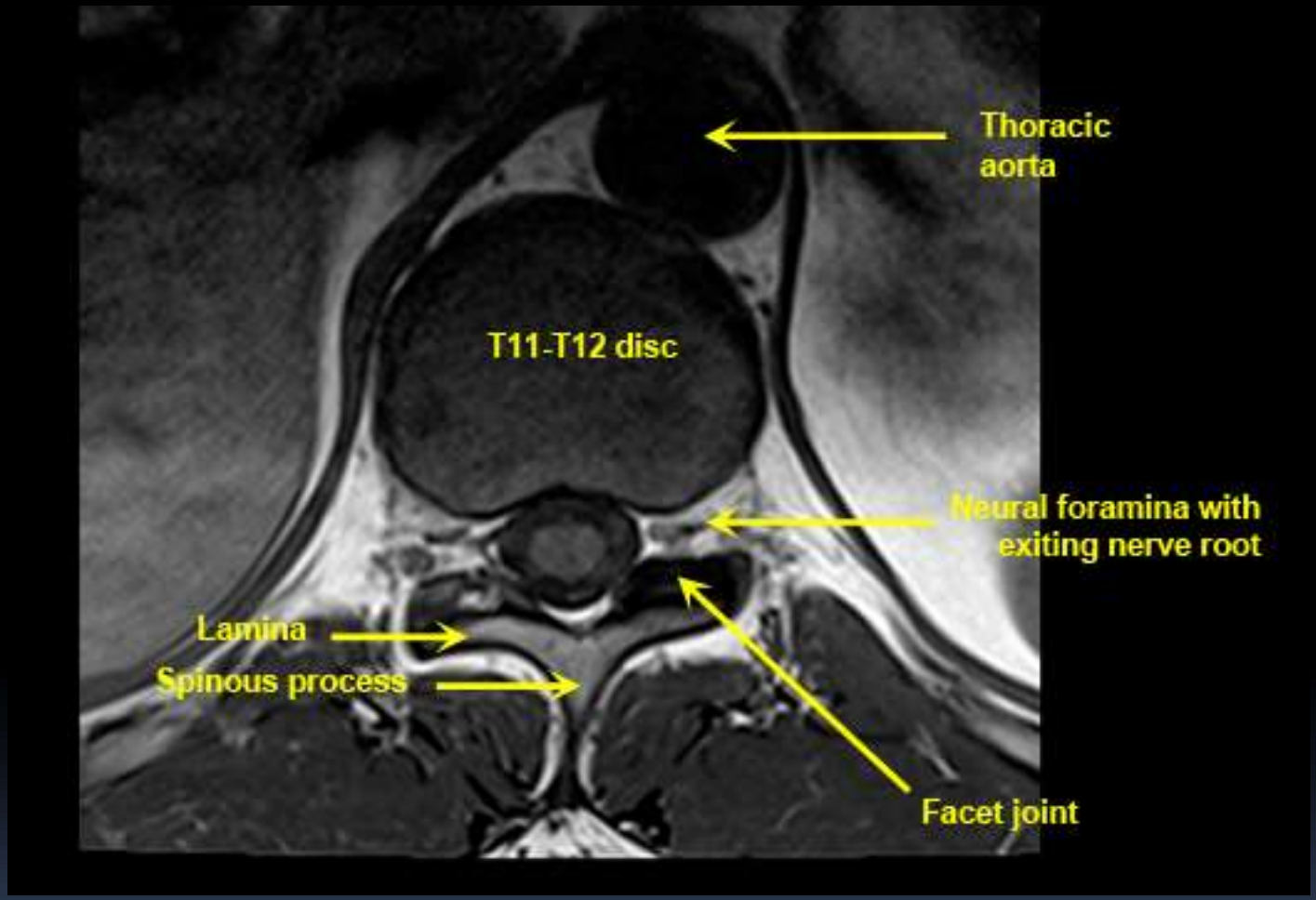




Pre-contrast sagittal T1 wtd MRI of cervical spine

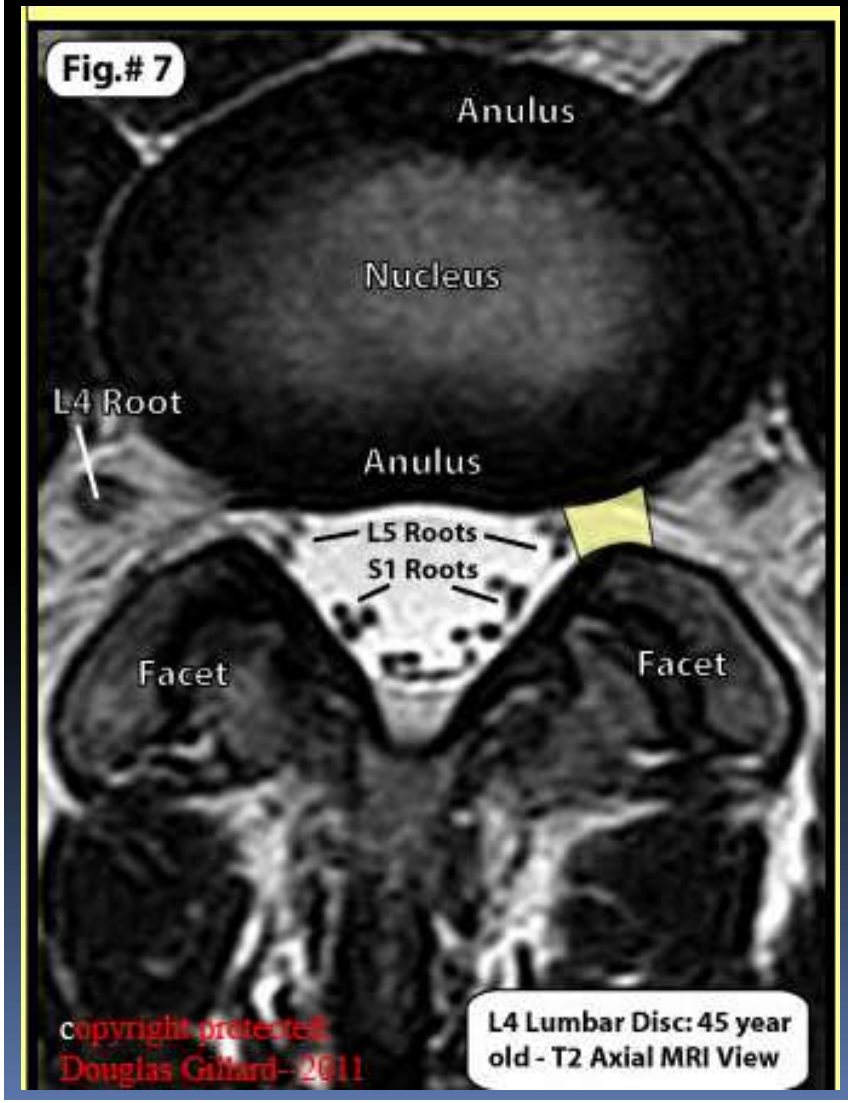


Pre-contrast axial T2 wtd MRI of cervical spine at C5-C6 level



Pre-contrast axial T1 wtd MRI of thoracic spine

T2 W axial of a normal L4 disc



- 42 yr old man
- Normal nucleus pulposus n annulus
- Water content decreases
- When age increases

Systematic approach to interpreting MRI spinal cord images

- High resolution axial vies a pre-requisite.
- Location and extent on the axial view
- Number of segments involved on the sagittal views.
- Swelling or volume loss of the involved cord.
- Contrast enhancement.
- Associated brain lesions.
- Involvement of structures adjacent to the cord eg. Vertebrae, neural foramina, paraspinal muscles.

Location of pathology on the axial view

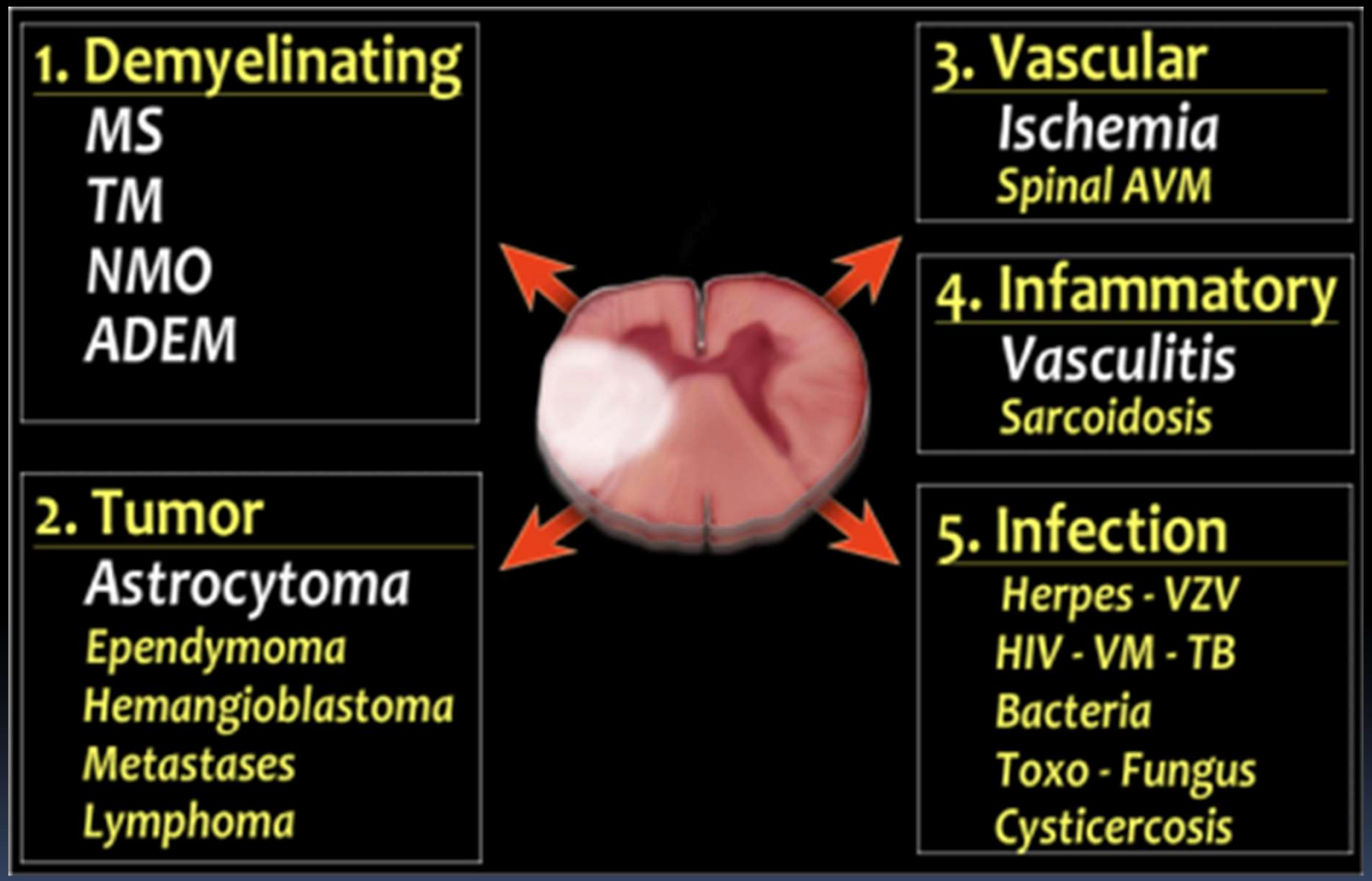
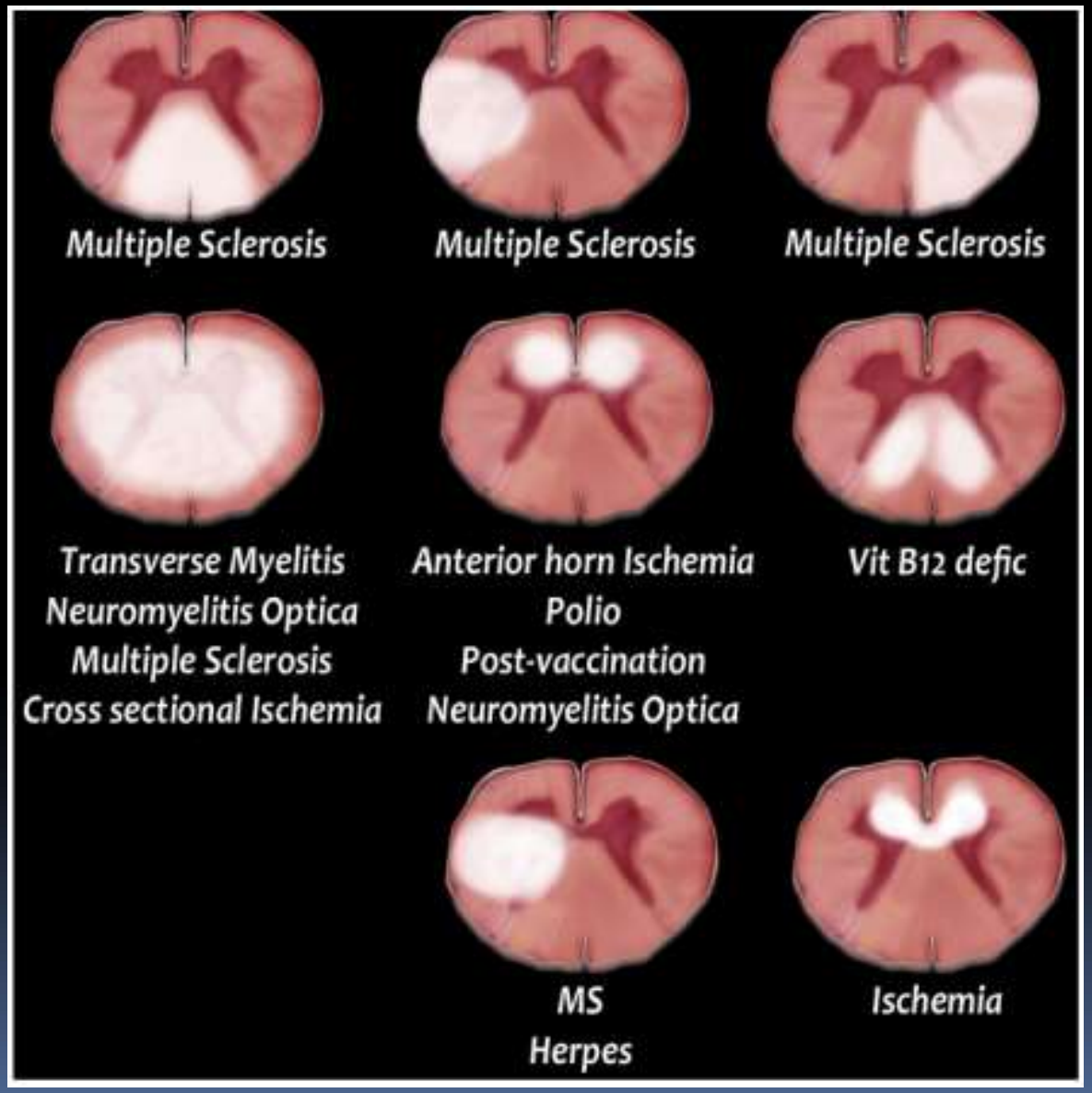


Image from Radiology Assistant

LOCATION OF THE PATHOLOGY ON THE AXIAL VIEW



High resolution transverse images

Anterior: arterial infarction.

