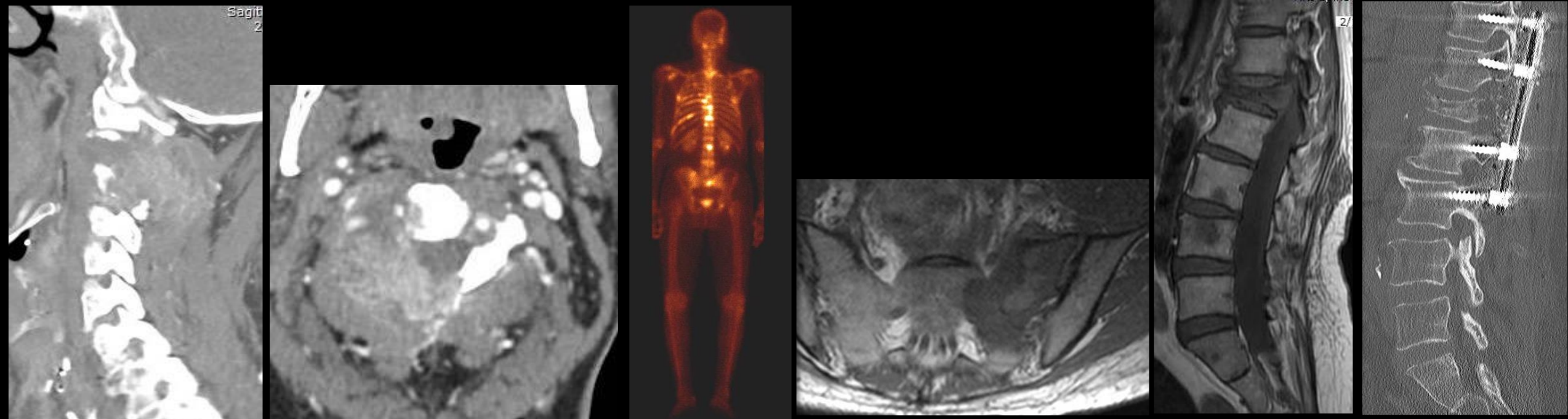




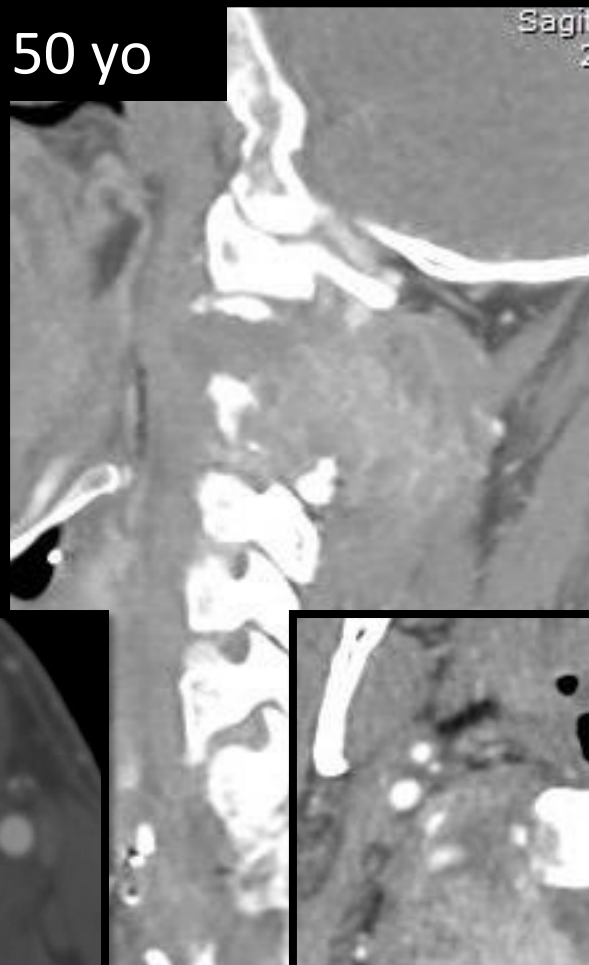
Spine: Tumor

Wende Gibbs, MD
Barrow Neurological Institute

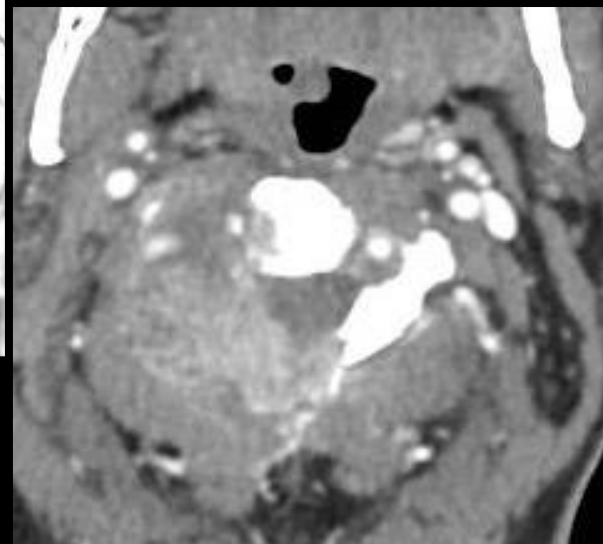
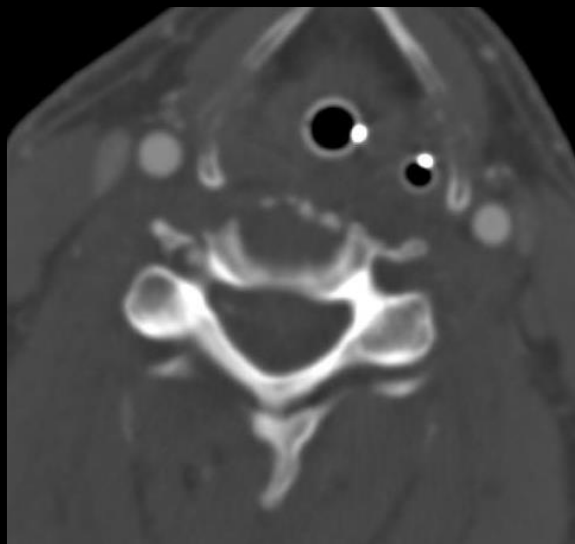
33 yo



50 yo

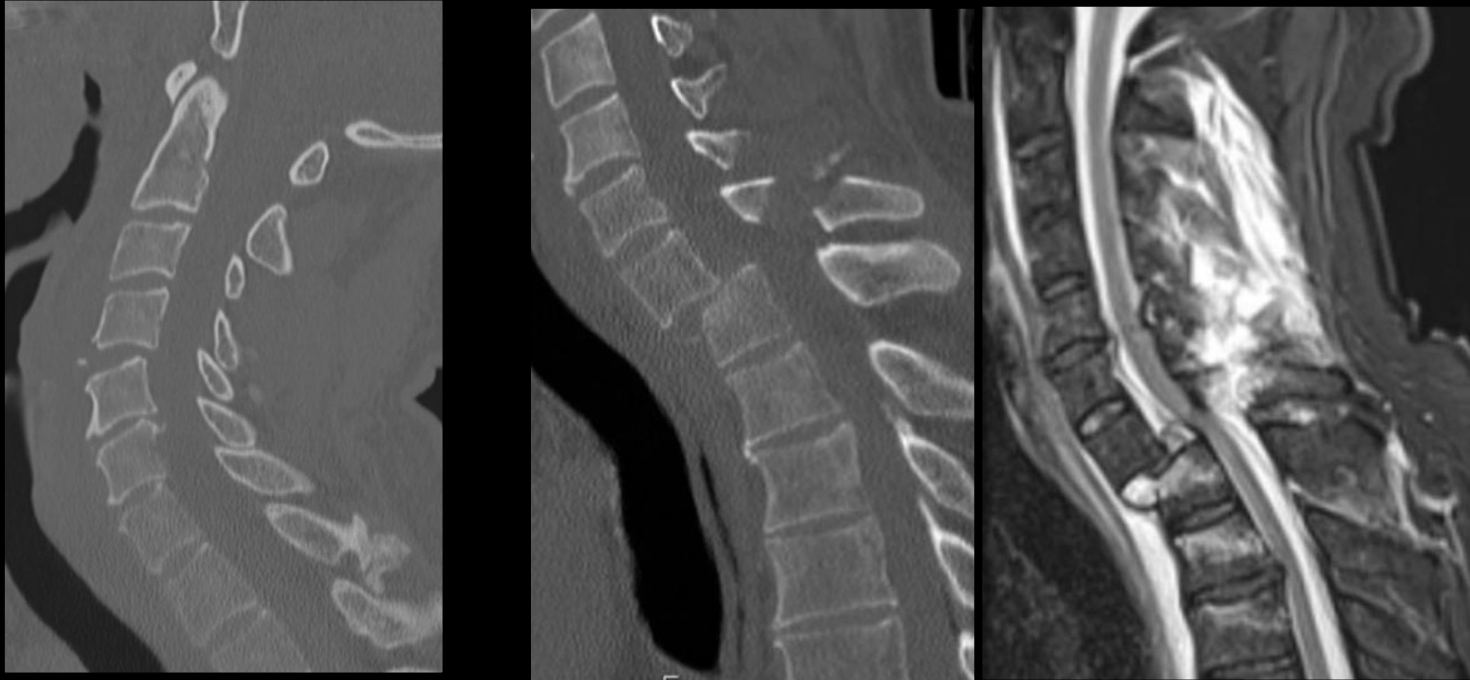


85 yo

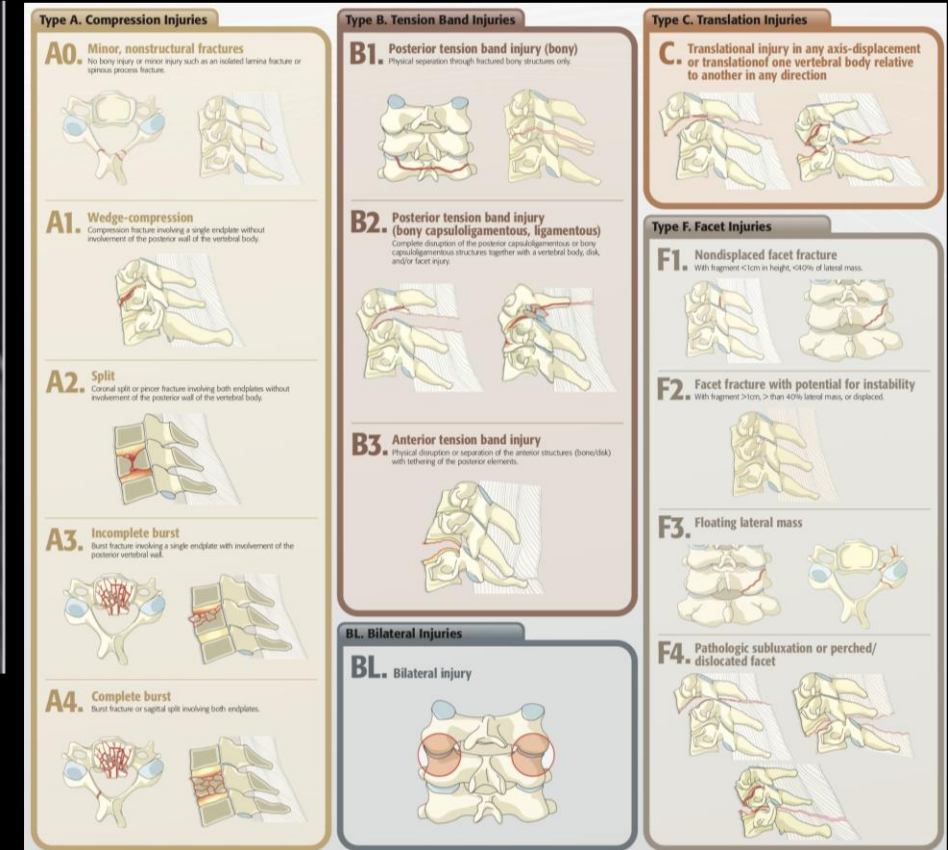


What matters in life?