Posterior : MS, vitamin B12 deficiensy,

Lateral: MS

Total (anterior, posterior, lateral and medial) : Transverse myelitis

Image from Radiology Assistant

Length of cord involved

- Short segment: typical for MS, uncommon for transverse myelitis.
- Short segment: typical for MS long segment : Transverse Myelitis, NMO and ischemia, uncommon for MS

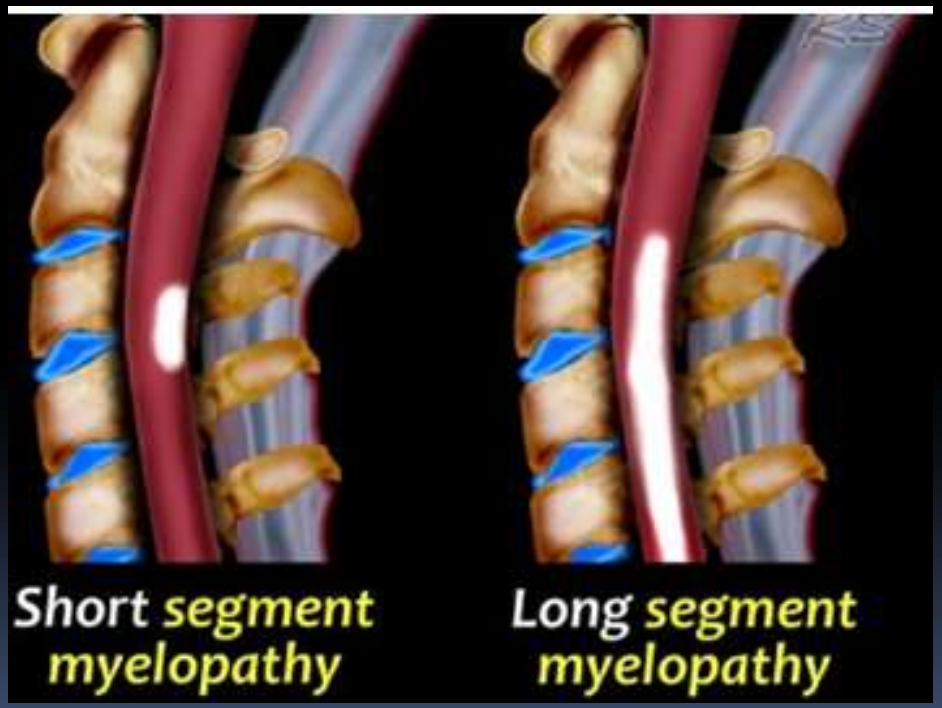


Image from Radiology Assistant

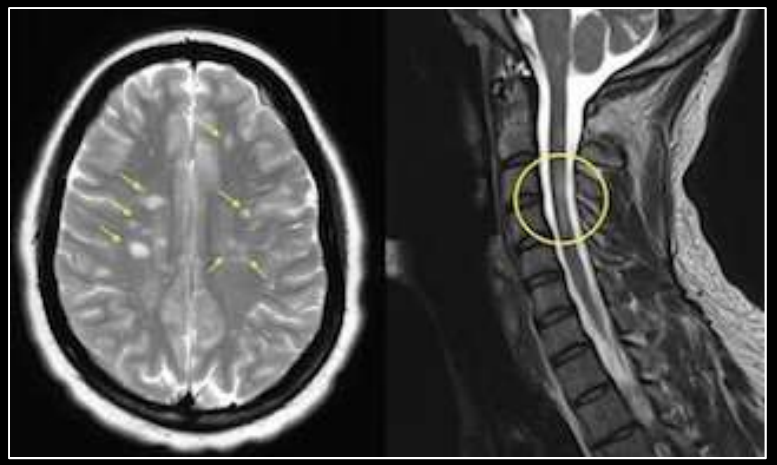
PROPORTION OF THE CORD INVOLVED

- Partial involvement : typically seen in MS.
- Complete involvement (includes both halves of cord) : Typically transverse myelitis and NMO.

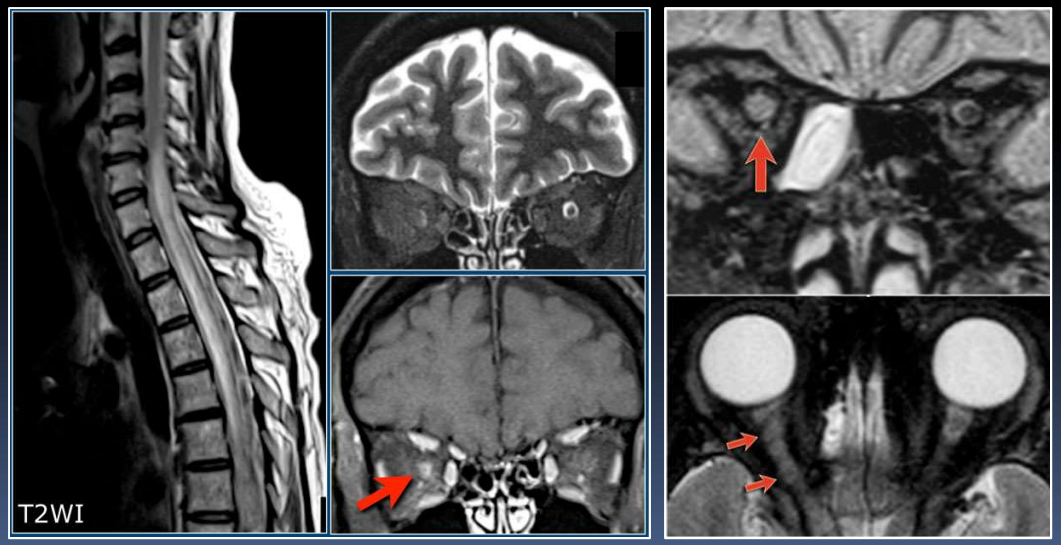
ASSOCIATION WITH BRAIN PATHOLGY

Brain may be involved in many types of myelopathies:

- MS: brain involvement



- NMO: brain and occular involvement

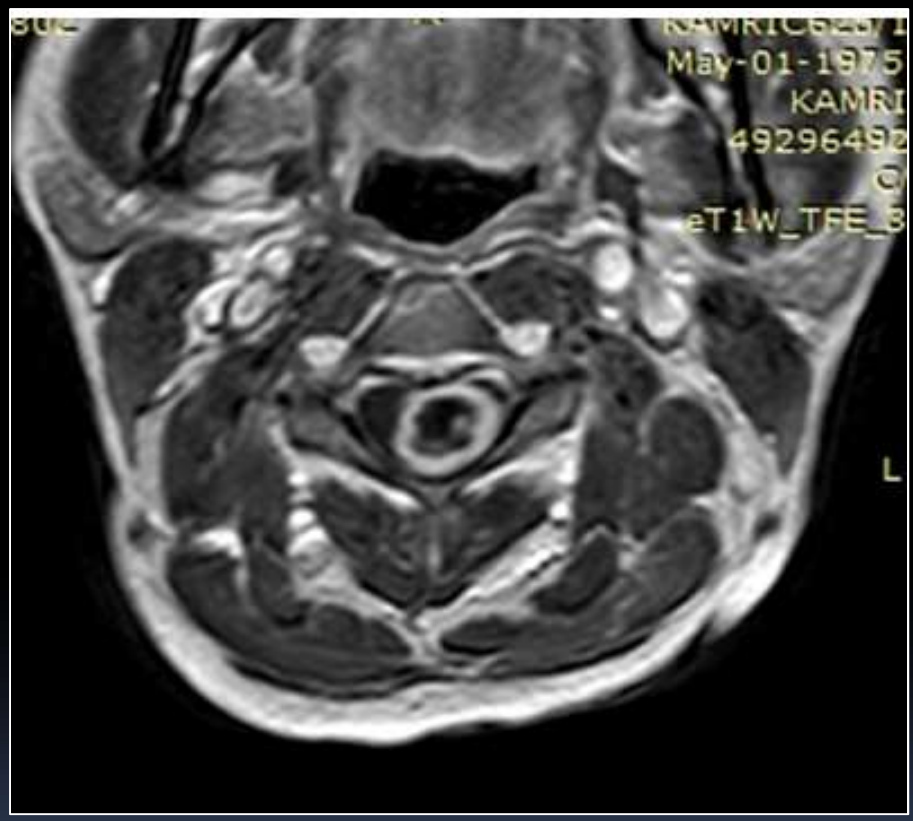


http://www.radiologyassistant.nl/en/p4f789faf60fa4/spine-myelopathy.html

Cord enhancement

- *enhancement?*
  inflammatory eg MS, TM

- Tumor eg: astrocytoma

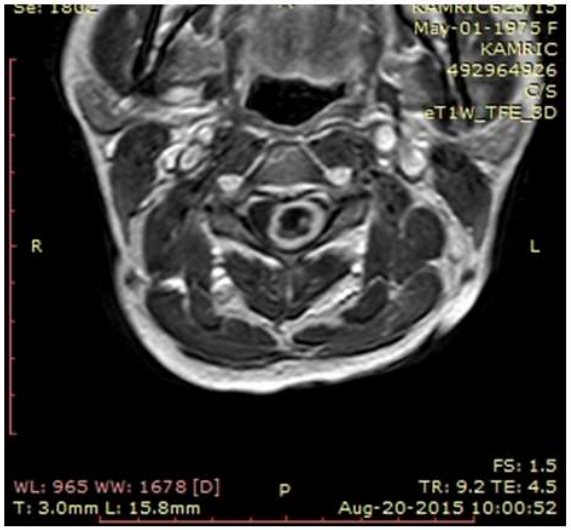


Cord swelling and ring enhancing lesions

- Cord swelling found in:
- Inflammatory: TB, TM,
- Tumor

Swelling absent in MS &

ADEM(acute demyelinating encephalomyelitis



RESULTS

- 118 patients.
- 1 to 82 years, M;F ratio = 1:1.
- Common MRI diagnosis
  - Spondylotic -compression myelopathy 30% % (n=35),
  - TB spondylitis 20% (n=24),
  - Transverse myelitis19% (n= 23)
  - Spinal tumors 14% (n=16).
  - Others included cord ischemia, trauma and syrinx.

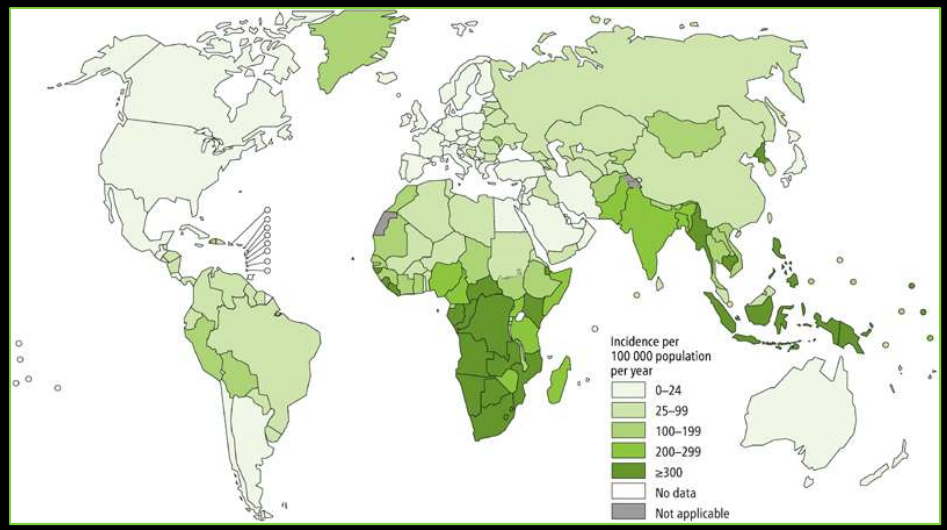
RESULTS 2

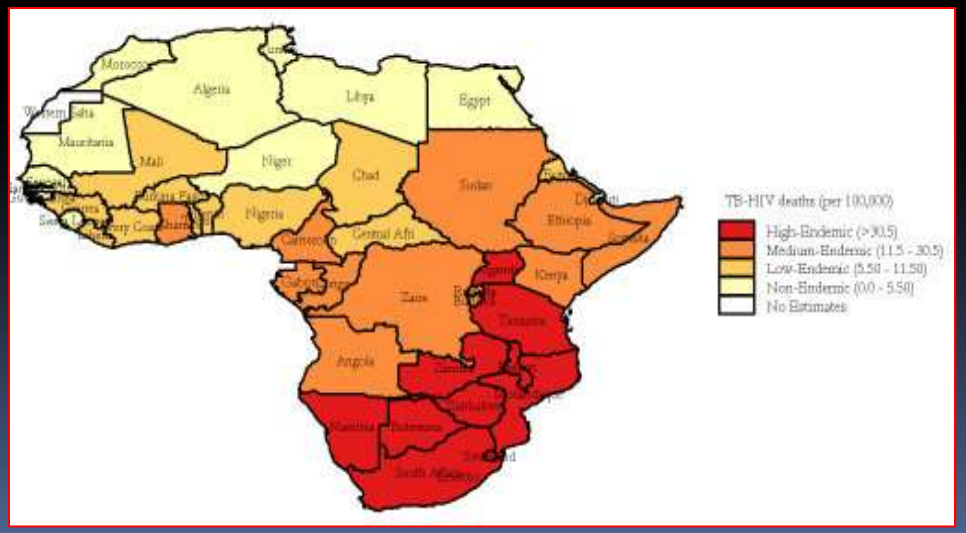
- Compressive spondylosis: commoner in males (74%) and in the cervical spine.
- TB spondylitis commoner in females (67%) and in the thoracic spine (70%). Findings in HIV positive and negative patients were similar.
- Transverse myelitis; M:F ration of 1:1, typically multi-segmental, commoner in thoracic and thoracolumbar spine.