Spinal Column Failure: Trauma



- What matters?
 - Correction of one problem
 - Alignment, tension bands, discs
- Young, healthy patients
- Fewer comorbidities, treatment unlikely to fail





One week after fall



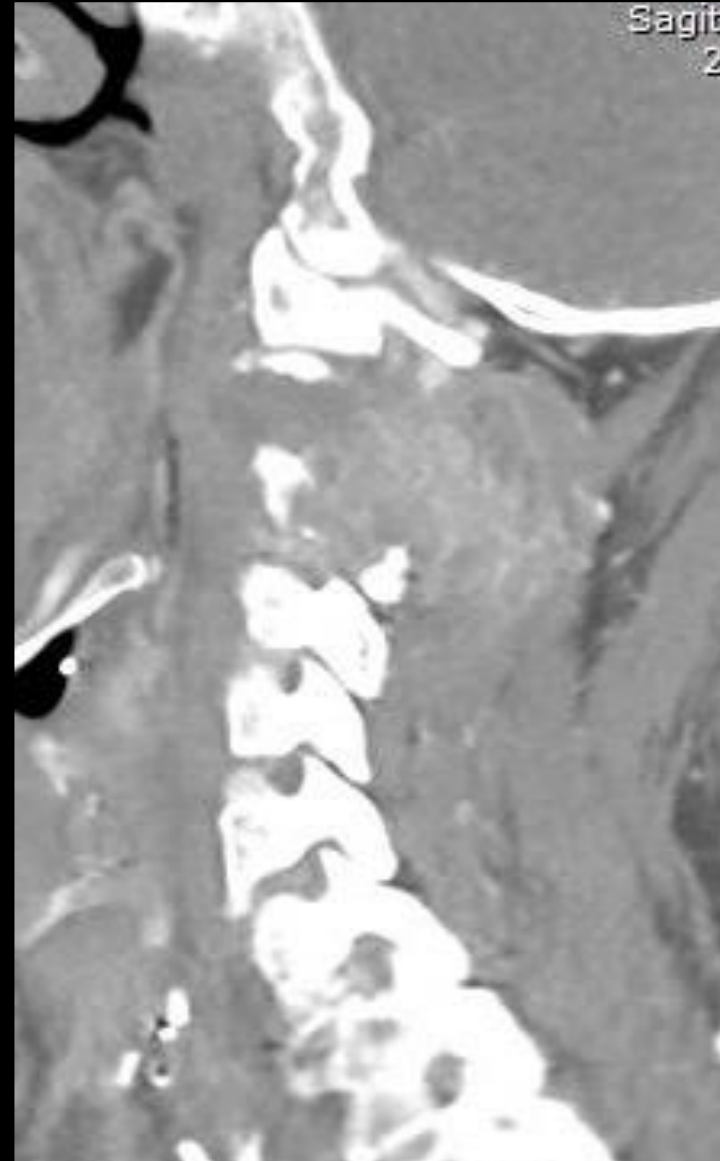
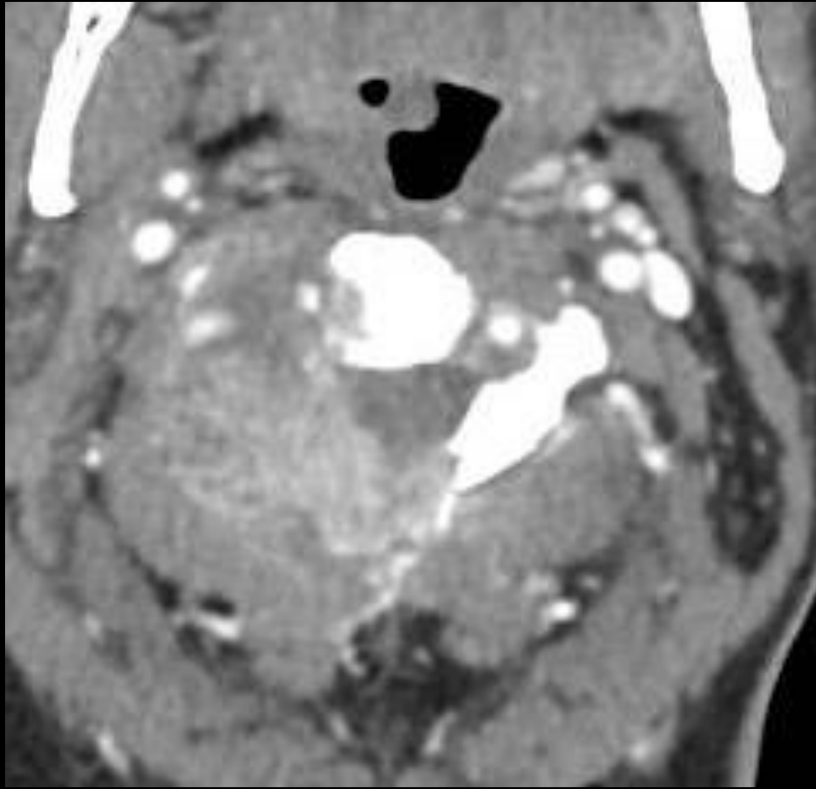
Three weeks after fall

Spinal Column Failure: Osteoporosis

- What matters?
 - Further collapse with neurologic compromise?
 - Additional fractures?
- Etiology: Trabecular bone loss
- Mechanism less relevant
- Many comorbidities
- Treatment failure more likely
- Prevent decline rather than focus on return to full function



Renal cell carcinoma



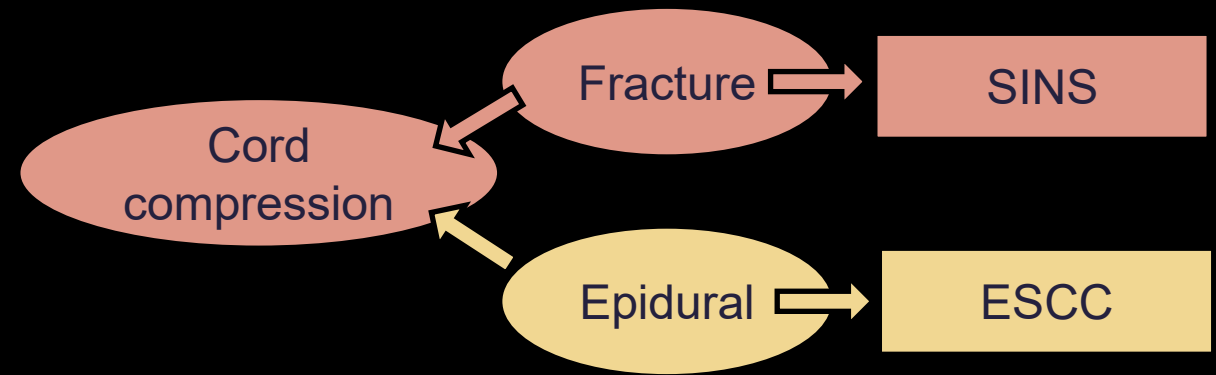
Spinal Column Failure: Tumor

- What matters?
 - *Is there current or impending instability*
- Instability will not respond to radiation or chemotherapy
- Etiology: Bone replacement (+ poor bone quality)
- Mechanism irrelevant
- Goal: pain palliation, restore/preserve function
- Many comorbidities, treatment failure much more likely
- *We can predict impending failure (and should) to prevent.... More pain, paralysis, death...*



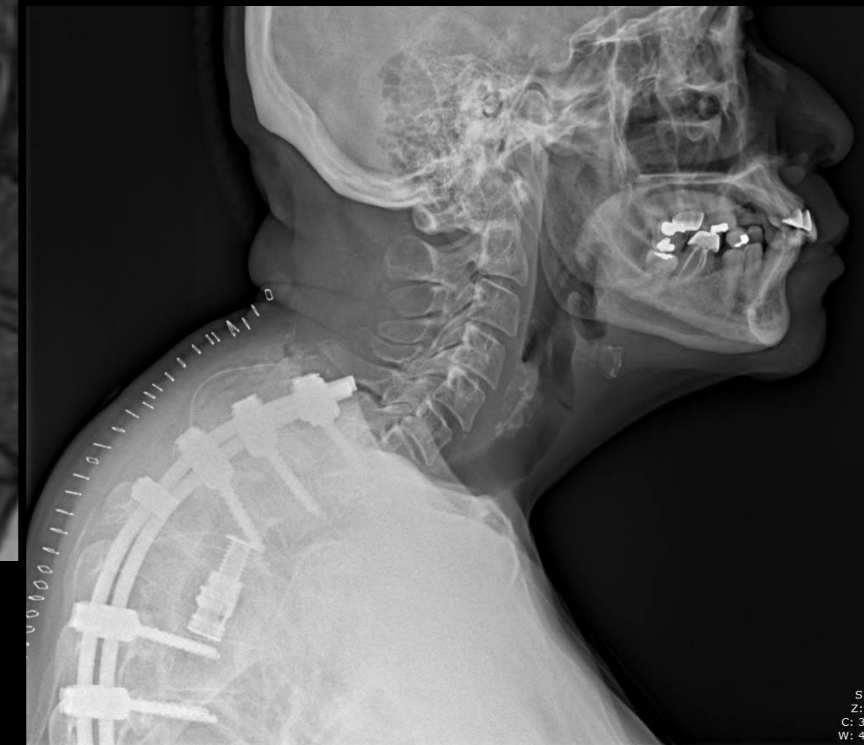
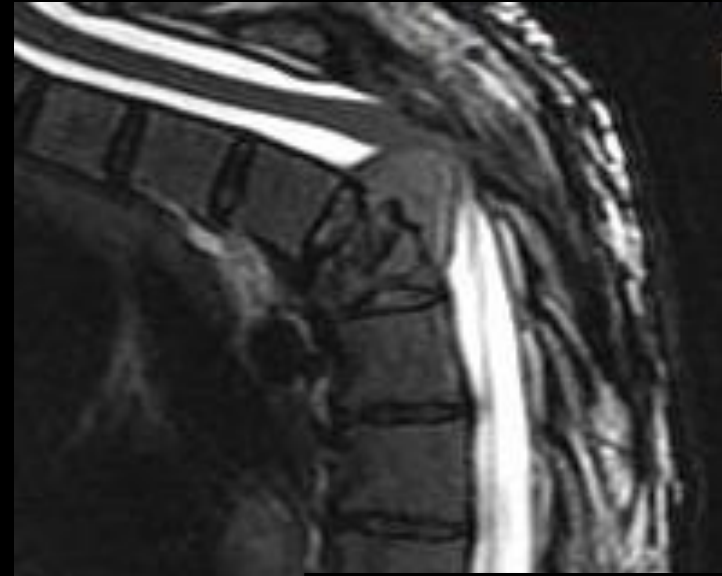
Oncologic Instability