TB SPINAL CORD AND TB SPINE

TB statistics 2017

- TB among 10 top causes of death worldwide
- Approx 10.0 million new cases of TB disease in 2017.
- Affects all countries and age groups, 64 % male, 9% are HIV
- Top 8 countries: India (27%), China (9%), Indonesia (8%), the Philippines (6%), Pakistan (5%), Nigeria (4%) and South Africa (3%)

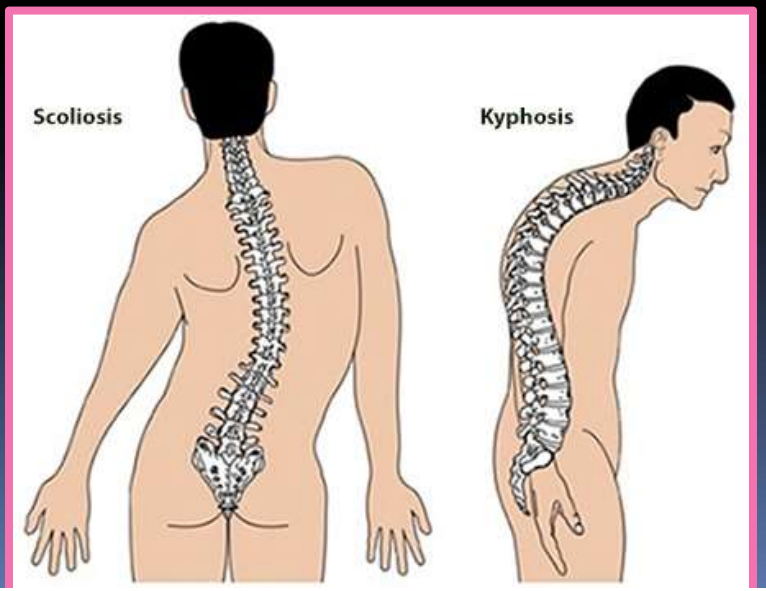




https://www.google.com/search?q=tb+in+africa+statistics

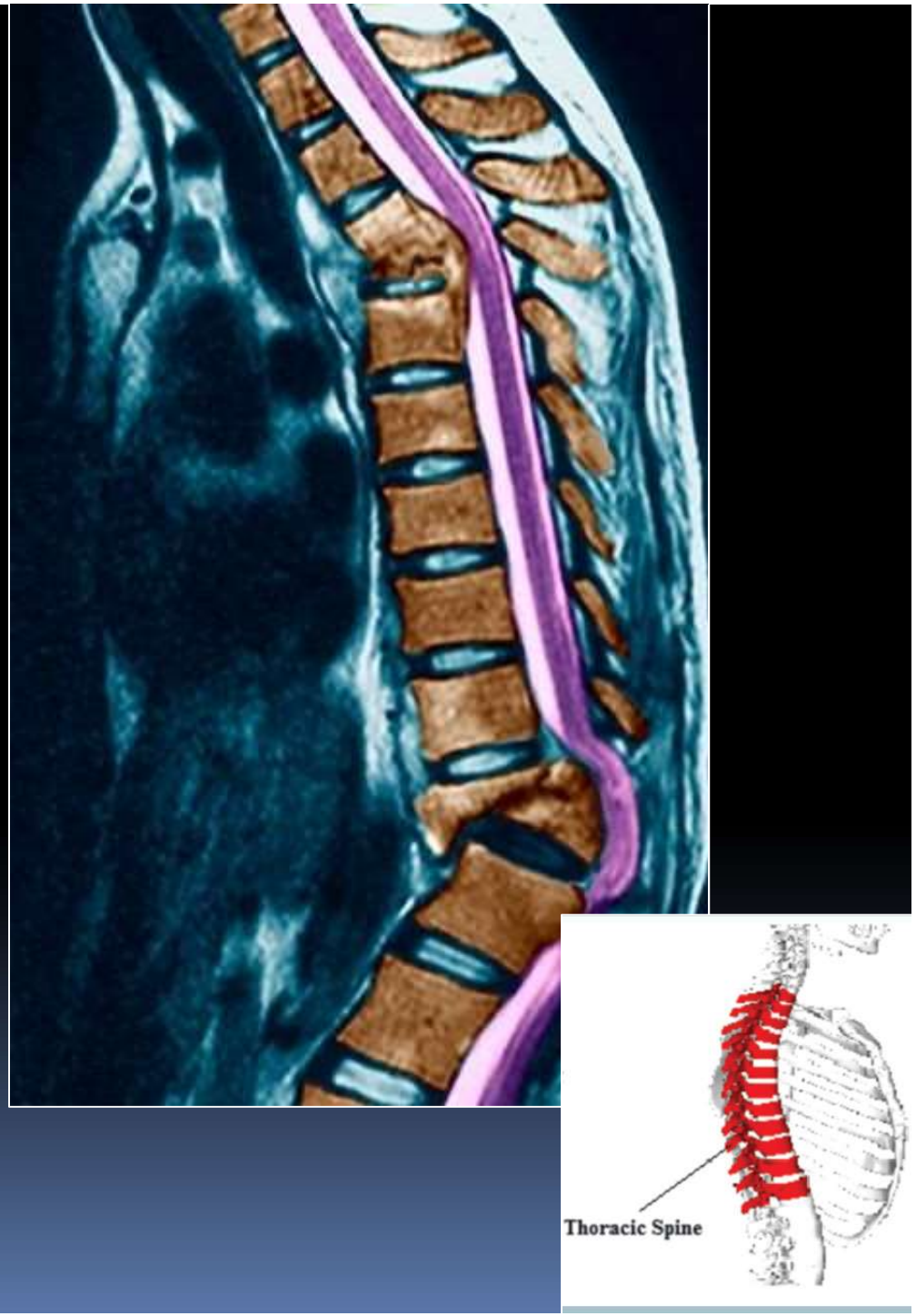
Clinical presentation of spinal TB

- Back pain.
- Lower limb weakness.
- Paraplegia.
- Kyphotic deformity.
- Constitutional symptoms rare compared to pyogenic spondylitis.



TB

- CXR show active infection in <50% of cases of spinal TB .
- May be primary or post primary .
- Diagnosis usually late unlike pyogenic .

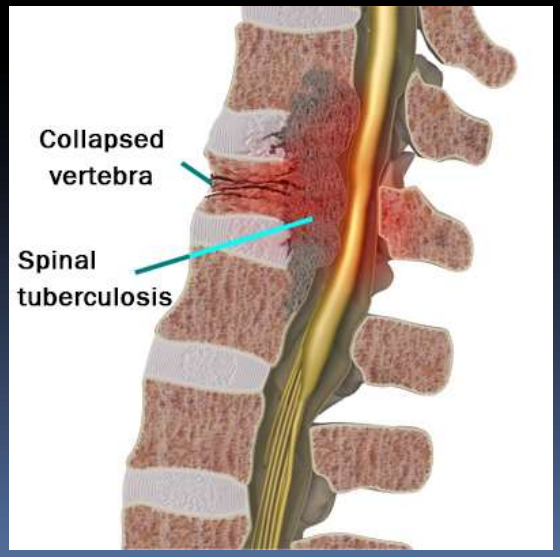


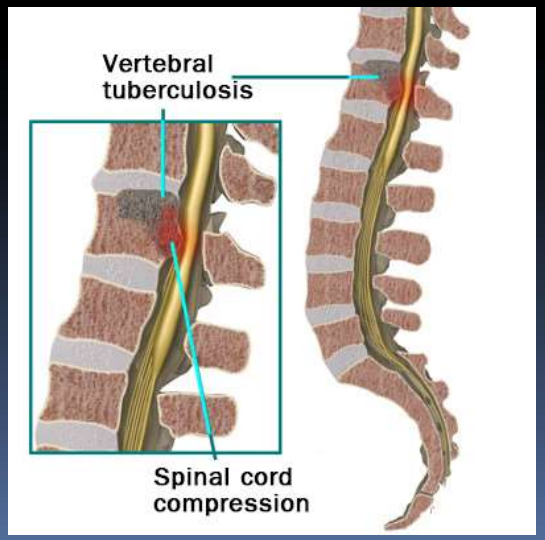
TB SPINAL CORD VERSUS TB VERTEBRAL BODY

Does not usually involve the spinal cord as primary focus.

Usually extra-dural from vertebrae extending into the spinal canal.

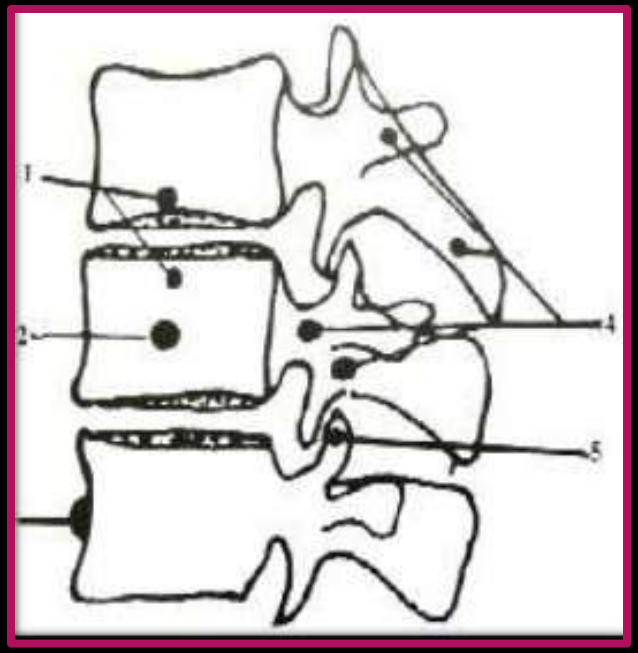
- Usually single lesion.
- .Destructive
- Accompanied by pus.
- May later calcify.

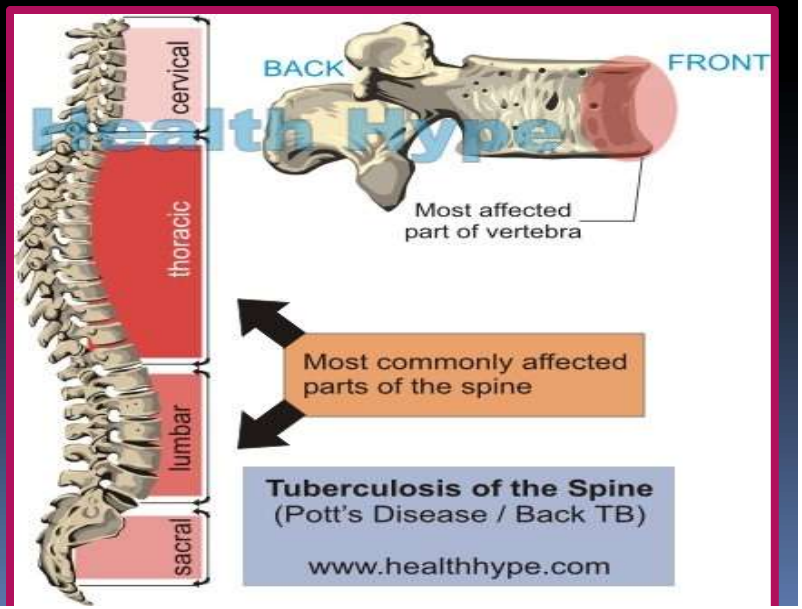




TB spine imaging features

- Initial vertebral foci:
  - Upper or lower disc margin (from arterial spread).
  - Centre of the vertebra (due to venous spread).
  - Anteriorly under the periosteum (from sub-periosteal spread).
  - Appendical (rare).
- Commonest affected: thoracic spine.
- Two or more vertebrae affected (below and above disc).





Usually 2 vertebrae involved.
Disc relatively spared.
Vertebral collapse.
Endplate and vertebral margin irregularity.

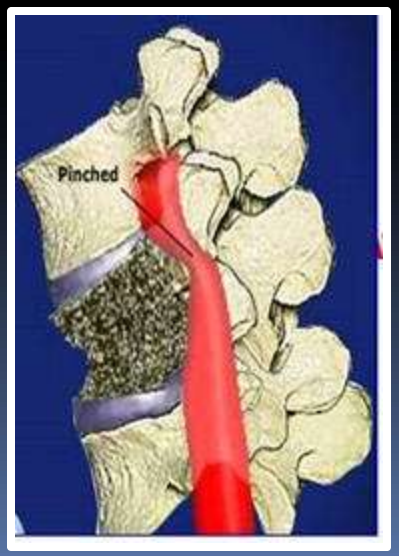
Paraspinal pus collections may be large and tracking.

Extension into spinal canal.

Cord compression and cord edema.

Vertebral calcification.

Gibbus &
Vertebra plana.



Differential diagnosis for TB spine

- Differential diagnosis: Pyogenic spondylitis (PS), brucellosis, fungal, sarcoidosis, lymphoma, metastases .
- Reactive new bone (osteophytes) more in PS.
- Disc destruction is earlier and more marked in PS.
- Calcification less common in PS.

27 Year female with paraplegia, and gibus. MRI: vertebra plana T6 and T7 with preserved disc and paravertebral shadow. Impression n: TB spine.

44 year female with neck pain, and radiculopathy. MRI :
Ring enhancing intramedullary mass: Impression: spinal cod tuberculoma

COMPRESSIVE SPONDYLOTIC MYELOPATHY

Clinical Anatomy and patho-physiology of disc degeneration

- Disc makes up 25% of vertebral column height.
- Nucleus Pulposus: Core
  - Gelatinous.
  - 60-70% water
- Annulus Fibrosus:
  - Outer rings
  - Multilayered fibers

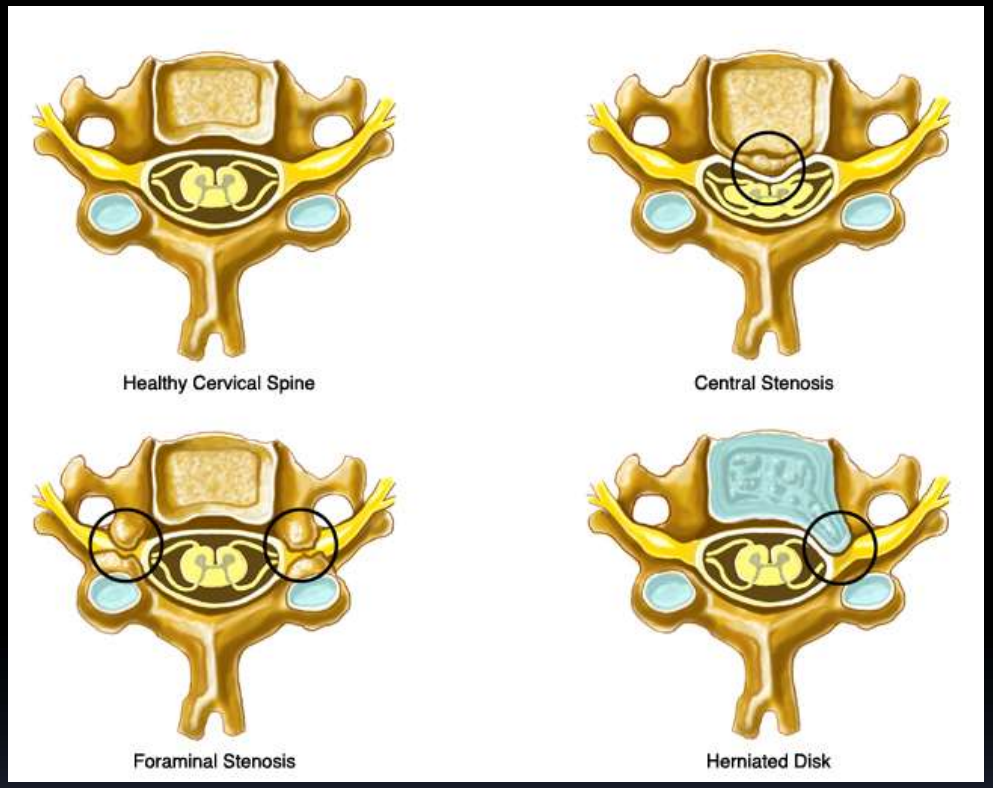
Nucleus pulposus undergoes aging:

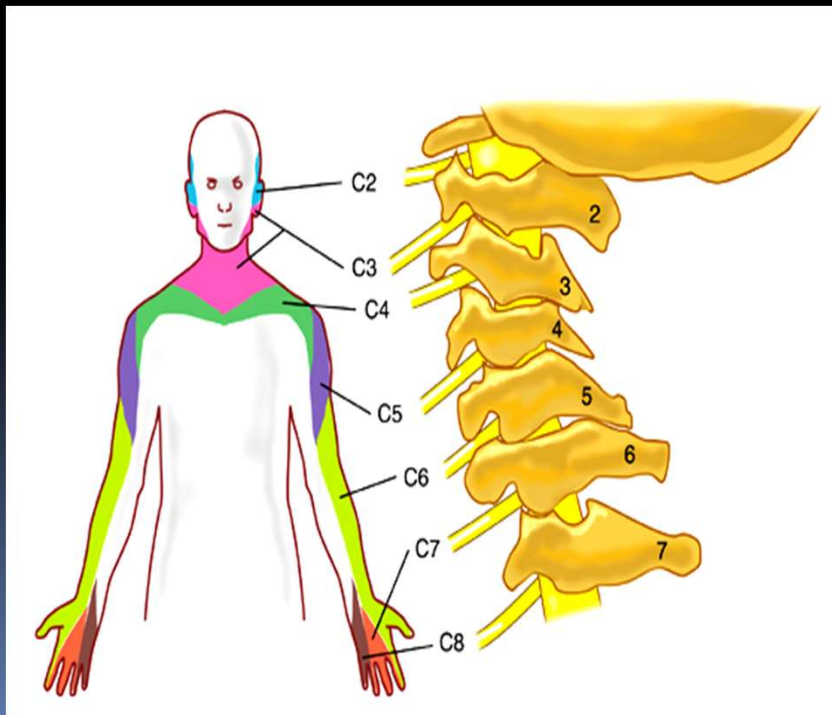
Permanent dehydration (ages 40 – 60)

Aged annulus fibrous may bulge and tear

Tear of annulus leads to herniation of nucleus pulposus

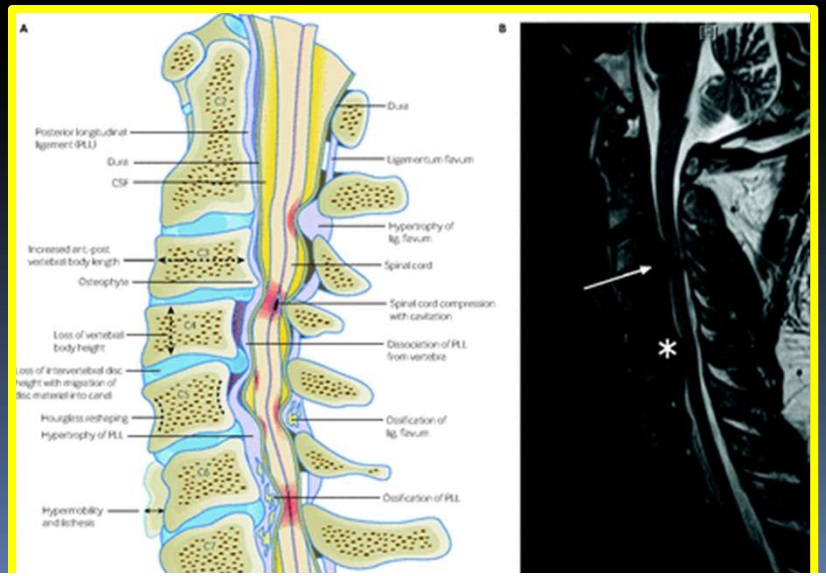
Cervical disc disease leads to compression myelopathy if central and to radiculopathy if foraminal



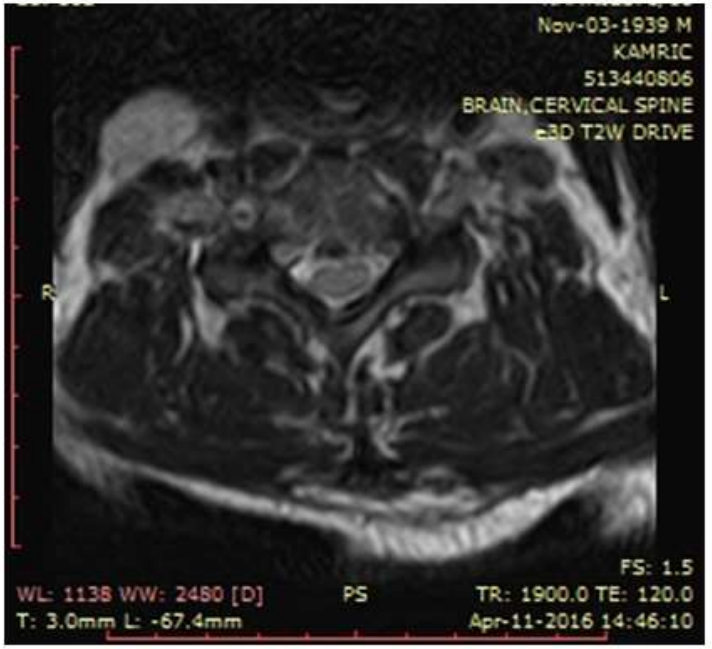


Compressive myelopathy radiological features

- Straightening of lordosis.
- Diffuse degenerative changes: osteophytes.
- Disc: desiccation, thinning, bulge, herniation.
- Spinal canal narrowing.
- Cord: compression, indentation, thinning, T2W hyperintensity.



76 year male with persistent neck pain for one month, radiating to the jaws and head. MRI showed extensive cervical Spondylosis with thinning and T2W-hyperintensity at C3 to C7. Impression : Compressive myelopathy.

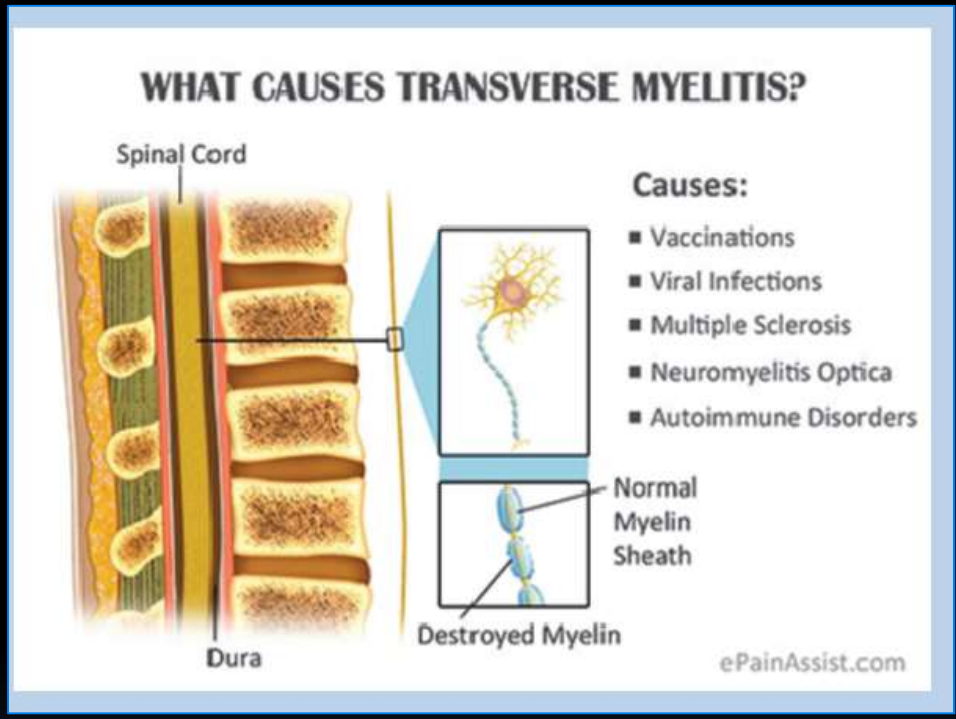


Transverse myelitis (tvm)

- Inflammatory process involving dorsal and ventral cord
- Both genders, two peaks 10-19 and 30-39
- Usually idiopathic
- May be associated with HIV, acute infections, post viral(ADEM) , post vaccination, systemic malignancies, autoimmune diseas
- Multi-segment involvement (more than 3 segments)
- Patient presents with rapidly progressive motor, bilateral sensory, and autonomic dysfunction.
- MRI most sensitive: hyperintensity on T2W and T2WSTIR, may or may not enhance, no restriction at DWI.

TVM: Associated conditions

- HIV/AIDS
- Acute infection (viral)
- Post –viral (ADEM
- Post-vaccination
- Autoimmune
- Malignancies elsewhere



TVM:diagnosis

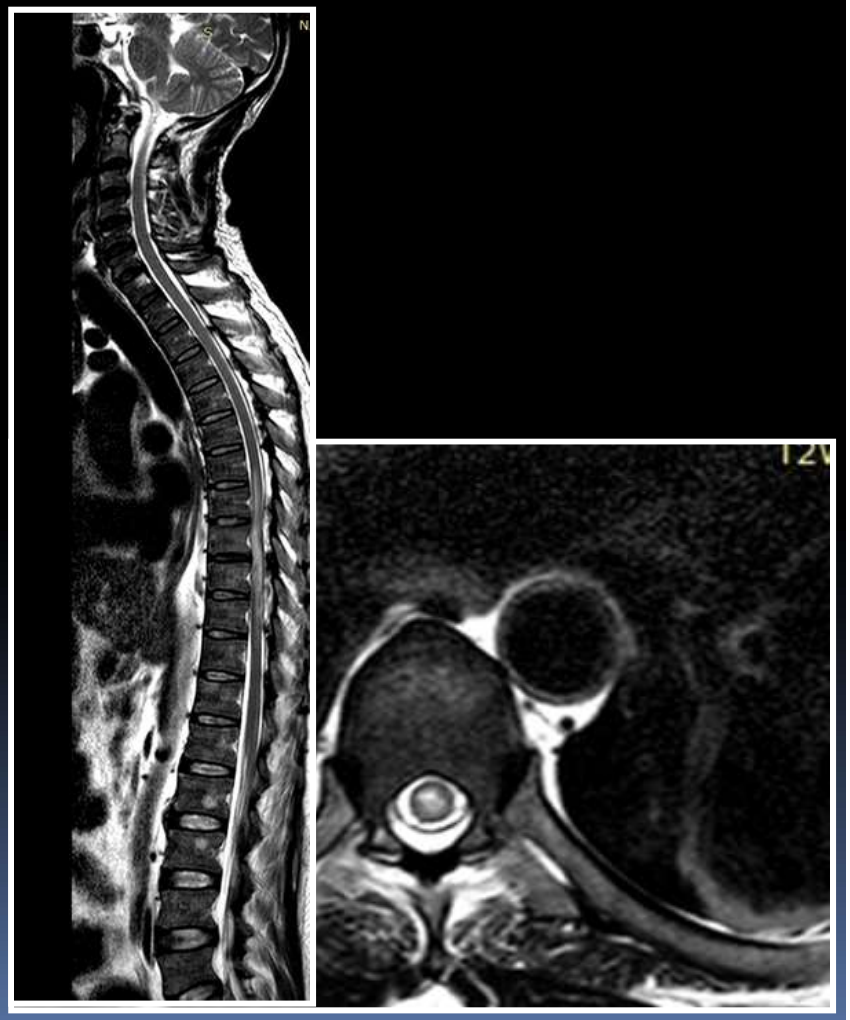
- Bilateral involvement : rapidly progressive motor, bilateral sensory, and autonomic dysfunction.
- Clear sensory level
- CSF may demonstrate CSF pleocytosis or increased IgG index
- Exclusion of other extra-axial structural causes of cord disease by CT/MRI
- History to r/o past cord irradiation