- Common, devastating consequences, identify early
- Differs from instability in trauma
 - Failure patterns (ligaments, discs typically spared)
 - Poor bone quality and compromised healing (surgical considerations)
 - Can predict impending failure based on pattern of involvement



Oncologic Instability

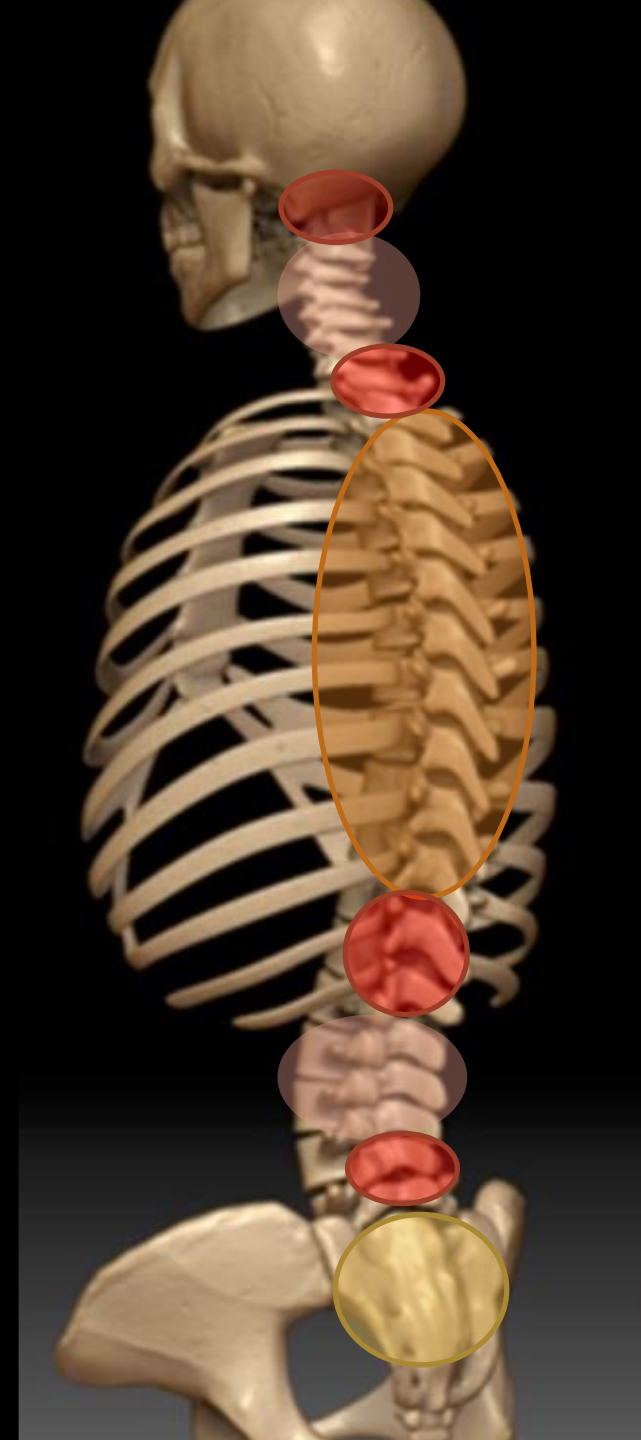
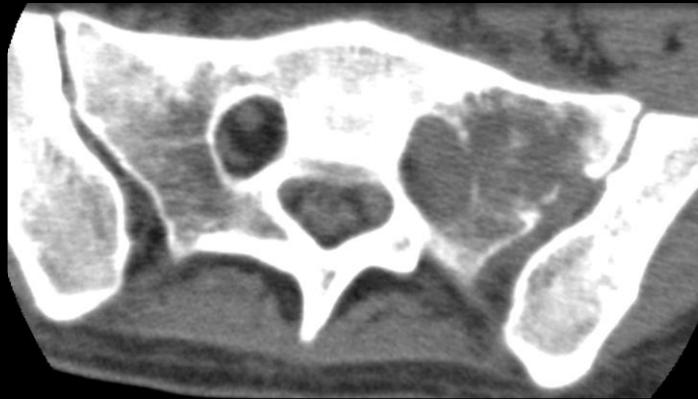
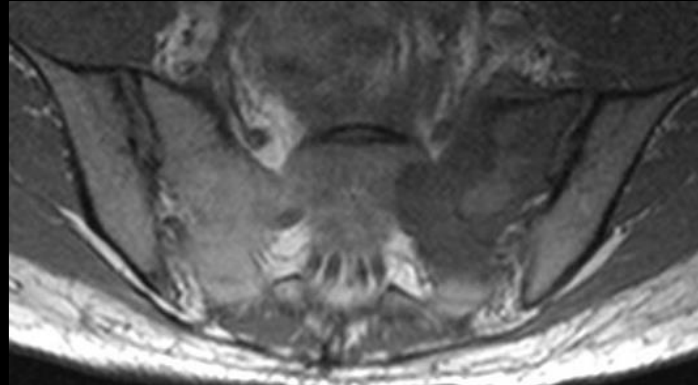
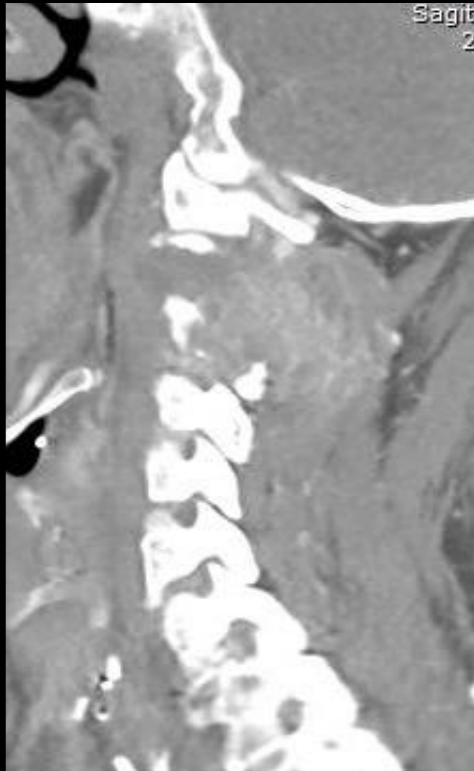
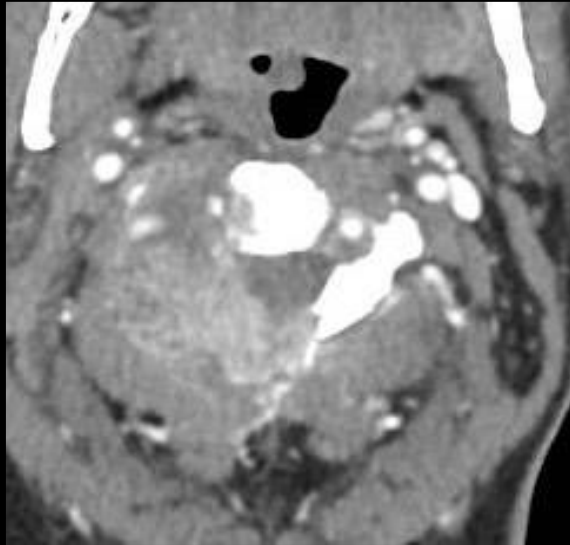
- My goal: Rapid triage of unstable/potentially unstable spine to surgical consultation
- The features that matter: The SINS score describes current instability and can predict impending instability
 - 5 radiologic components, 1 clinical
 - The higher the score, the more urgent



SINS

Questions	Answers (Point assignment)				
	4	3	2	1	0
Location		Junctional	Mobile	Semi-rigid	Rigid
Quality			Lytic	Mixed	Blastic
Alignment	Subluxation		Deformity		Preserved
Collapse		> 50%	< 50%	< 50% but > 50% body involved	None
Posterior Elements		Bilateral		Unilateral	None
Pain (Mechanical)		Yes		Occasional, not mechanical	No
Score	13-18 = Unstable		7-12 = Indeterminate		0-6 = Stable
Recommendation	Urgent surgical consult		Surgical consult		

Location



SPINE LOCATION	Score
Junctional (Occ-C2, C7-T2, T11-L1, L5-S1)	3
Mobile (C3-6, L2-4)	2
Semi-rigid (T3-10)	1
Rigid (S2-5)	0

Lesion and Bone quality

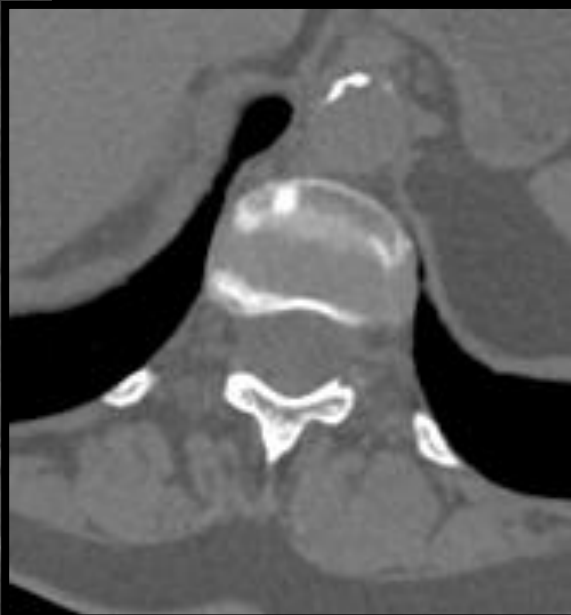
Lytic: greater risk of fracture:

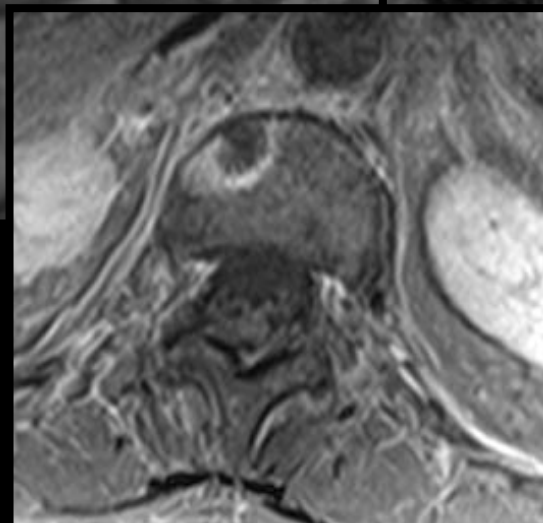
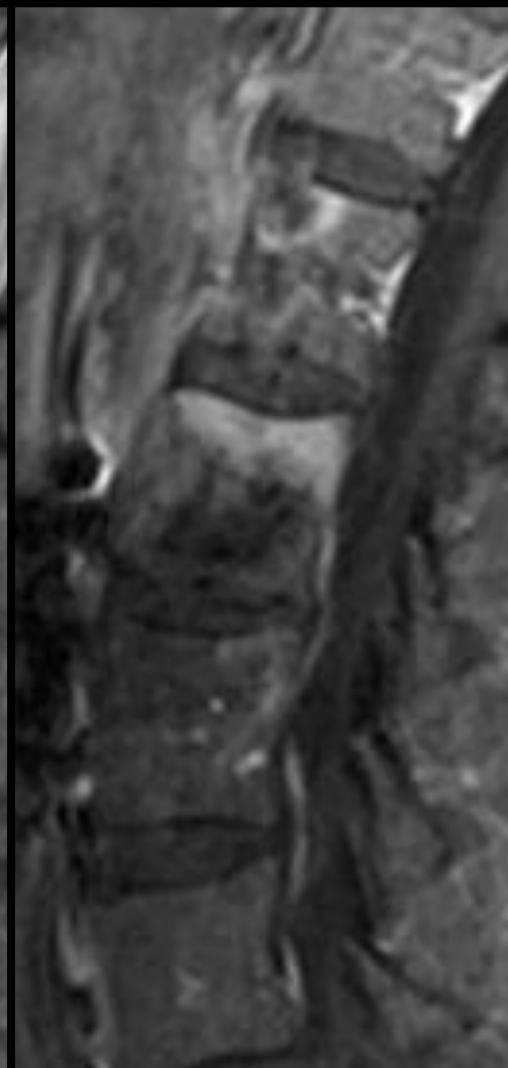
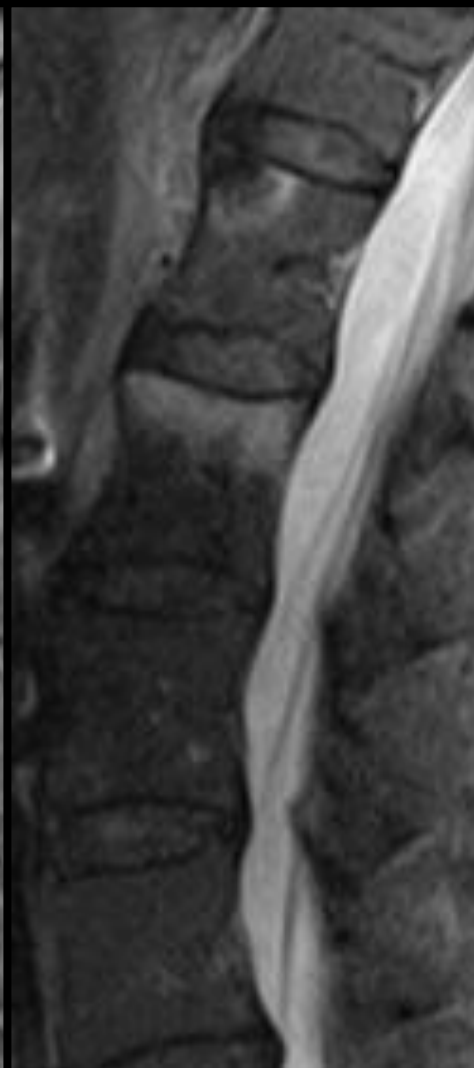
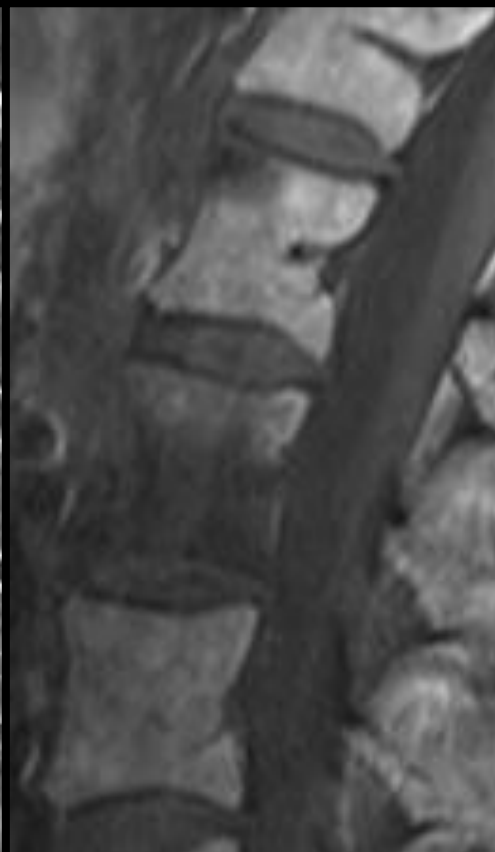
- lack of mineralization/ load-bearing
- Increased pressurization (burst)



LESION QUALITY	Score
Lytic	2
Mixed	1
Blastic	0









Lytic or blastic?

LESION QUALITY	Score
Lytic	2
Mixed	1
Blastic	0



**Lytic or
blastic?**

LESION QUALITY	Score
Lytic	2
Mixed	1
Blastic	0



Alignment, % Body Involvement/Collapse

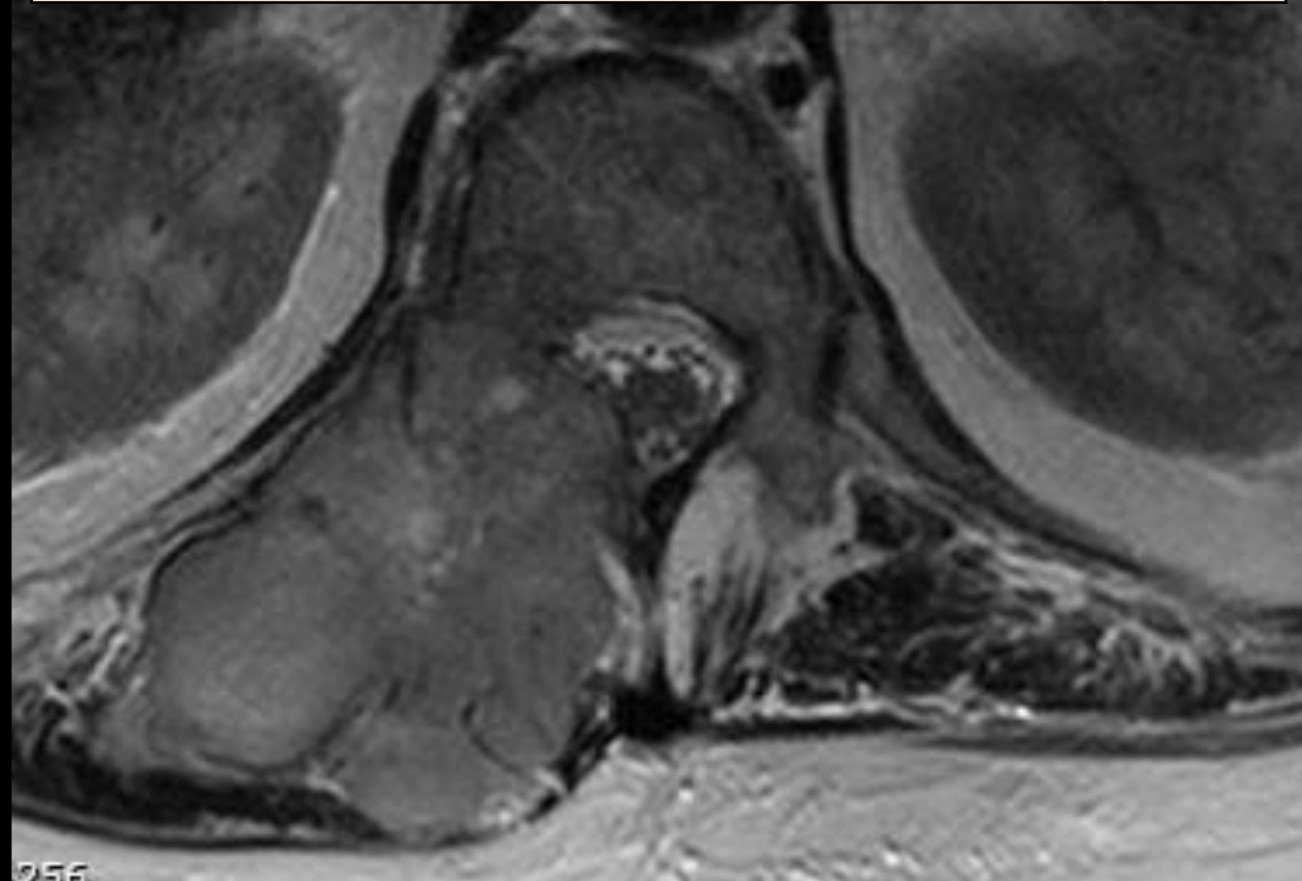
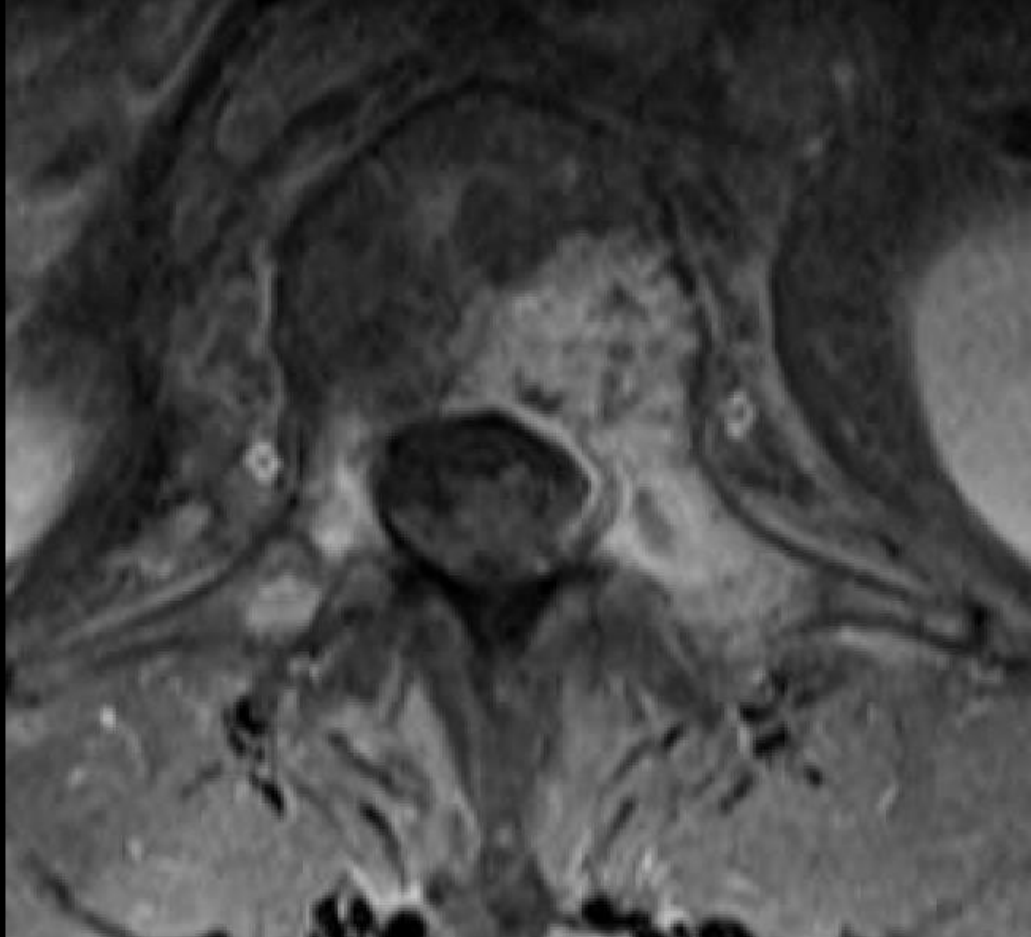


ALIGNMENT	Score
Subluxation/translation	4
New kyphosis/scoliosis	2
Normal	0

VERTEBRAL BODY INVOLVEMENT	Score
> 50% Collapse	3
< 50% Collapse	2
No collapse, > 50% involved	1
Less than 50% involved	0



Posterior elements



POSTERIOR ELEMENTS (Pedicle, Facet, CV joint)	Score
Bilateral	3
Unilateral	1
None	0