TVM: Role of imaging (MRI)

- Assess for TVM MRI features
- Exclusion the following
  - Space occupying intra and extra axial cord pathology
  - vascular ischemia which is usually anterior cord and symmetrical
  - AVF which may show flow void
  - Brain MRI to exclude MS, NMO

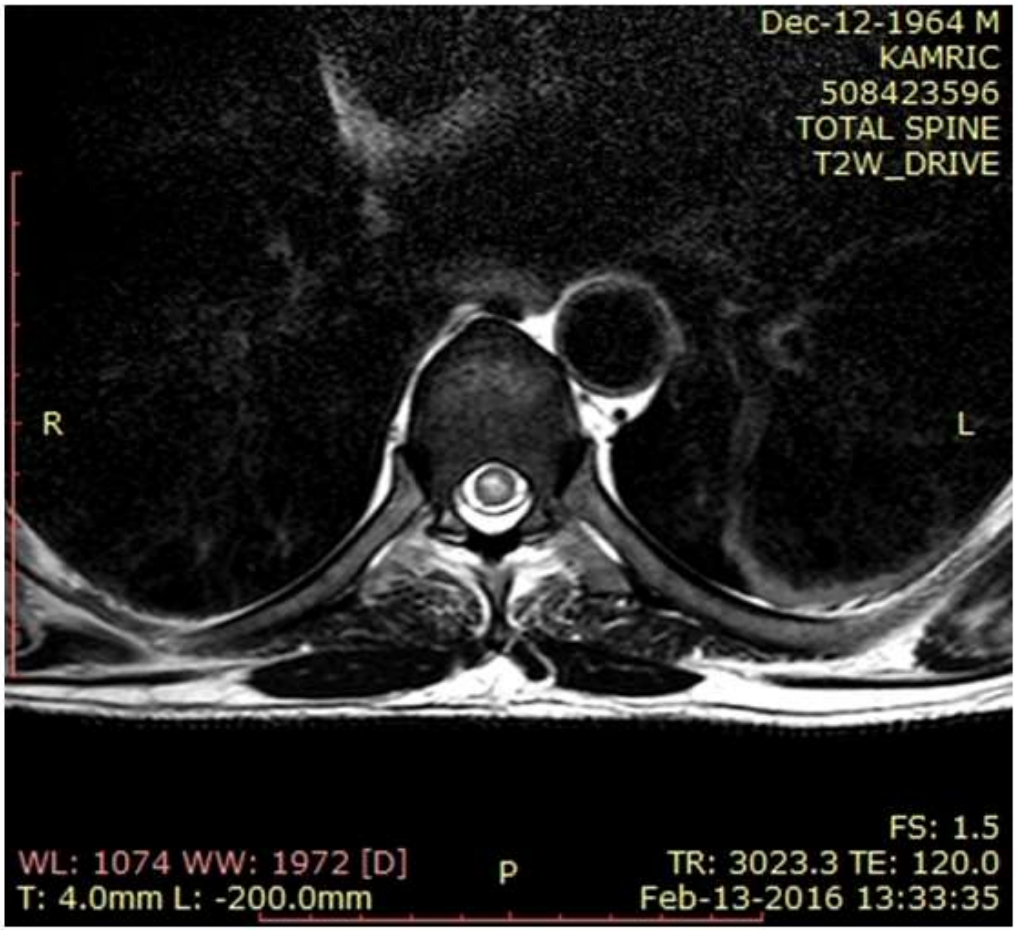
TVS: MRI features

- MRI may be normal in up to 40%
- Appearances may vary
- Usually up to 3-4 segments but may be more
- Usually dorsal and ventral cord involved (> 2/3 of axial section of cord).
- Cord may be swollen or normal
- **T1:** iso/ hypointense
- **T2:** slight to moderate hyperintensity but may be iso
- **T1 W + gad variable enhancement**



TVS differential diagnosis

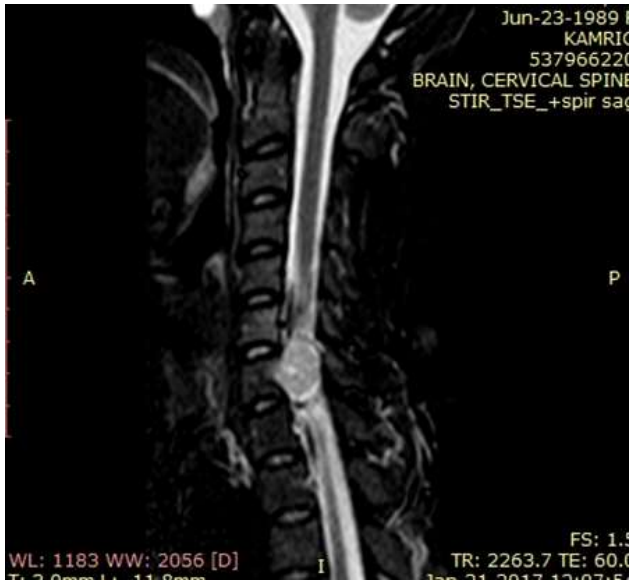
- MS (shorter segment, brain lesions)
- ADEM (younger age, shorter segment as MS, brain involvement)
- Vascular ischemia (usually ventral cord, grey matter, DWI –hyperintense)
- Vit B def. (usually posterior)
- Intramedullary tumour (cord expansion, contrast uptake).

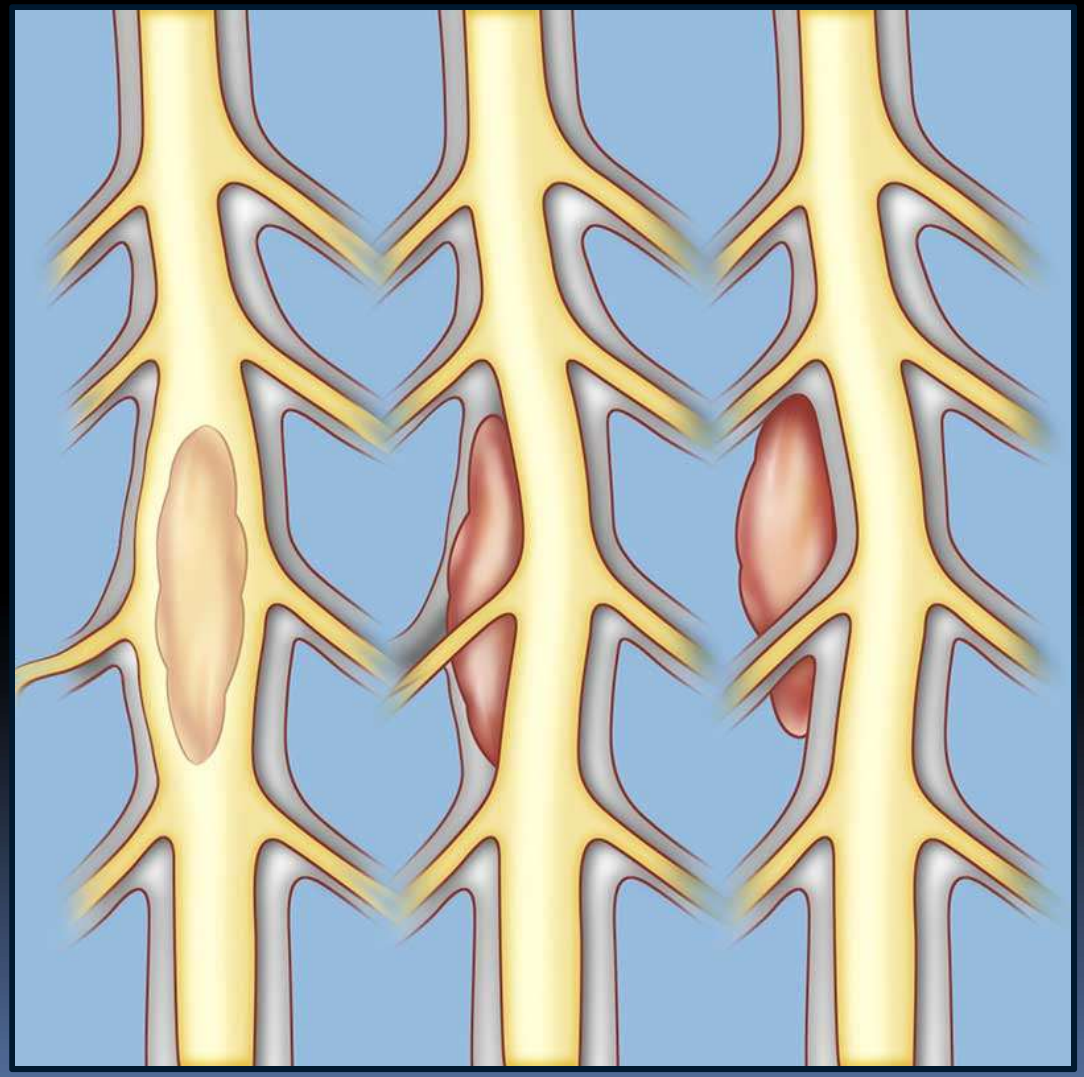


55 year HIV positive male developed inability to pass urine, paraplegia and sensory level. MRI: long segment of central cord T2W and T2WSTIR hyperintensity stretching from the mid T5 vertebral body to the inferior border of T10. Diagnosis: Transverse myelitis.

SPINAL TUMORS

- **Spinal tumors:**
  1. **Extradural**
  2. **Intradural**
  3. **Intramedullary**

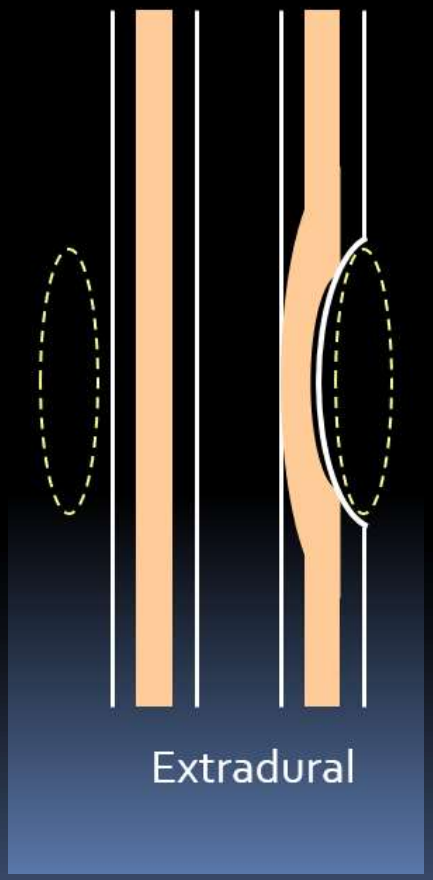




Extradural tumors

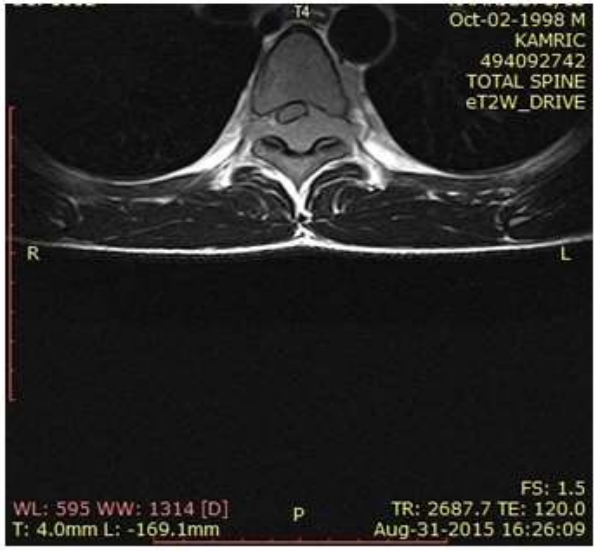
BENIGN

- Neurofibroma.
  Schwannoma.
- Osteochondroma.
- Dermoids/ epidermoids.
- Vertebral body: hemangioma.
  Osteoblastoma.
  Aneurysmal bone cyst.

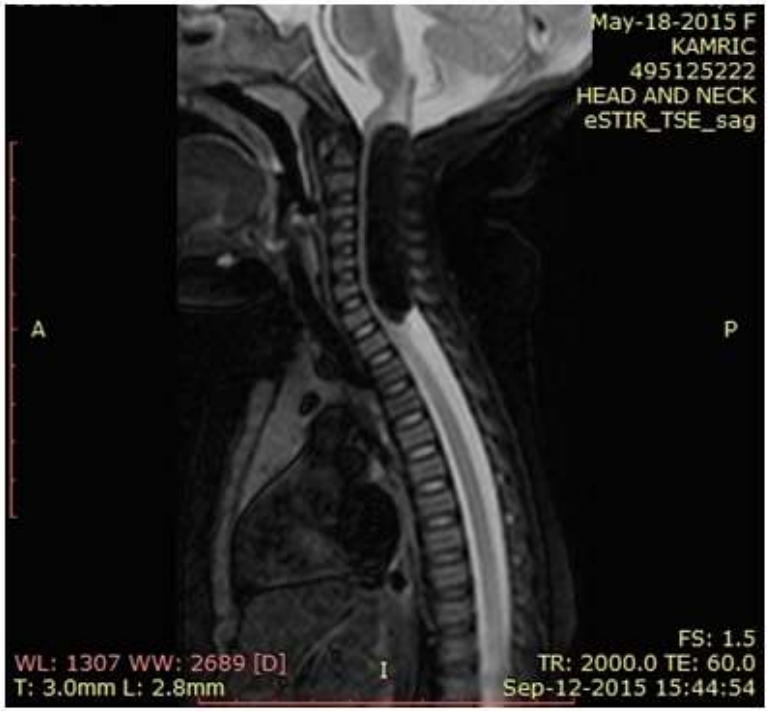


MALIGNANT

- Metastases (commonest)
- Lymphoma (HIV/AIDS)
- Myeloma
- Sarcoma
- Chordoma

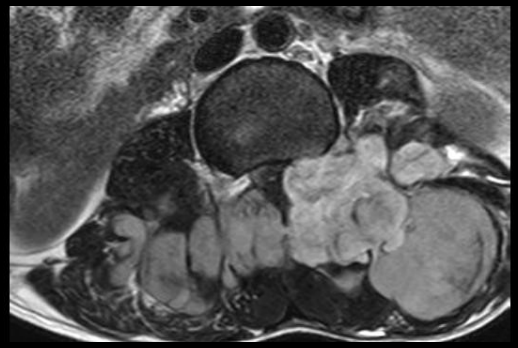


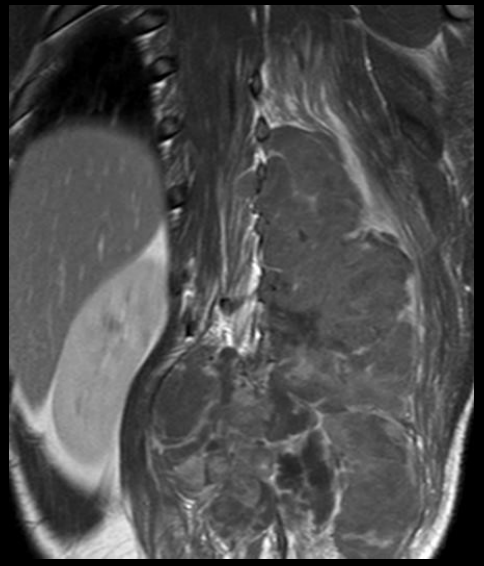
Multi-segment intra-spinal extradural lesion compressing and displacing the thecal sac anteriorly. This is most likely a neoplasm possibly lymphoma or leukemia.