Costovertebral joint involvement greatest contributor to thoracic spine

Pain

- Mechanical pain
- Pain associated with periosteal stretch or nerve root/cord compression is NOT indicative of instability (but may coexist)
- Pain unique component in definition of oncological instability



PAIN (mechanical) Relief with recumbence, pain w/ movement /loading	Score
Yes	3
Occasional, not mechanical	1
Pain free	0

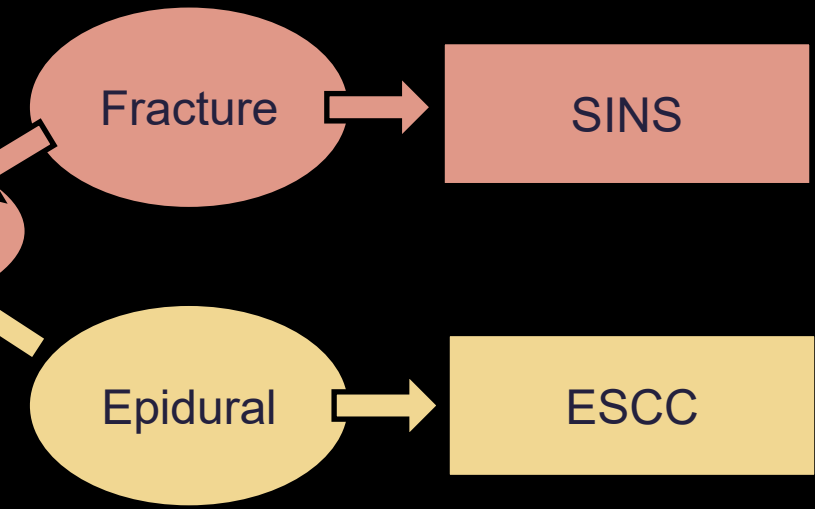
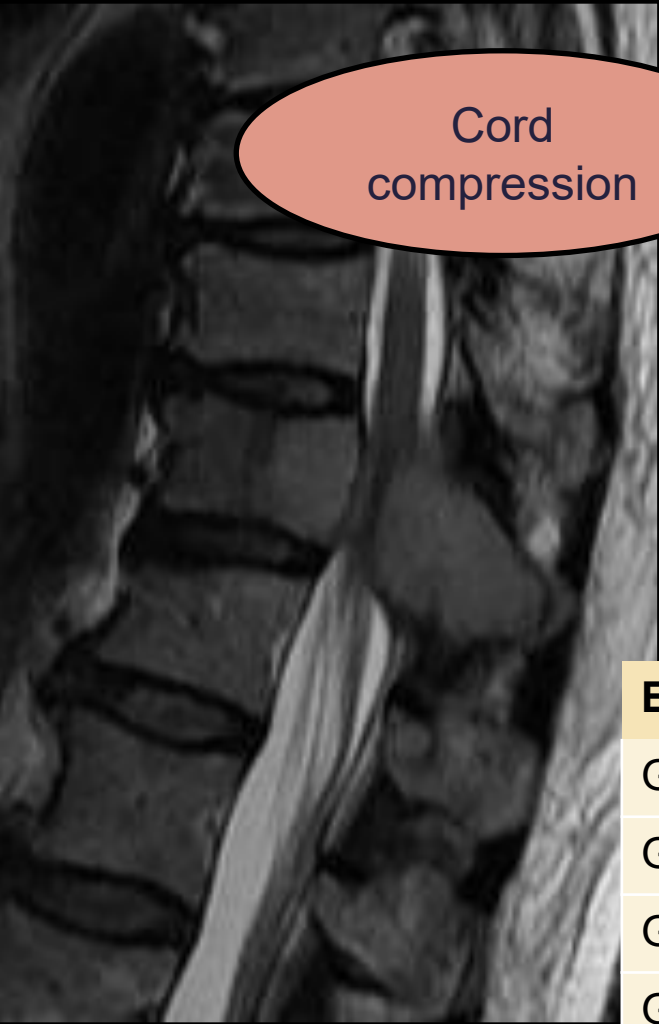


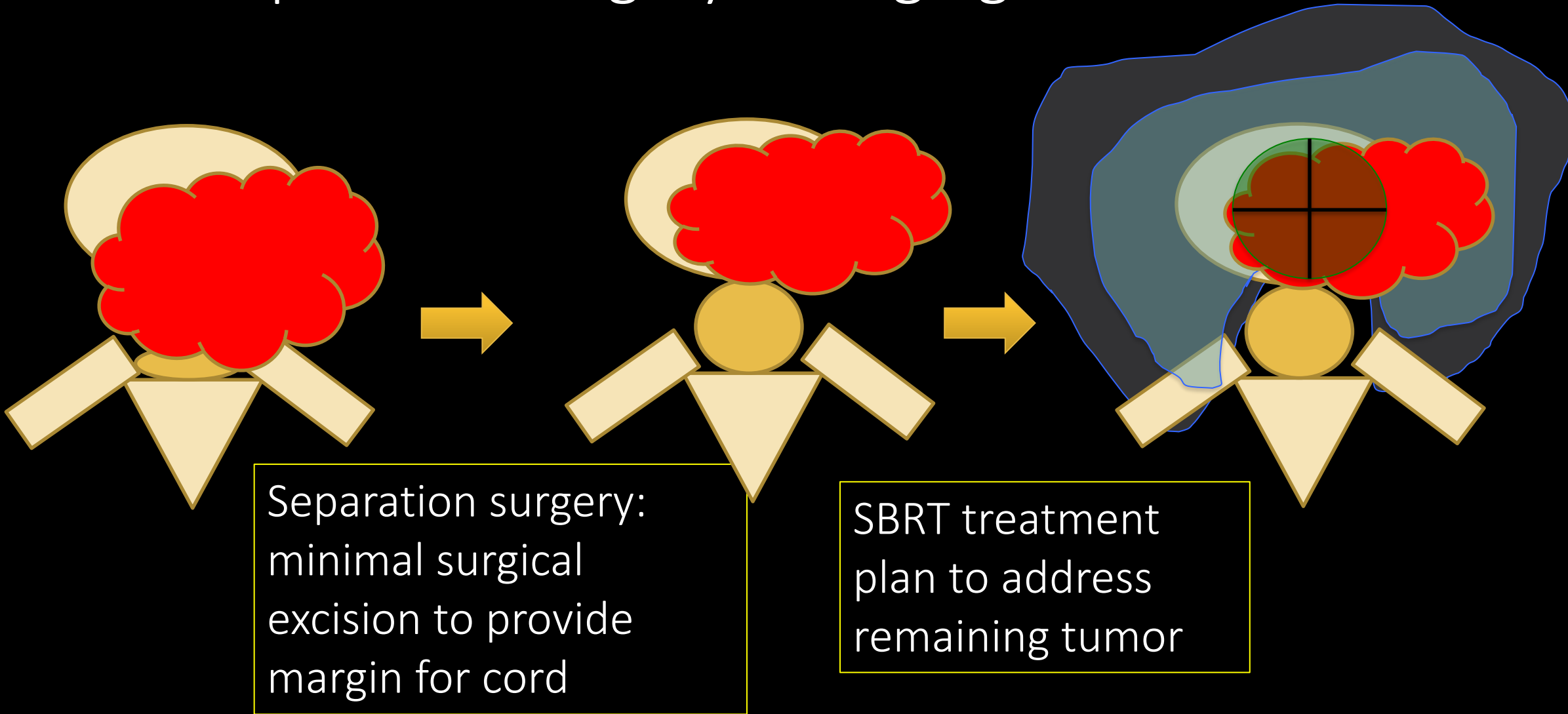
Table 8. Summary Table Including All Elements of the SINS

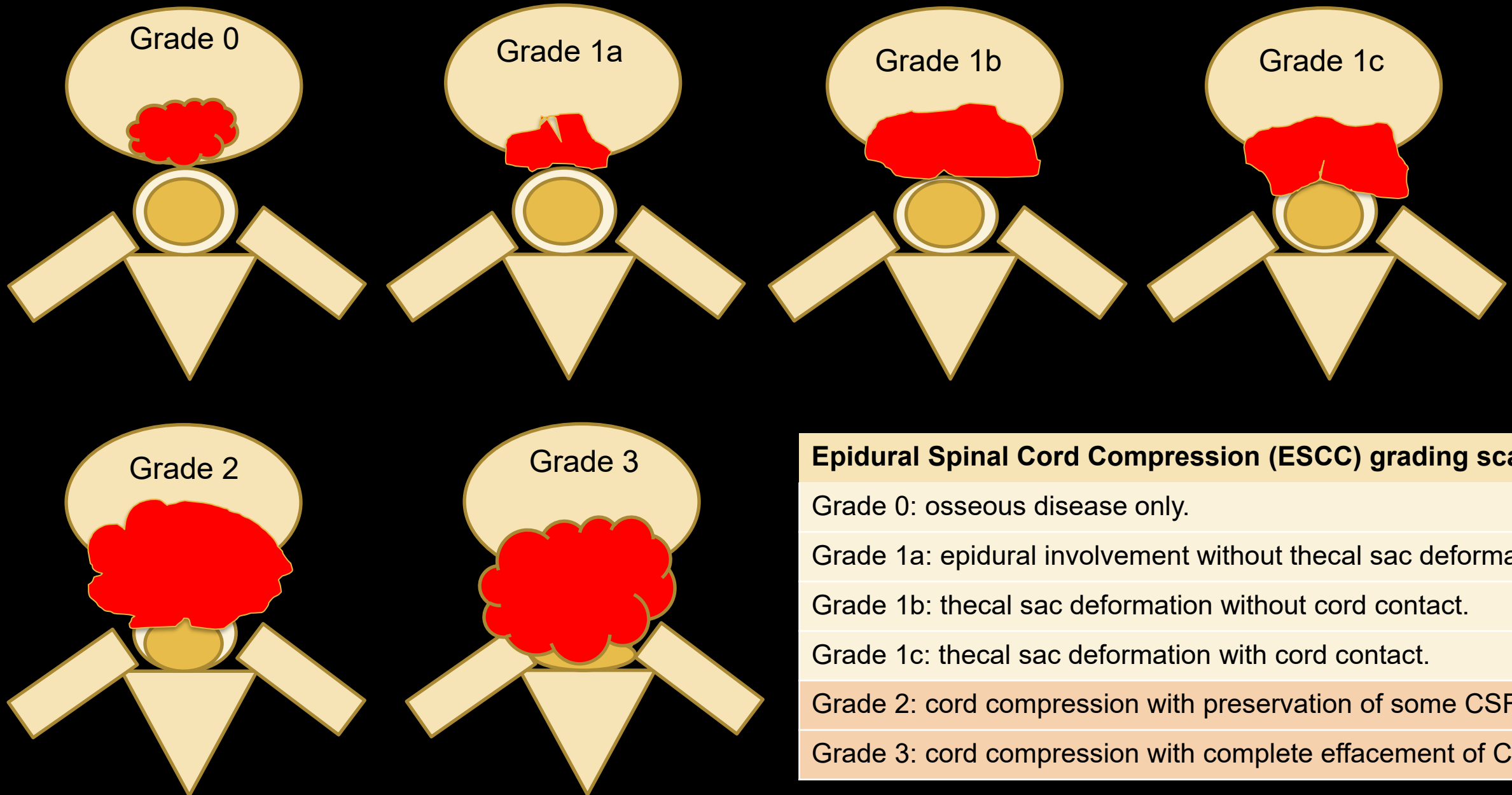
Element of SINS	Score
Location	
Junctional (occiput-C2, C7-T2, T11-L1, L5-S1)	3
Mobile spine (C3-C6, L2-L4)	2
Semi-rigid (T3-T10)	1
Rigid (S2-S5)	0
Pain relief with recumbency and/or pain with movement/loading of the spine	
Yes	3
No (occasional pain but not mechanical)	1
Pain free lesion	0
Bone lesion	
Lytic	2
Mixed (lytic/blastic)	1
Blastic	0
Radiographic spinal alignment	
Subluxation/translation present	4
De novo deformity (kyphosis/scoliosis)	2
Normal alignment	0
Vertebral body collapse	
>50% collapse	3
<50% collapse	2
No collapse with >50% body involved	1
None	0
Spinal element involvement of the spinal elements (vertebrae, intervertebral disc or CV joint fracture, or element with tumor)	
3 or more elements	3
1-2 elements	1
None	0

Epidural Spinal Cord Compression (ESCC) grading scale

- Grade 0: osseous disease only.
- Grade 1a: epidural involvement without thecal sac deformation.
- Grade 1b: thecal sac deformation without cord contact.
- Grade 1c: thecal sac deformation with cord contact.
- Grade 2: cord compression with preservation of some CSF.
- Grade 3: cord compression with complete effacement of CSF.

Separation surgery for high grade ESCC





Epidural Spinal Cord Compression (ESCC) grading scale

Grade 0: osseous disease only.

Grade 1a: epidural involvement without thecal sac deformation.

Grade 1b: thecal sac deformation without cord contact.

Grade 1c: thecal sac deformation with cord contact.

Grade 2: cord compression with preservation of some CSF.

Grade 3: cord compression with complete effacement of CSF.

ESCC: Low Grade

Epidural Spinal Cord Compression (ESCC) grading scale

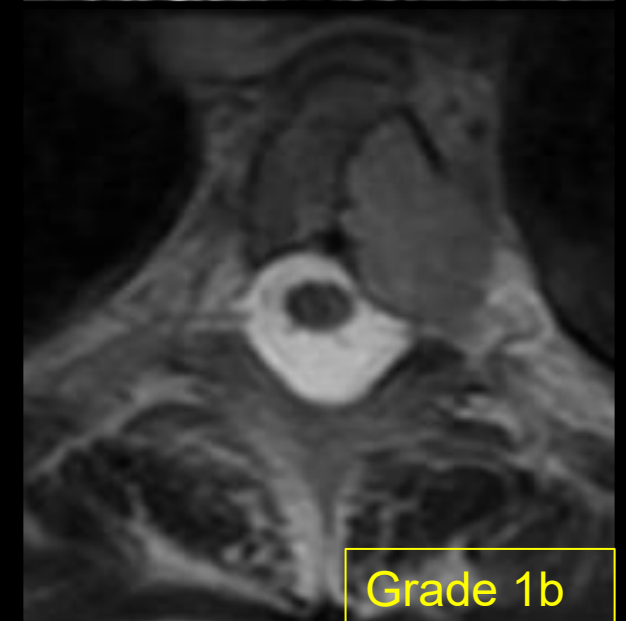
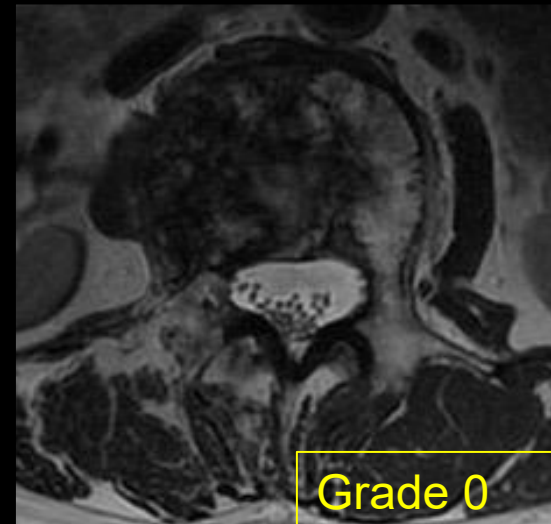
Grade 0: osseous disease only.

Grade 1a: epidural involvement without thecal sac deformation.

Grade 1b: thecal sac deformation without cord contact.

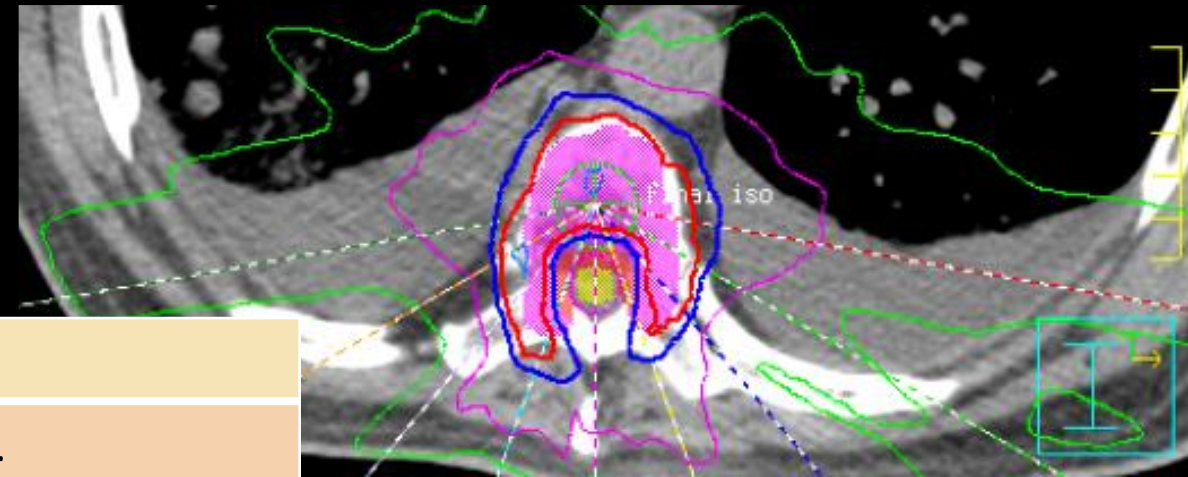
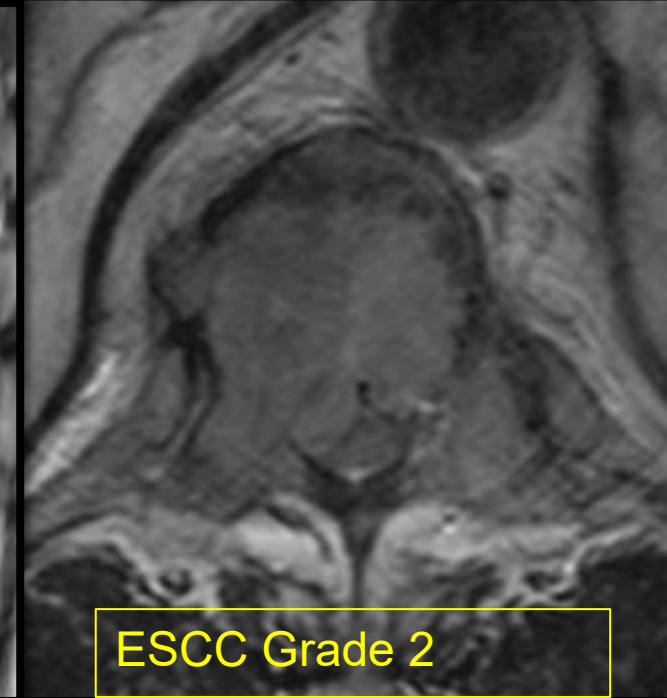
Grade 1c: thecal sac deformation with cord contact.

The ESCC is based upon **axial T2-W** images at the level of greatest compression



ESCC: High Grade

- Requires surgical decompression/ **separation surgery** before radiation (unless radiosensitive histology)



Epidural Spinal Cord Compression (ESCC) grading scale

Grade 2: cord compression with preservation of some CSF.

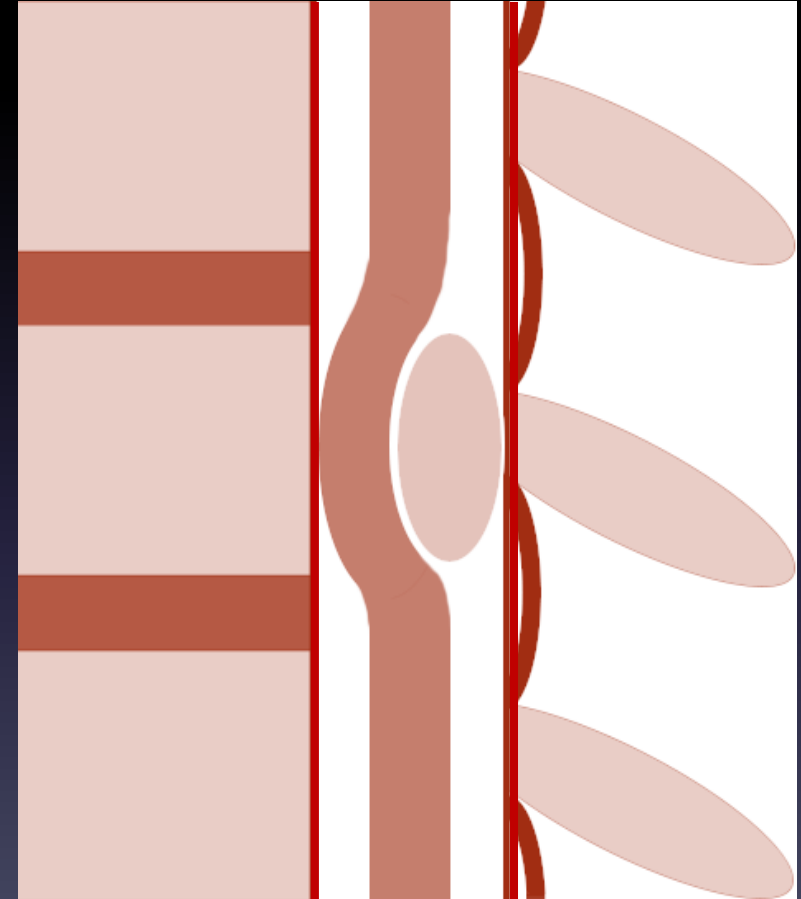
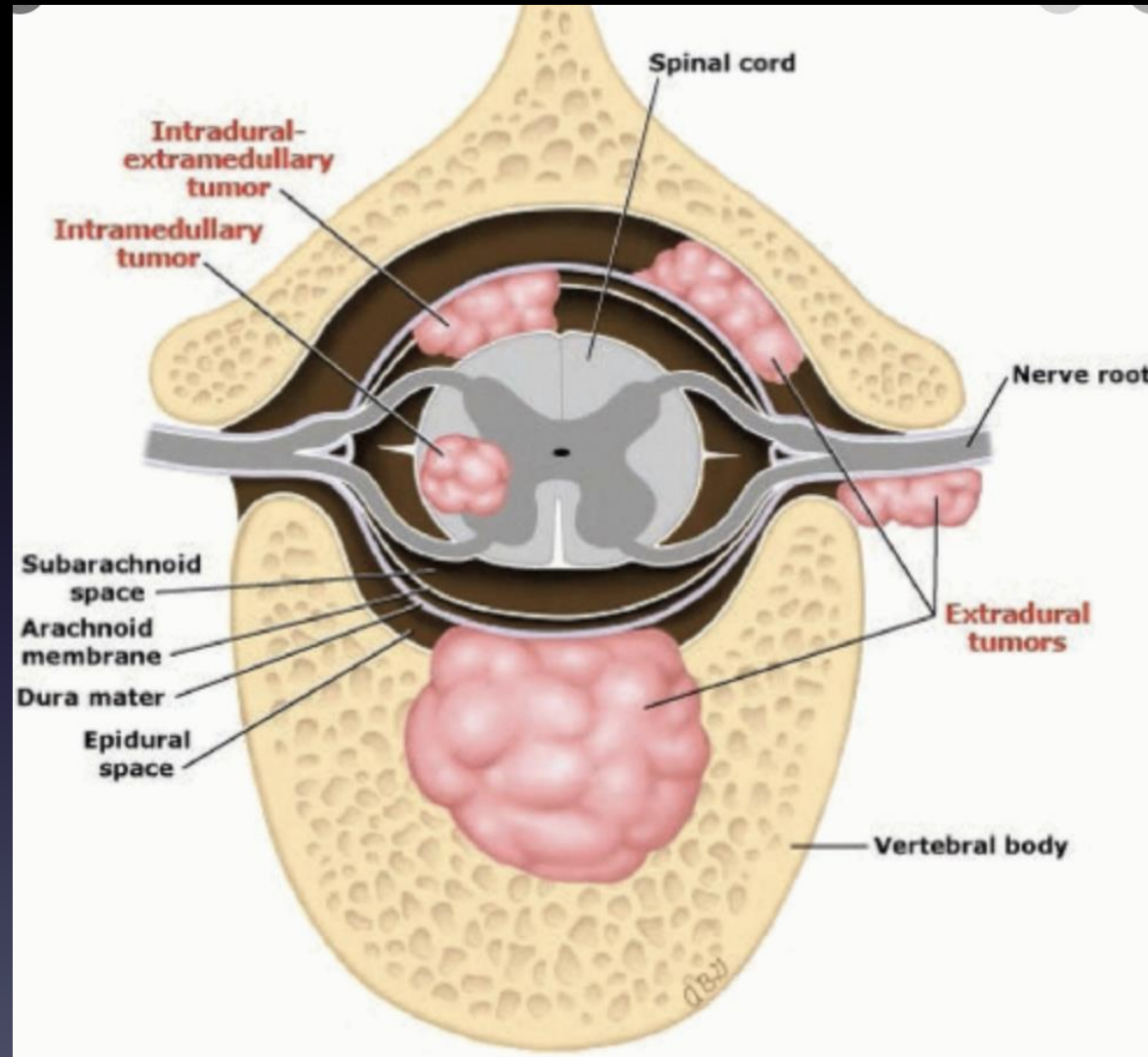
Grade 3: cord compression with complete effacement of CSF.