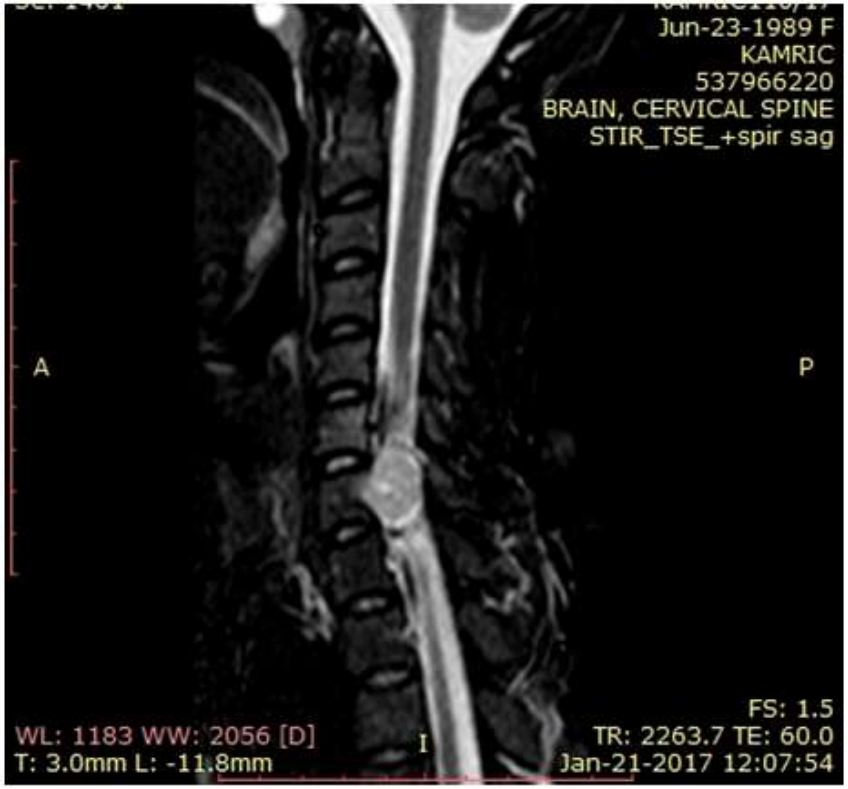
3 months female with limb weakness: Intradural- extra medullary sausage-shaped lesion. Fat signals and cord compression : Lipoma.

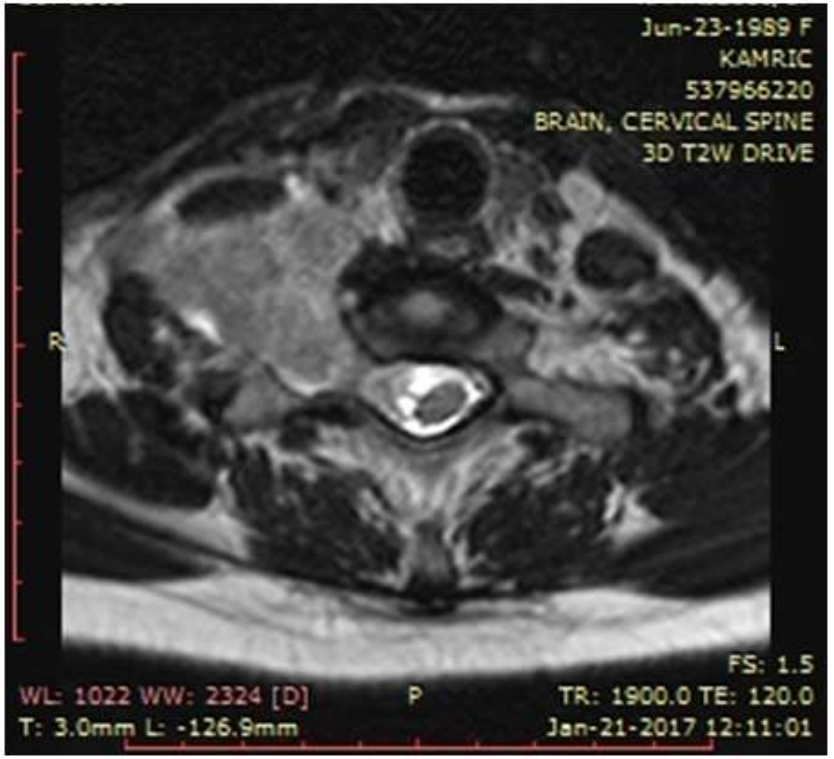
25 YR M back mass for 2 yrs, difficulty in walking, incontinence





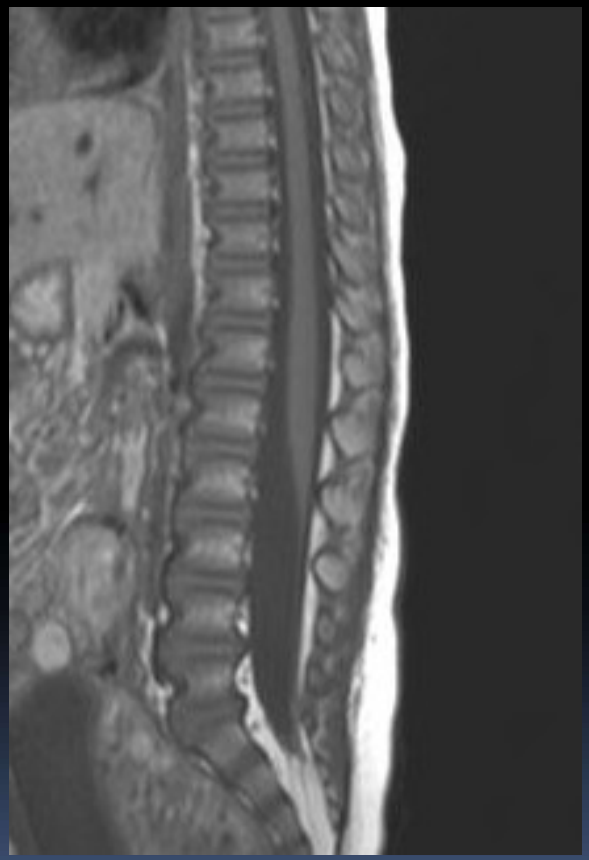
Multi-segment extradural lesion, T12 to L3, with intraspinal extension and cord compression. This is most likely a neoplasm possibly neurofibroma or lymphoma.

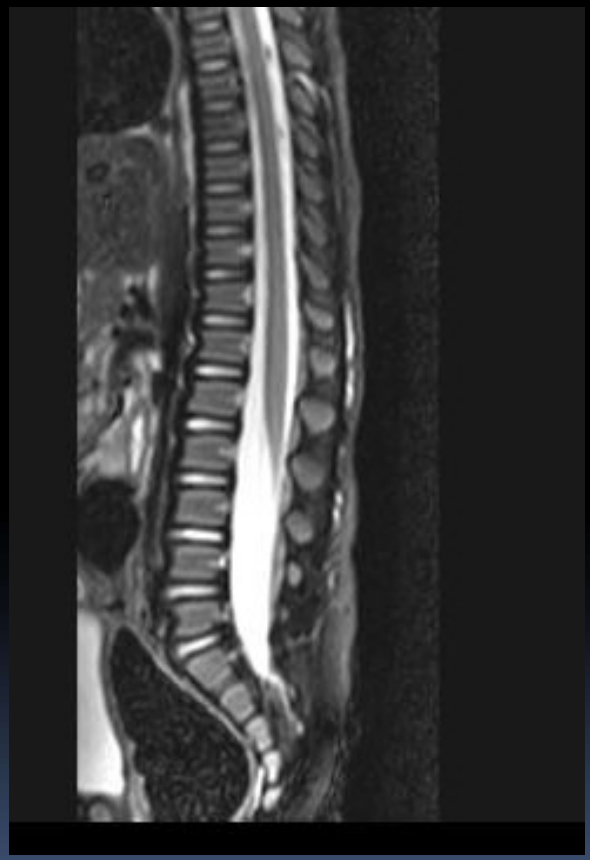




27 year female with sudden onset of clawing of the right fingers. MRI shows a right paravertebral mass with "dumb-bell" trans-foraminal extensions into the spinal canal. Diagnosis: nerve sheath tumor most likely schwannoma.

1.5 YRS M, constipation, lower limb weakness, dorsi-planter flexion both feet? Tethered cord



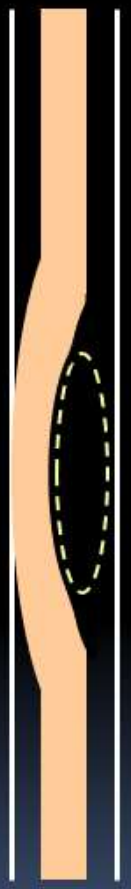


- **Lower location of the conus medullaris (L3) suggesting tethering of the cord.**

Intradural extramedullary tumors

Menigiomas

80% the thoracic region.
80 % :middle aged women.
Calcifications +/_
Hyperostosis ++
May extend outside spinal canal.
Isointense on T1/T2.
Gad ; enhance



Intradural Extramedullary

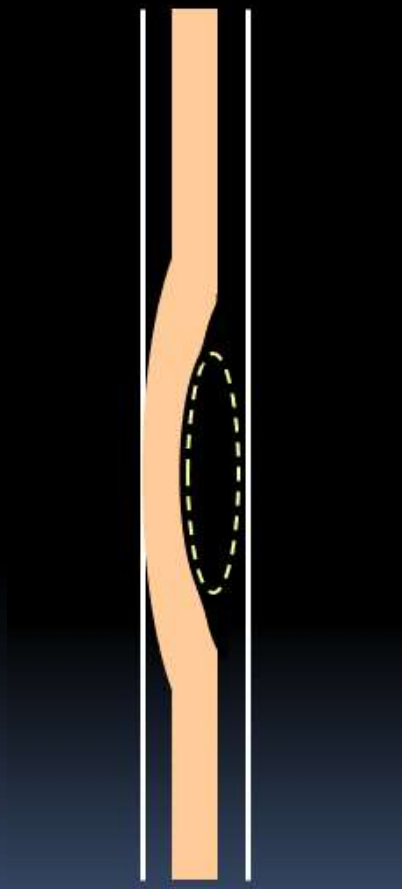
Neurinomas

Occur at any level
Almost any age
F:M = 1:1.
Calcifications +/_
Diffuse thickening of the spinal roots.
May extend outside spinal canal.
Hyperintense on T2W.
Gad: enhance

Intradural extramedullary tumors

Intradural-extramedullary

- Nerve sheath tumor
  - Neurofibroma
  - Schwannoma
- Meningioma
- Drop Metastasis



Intradural Extramedullary

Menigiomas

80% the thoracic region.
80 % :middle aged women.
Calcifications +/_
Hyperostosis ++
May extend outside spinal canal.
Isointense on T1/T2.
Gad ; enhance

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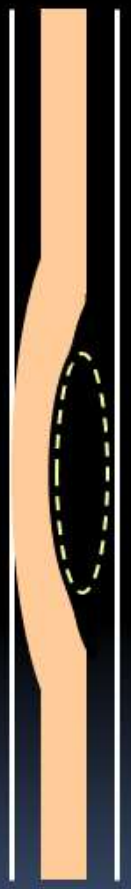

Intradural Extramedullary

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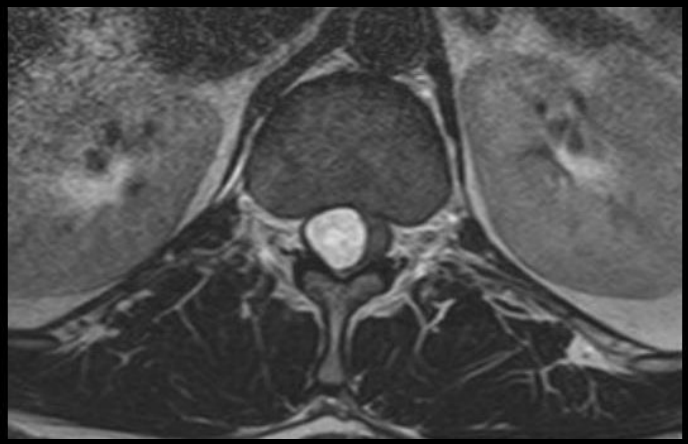
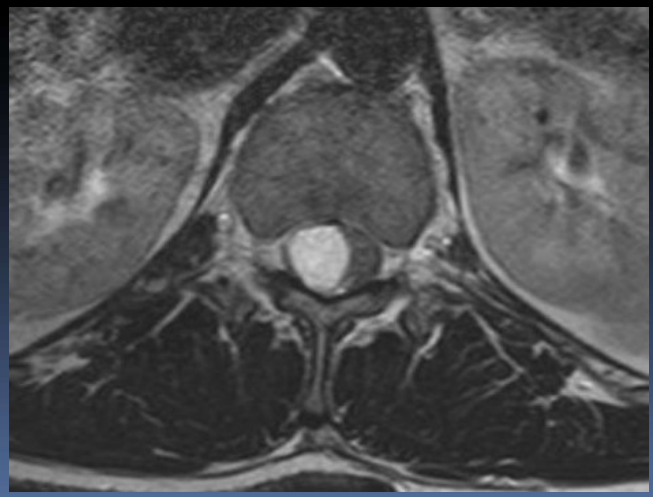
34 M low back pain for 3 years radiating to lower limbs