Spine Oncology Management Algorithm (NOMS)

Neurologic (Cord compression)	Oncologic (Is the tumor radiosensitive (cEBRT)?)	Mechanical (Is the spine stable?)	Systemic (Can the patient tolerate surgery?)	Treatment Decision
Low-grade	Yes	Yes		External beam radiation (cEBR)
		No		Surgical stabilization -> cEBR
	No	Yes		Stereotactic radiosurgery (SRS)
		No		Stabilization ->SRS
High-grade	Yes	Yes		cEBR
		No		Stabilization -> cEBR
	No	Yes	Yes	Separation surgery -> SRS
			No	cEBR
		No	Yes	Stabilization & Sep surgery ->SRS
			No	Stabilization (cement) -> cEBR

Based on data from
radiology images /
reports

Now the rare stuff....



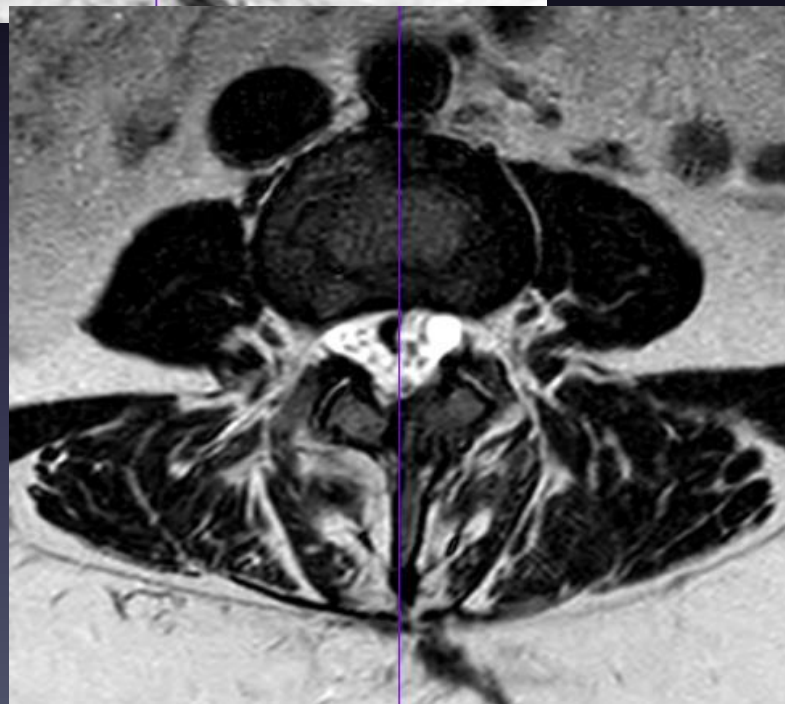
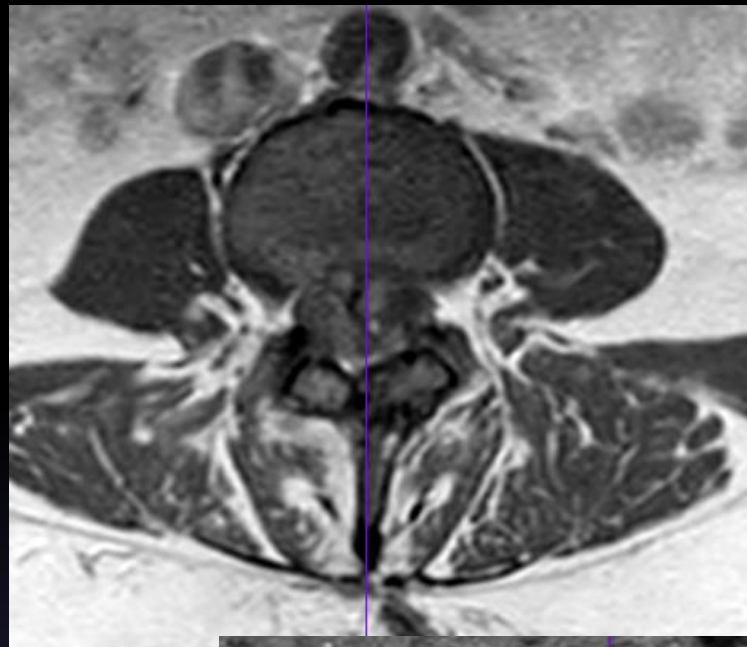
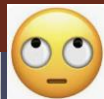
29-yo with 2-week history of
worsening saddle anesthesia
(cauda equina)

History of “tumor resection”
2018

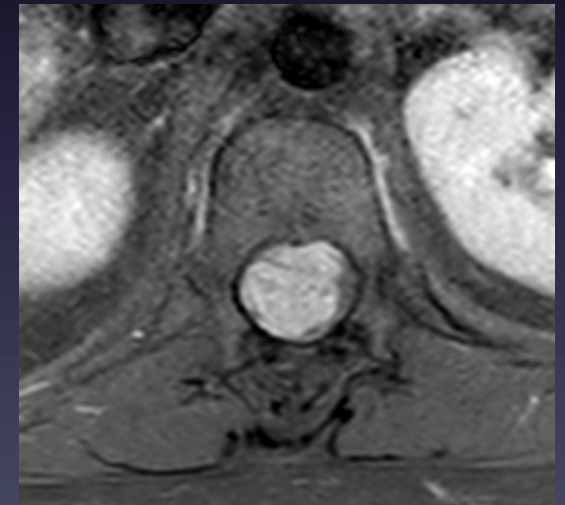
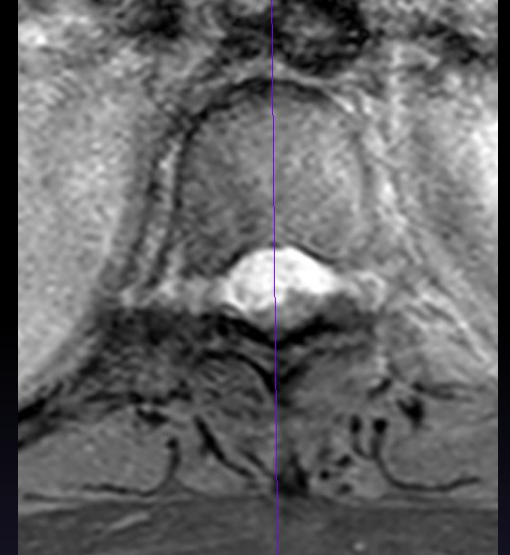




They got my MR, but not with contrast

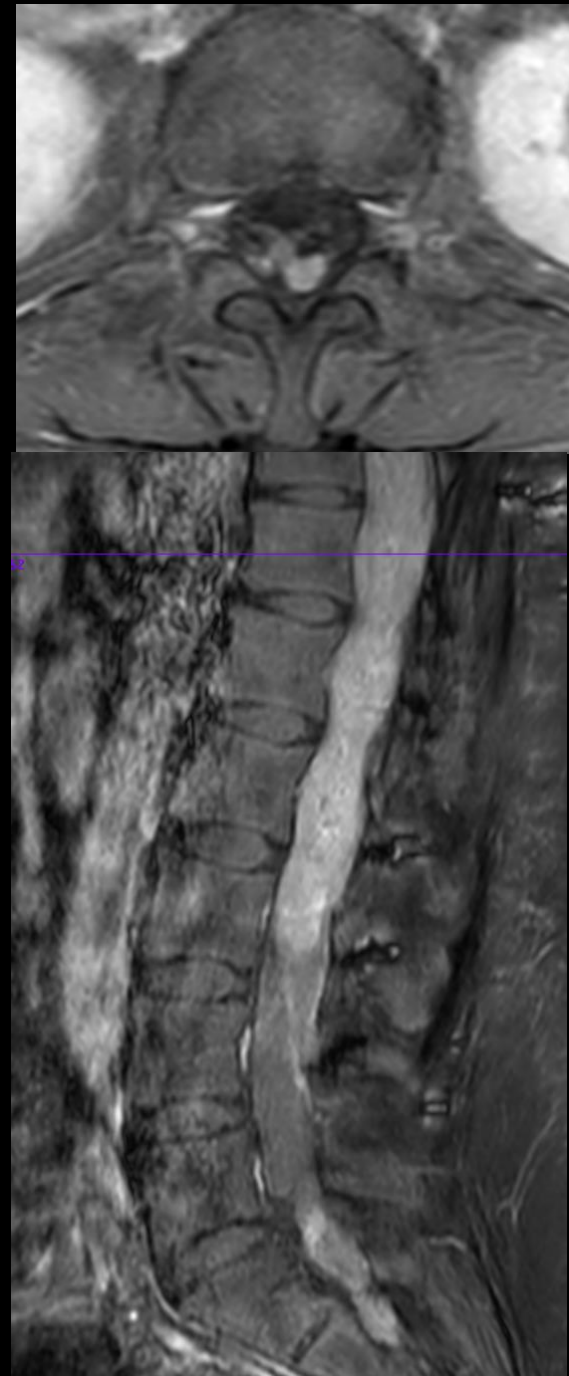


Ependymoma



Cauda Equina Syndrome: Tumor

- Neoplastic cause of CES 3% - compression, metastasis, leptomeningeal
- Ependymoma most common
- Myxopapillary ependymoma in adults, slow growing with scalloping, hemosiderin, cysts
- Metastasis or recurrence with subtotal resection