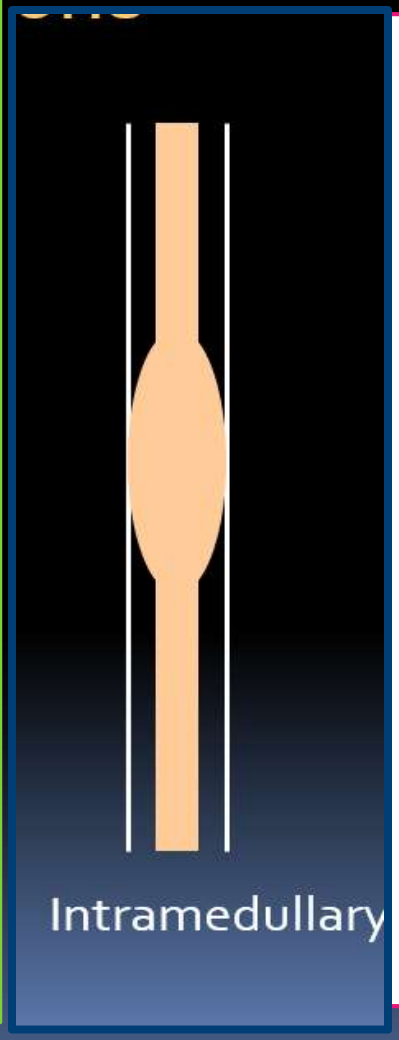




- **Expansile eccentrically located intradural extra-medullary lesion, at the level of T12/L1.. Ependymoma or astrocytoma**

INTRAMEDULLARY TUMORS

- **Glioma**
  - Ependymomas
  - Astrocyctoma
- Spinal capillary Hemangioblastoma
- Metastases
- Primary lymphoma

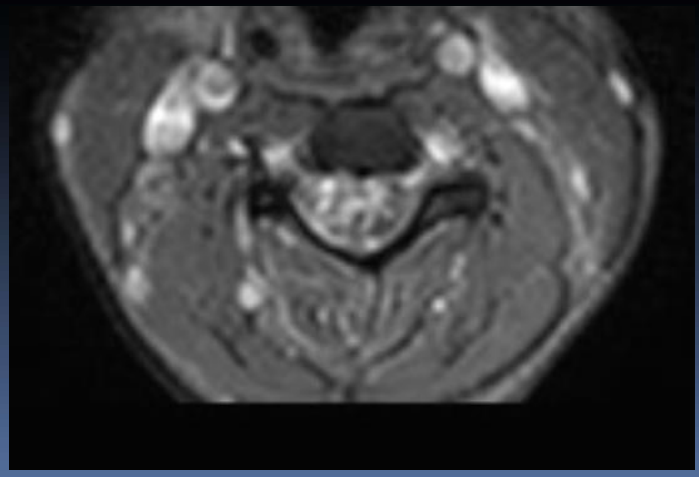


Ependymomas

- Mostly at filum terminale FT
- Commoner in children
- Usually the mxyopapillary
- Extra-dural rare (pre-sacral/ sacral mass)
- Prone to metastases

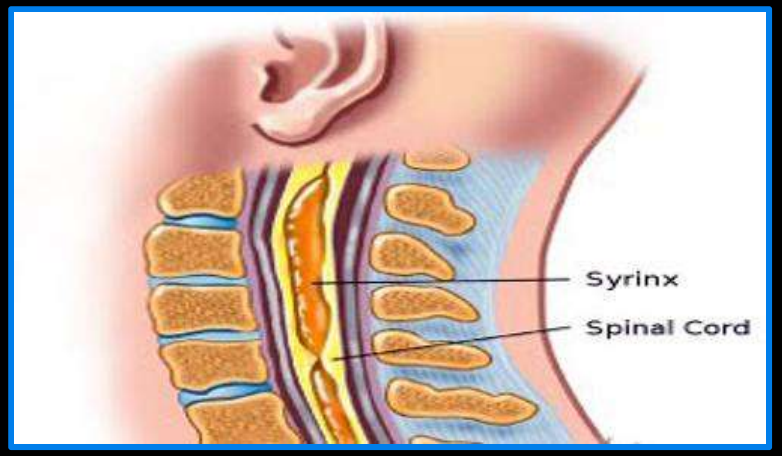
18 F, quadriplegia, incontinence, sensor level C3, vascular-carvenous malformation.

- Intramedullary lesion with morphological and signal characteristics characteristic of a vascular lesion . This is most likely a spinal cord cavernous malformation.



Syringomyelia (SM)

- Cystic collection of fluid in the spinal cord around the central canal.
- Hydromyelia (HM) is dilatation of central canal.
- SM and HM difficult to differentiate by imaging.
- Usually in cervical and upper thoracic but may extend to conus medullaris.



Syringomyelia : Causes

Congenital

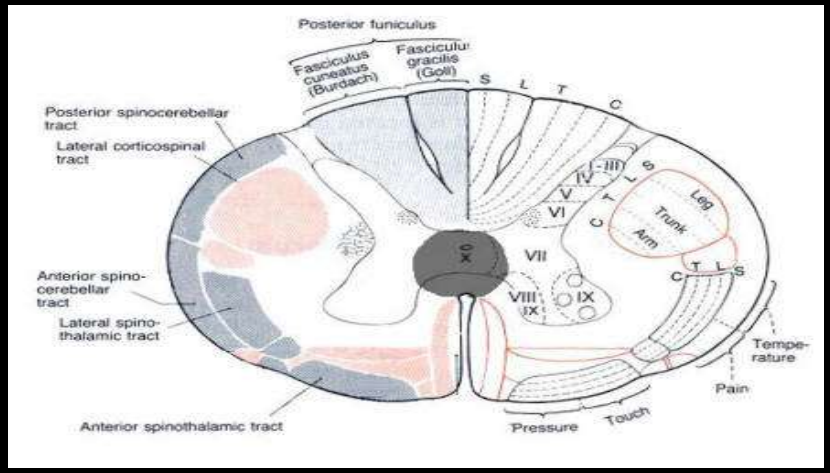
- Myelomeningocelle
- Chiarri malformaitons,
- Dandy-Walker,

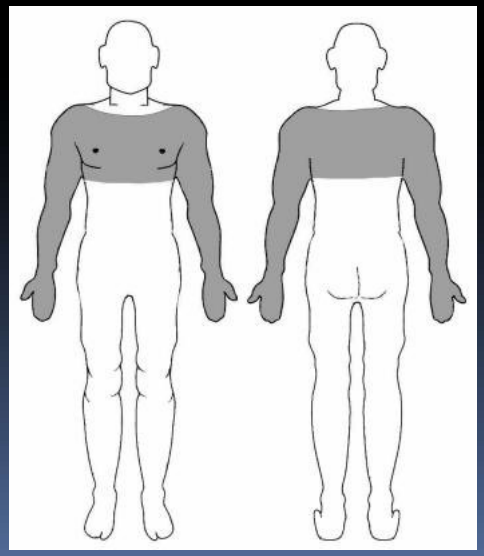
- Acquired
  - Post traumatic
  - Post inflammatory
  - Associated with tumors
  - Compressive myelopathy

Syringomyelia: Symptoms

Symptoms depend on level and extent of syrinx.

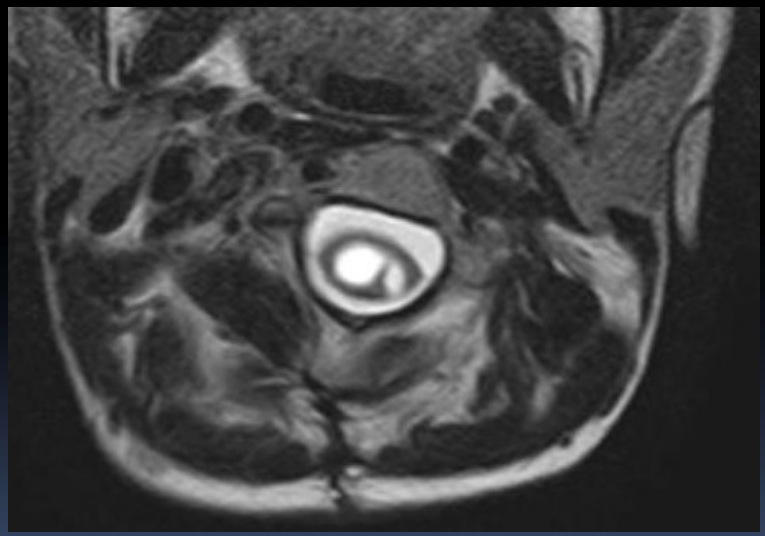
- "Cape"-like loss of pain & temperature sensation along the back and arms- 'suspended sensory level'
- More motor weakness in upper compared to lower limbs
- Gradual atrophy of upper limbs starting with hands.
- May end with "claw-hand+





Cape-like sensory loss to pain and temperature in a small central cord lesion in the cervical and upper thoracic cord.

16 YRS M, difficulty in swallowing: basillar invagination, tonsillar herniation, Anorld-C1.5 malformation



- **Basillar invagination, Slight downward descent of the medulla and tonsillar herniation associated with a long cervico-thoracic syrinx in keeping with *Chiari 1.5 malformation .***

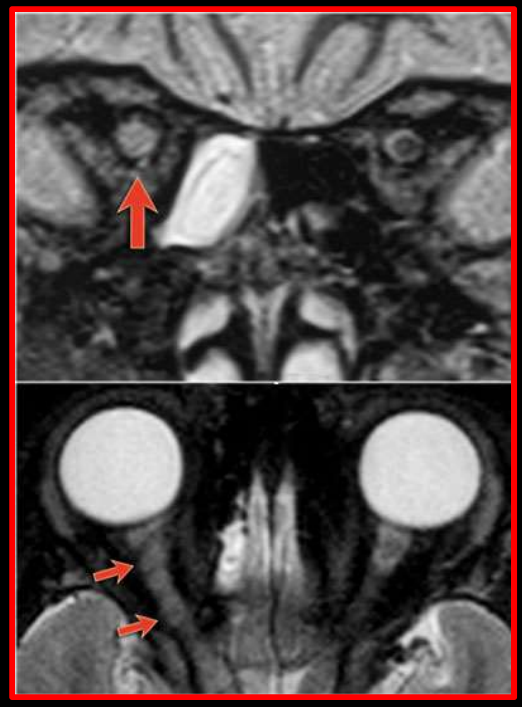
29 year old male with scoliosis and right sided weakness. MRI: Wide foramen Magnum and tonsillar and cerebellar herniation compressing the proximal cervical spinal cord plus extensive syrinx.

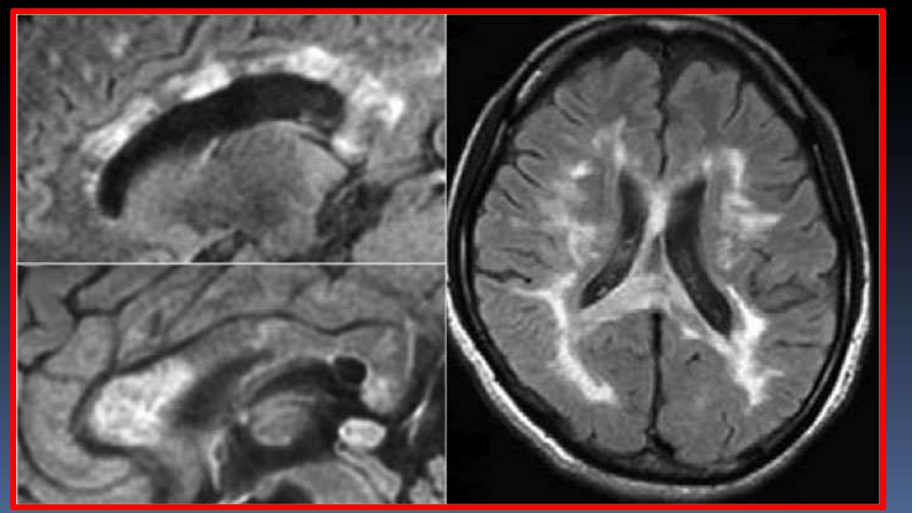
NEUROMYELITIS OPTICA

- Neuromyelitis Optica (NMO) : autoimmune demyelinating disease
- Specific auto-antibody, the NMO-IgG against the aquaporin-4 water channel.
- Closely related to neuromyelitis optica spectrum disorder (NMOSD)
- NMO presents classically as triad: optic neuritis, extensive myelitis and positive anti-AQP4 antibody
- Presentation: blindness and paraplegia.
- Relapsing-remitting ; asymptomatic periods
- Patients 41 years +
- M:F =1:9

NMO MRI optic nerve & brain appearances

- Optic nerve up to chiasma swollen, T2W – hyperintense and enhance of T1.
- Brain lesions do occur and often are distinct from those seen in MS.
- Ovoid periventricular white matter lesions and extensive corpus callosum involvement.
- Corticospinal tract involvement



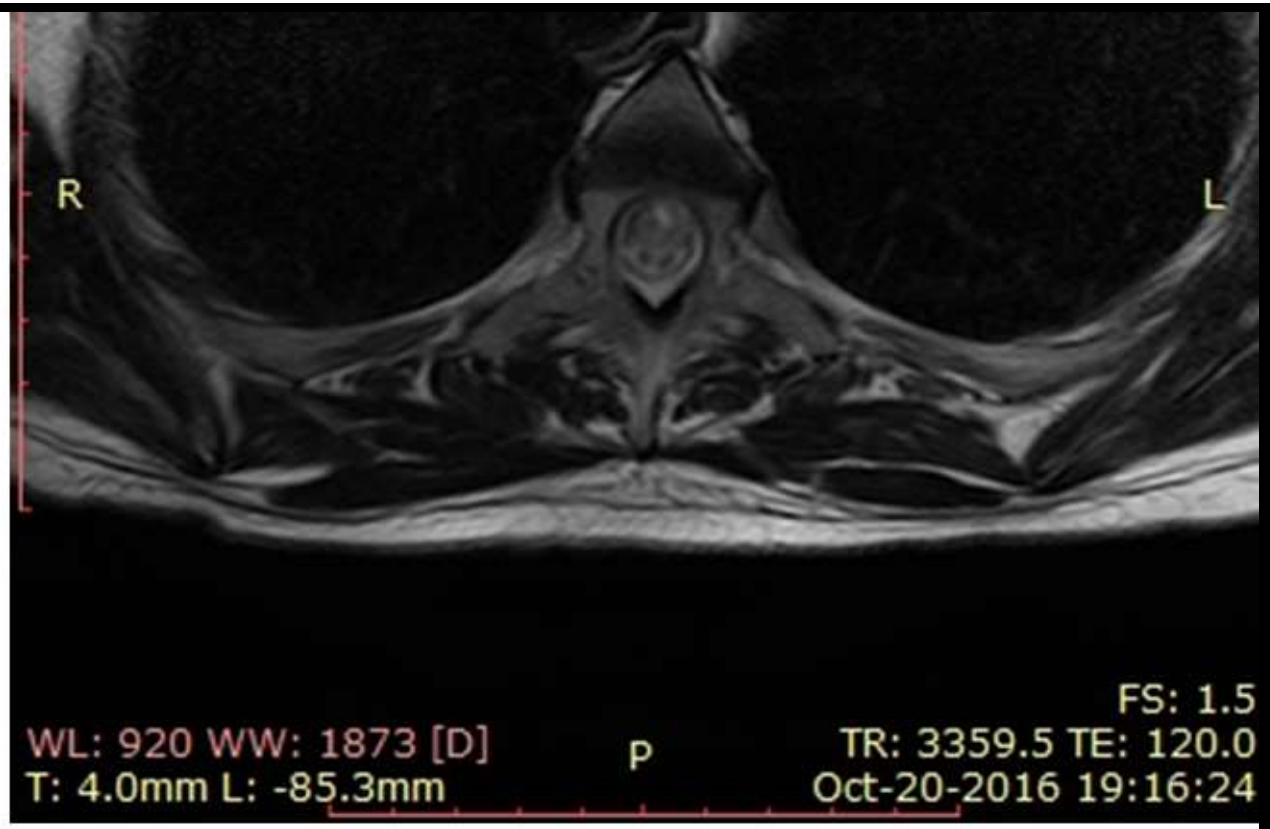


http://www.radiologyassistant.nl/en/p4f789faf60fa4/spine-myelopathy.html

NMO spinal cord involvement

- Demyelination of the spinal cord.
- Resembles TVS-myelitis: 4 -7 vertebral segments.
- May involve full axial cord diameter.
- Differential diagnosis:
  - MS
  - Tvs myelitis
  - Sucas syndrome
  - Adem

Radiology Assistant

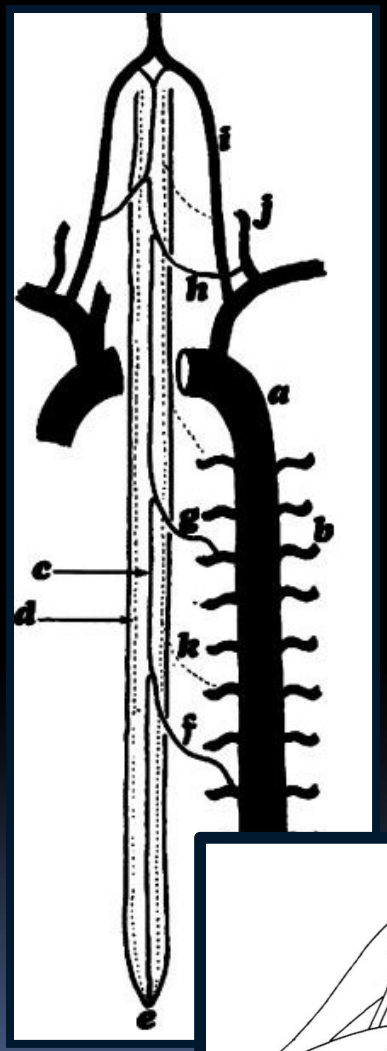


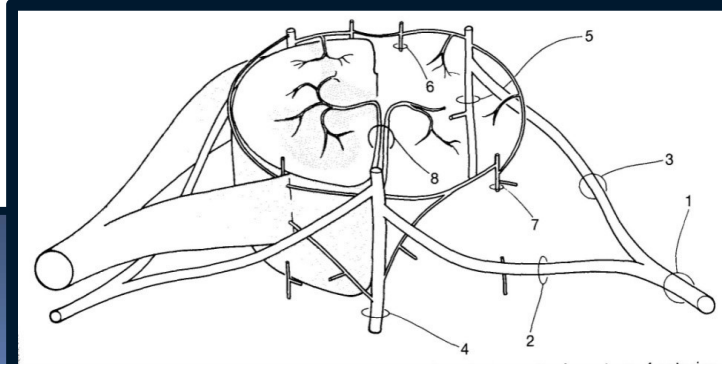
40 year old female, with blindness both eyes, left hemiparesis and abnormal sensation both sides of the body. Brain MRI showed bilateral optic neuritis Spine MRI shows a long segment of demyelination largely in the left lateral column. Diagnosis Neuromyelitis Optica (NMO).

Vascular: cord ischemia

VASCULAR ANATOMY OF SPINAL CORD

- Anterior spinal artery (ASA) is the most important of the axes
- ASA supplies , major portion of the cord
- ASA supplies motor cells of the ventral horns.
- .





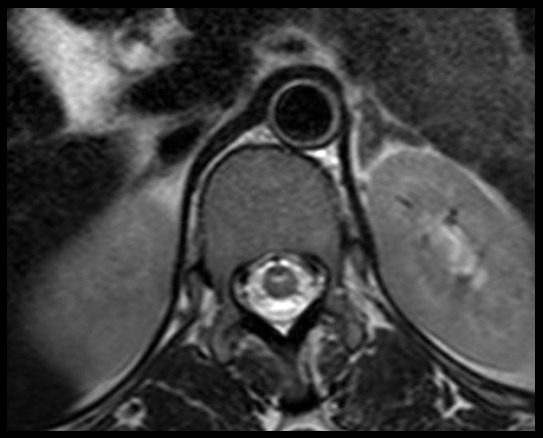
Anterior-spinal-cord Ischemia syndrome: symptoms

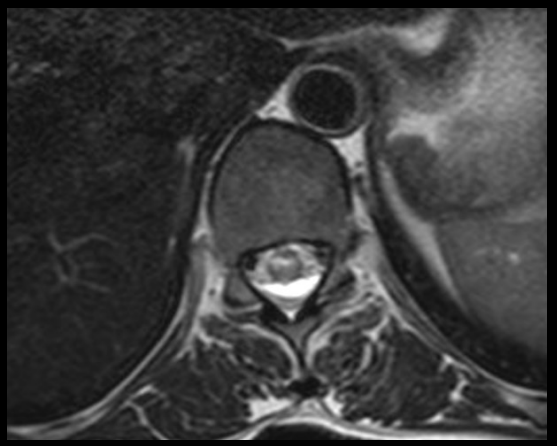
- Commonly manifests in the ventral columns:
- Causes: trauma, hypotension, congenital cardiac anomaly, aortic aneurysm, post surgical.
- Symptoms develop rapidly between 12-72 hours
- Symptoms depend on which artery :anterior Vs. posterior, anterior commonest.
- Severe back pain, sensory (pain and temperature), bladder control & bowel control loss .

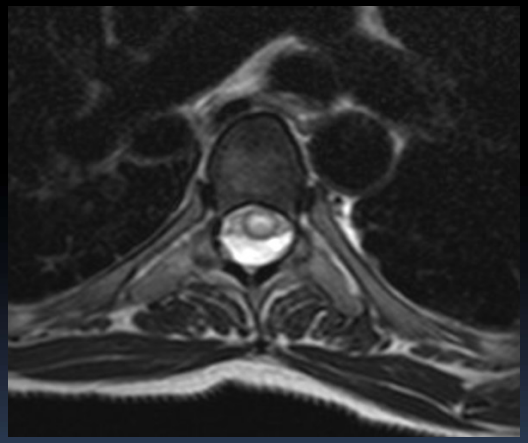
Spinal cord ischemia: MRI appearances

- depend on artery involved
- Swelling and T2W-hyperintensithy common in acute stage
- For ASA: "Owl-eye" appearance of bilateral ventral column ischemic edema.
- At times the anterior horn cell ischemic edema gives a sharp T2W-hyperintense line "pencil-line" running anterior.
- Posterior spinal artery is usually unilateral

40 YR F, HIV, sudden onset of lower limb weakness, incontinence, constipation







- Bilateral T2W, T2WSTIR- hyperintensity involving the anterior columns, from the level of T_4 to the conus medullaris. Vascular cord ischemia r/o TVS-myelitis

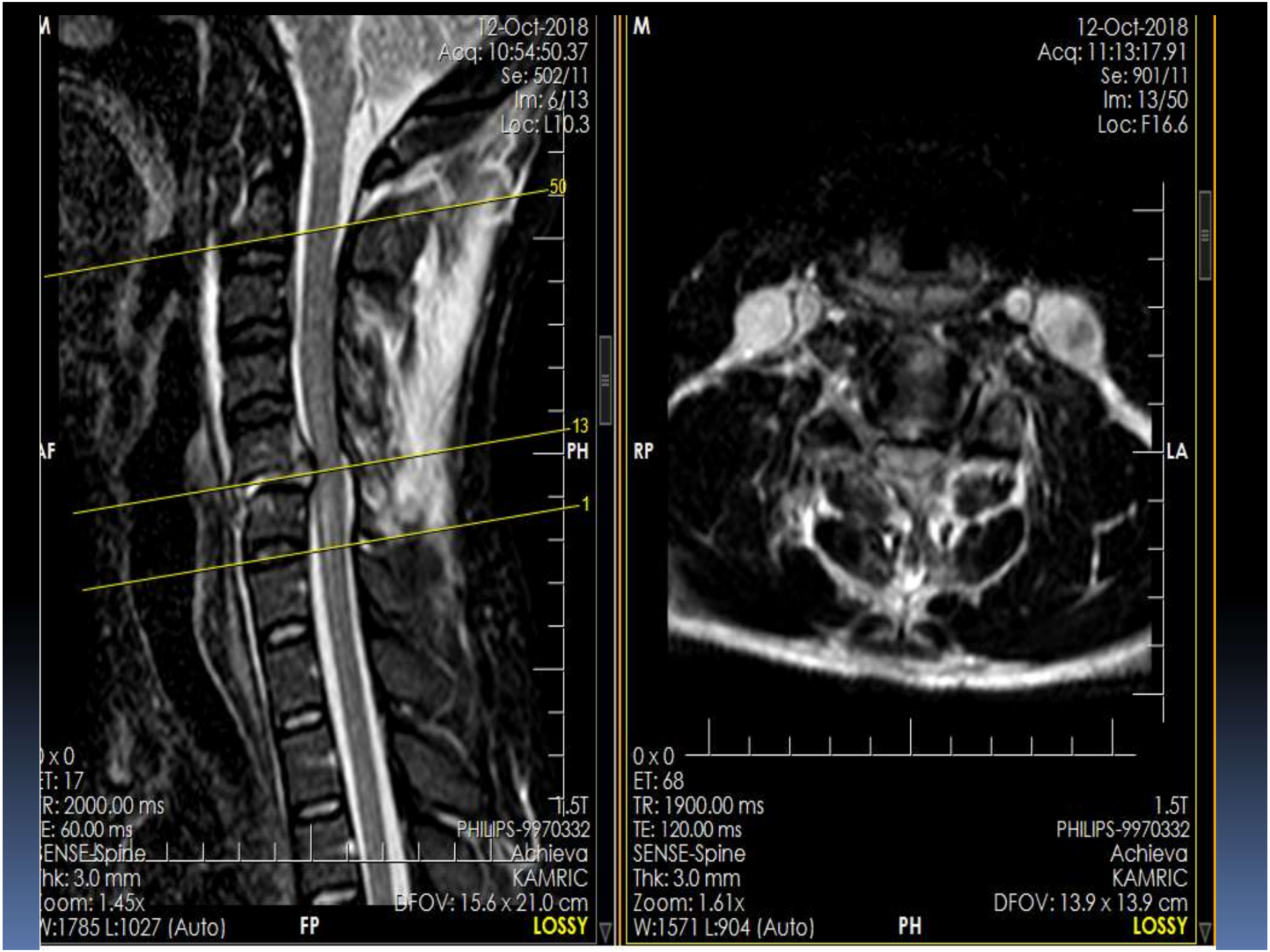
14 year female who developed paraplegia and urine incontinence following secondary ASD closure and mitral valve repair. She had had cardiac arrest during surgery and excessive post-operative bleeding. MRI: bilateral T2W, T2WSTIR-hyperintensity involving the ventral (anterior) columns from the level of T2 vertebra down to the conus medullaris. Impression: Vascular myelopathy.

TRAUMA

- ≈ 3 % of patients who present to the emergency department as the result of a motor vehicle accident or fall have a major injury to the cervical spine.
- Cord damage may be due to direct trauma (laceration,contusion, intramedullary hemorrhage)
- Mechanical pressure by extra-dural hematoma , bone or disc fragemnts.

Stable single column Vs Unstable two column injuries

- Interspinous ligaments suggesting a.
- Posterior longitudinal ligament tear
- Ligamentum flavum tear
- Ligamentum nuchae tear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Zoom: 1.61x
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1.5T
PHILIPS-9970332
Achieva
KAMRIC
DFOV: 13.9 x 13.9 cm
LOSSY

CONCLUSION

- MRI is the most informative imaging for spinal cord disease.
- High resolution axial images are important in addition to sagittal
- Knowledge of anatomy is key.
- Must relate clinical presentation to the MRI findings.
- Common causes in our environment: Spondylotic -compression myelopathy, TB spondylitis , Transverse myelitis and Spinal tumors.

THANK YOU