60-year-old with cauda
equina syndrome



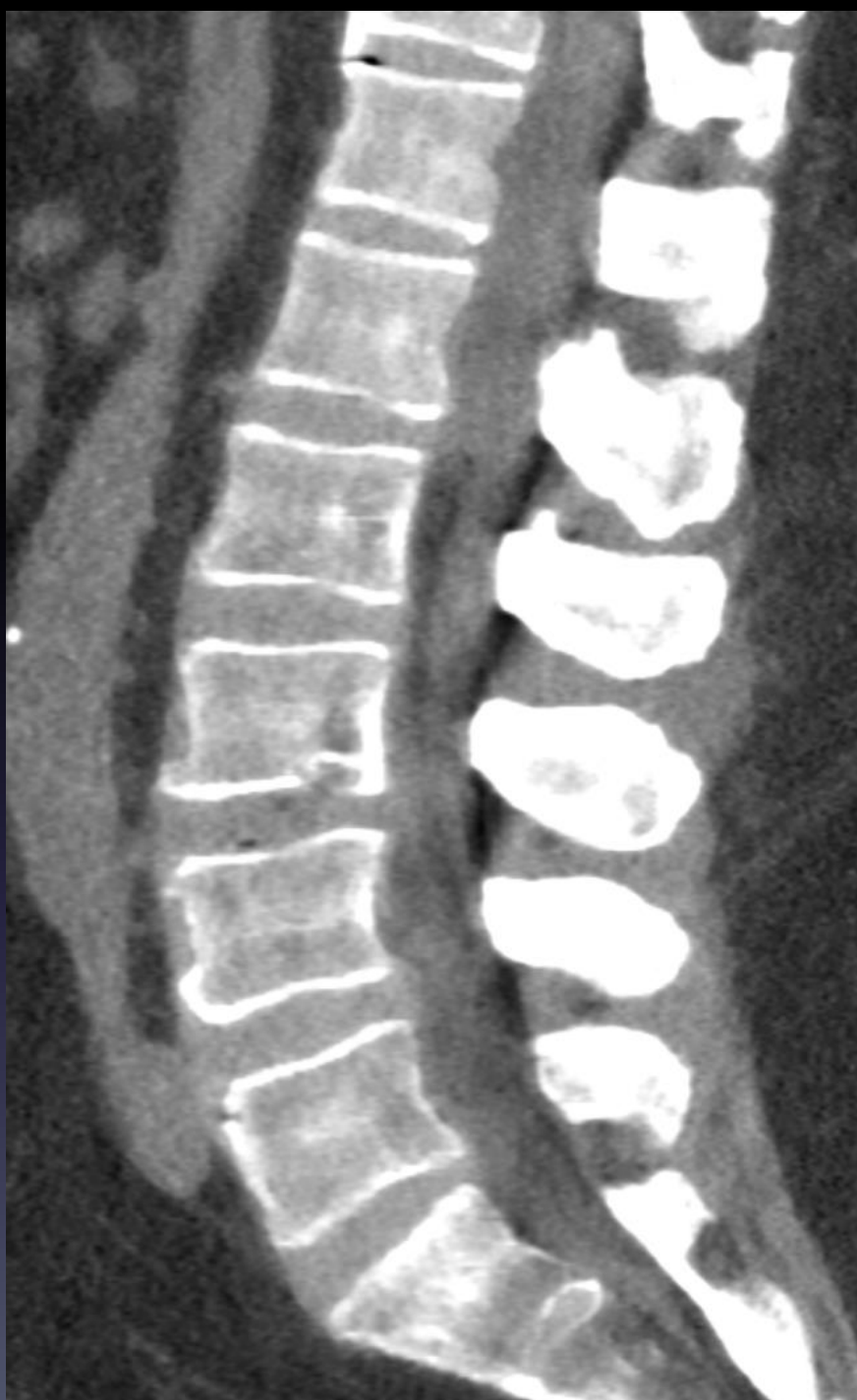
Leptomeningeal metastases

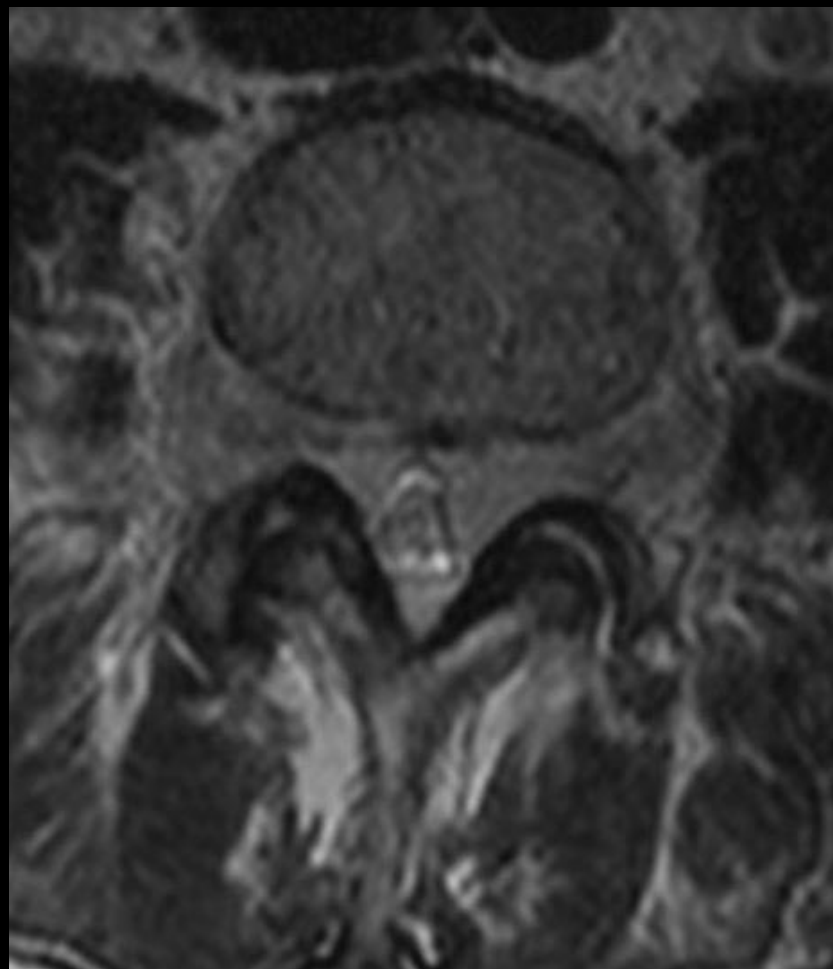
- Much more frequent than intramedullary metastases
- More common in advanced disease (always known diagnosis)
- MR more sensitive than CSF*
- Cauda equina symptoms (mimics compression)



25-year-old with constant
and severe back and leg
pain







Burkitt Lymphoma





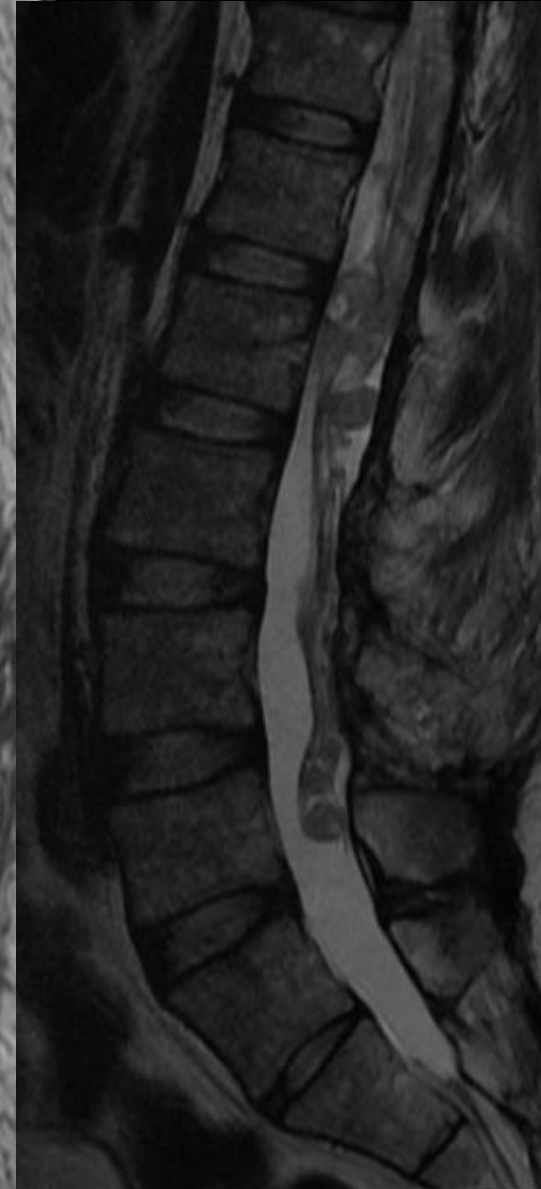
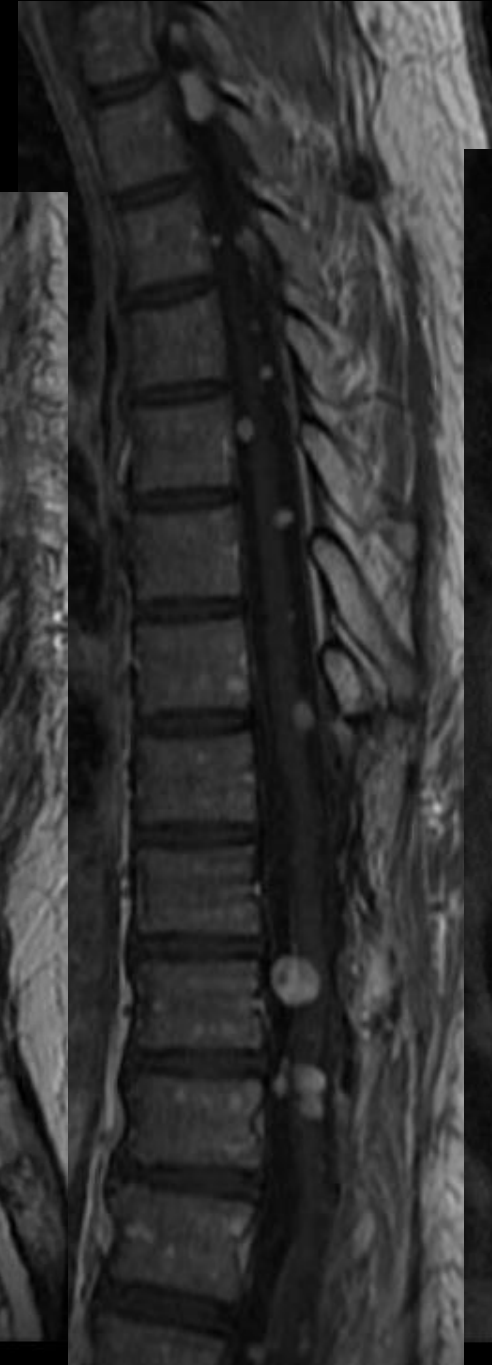
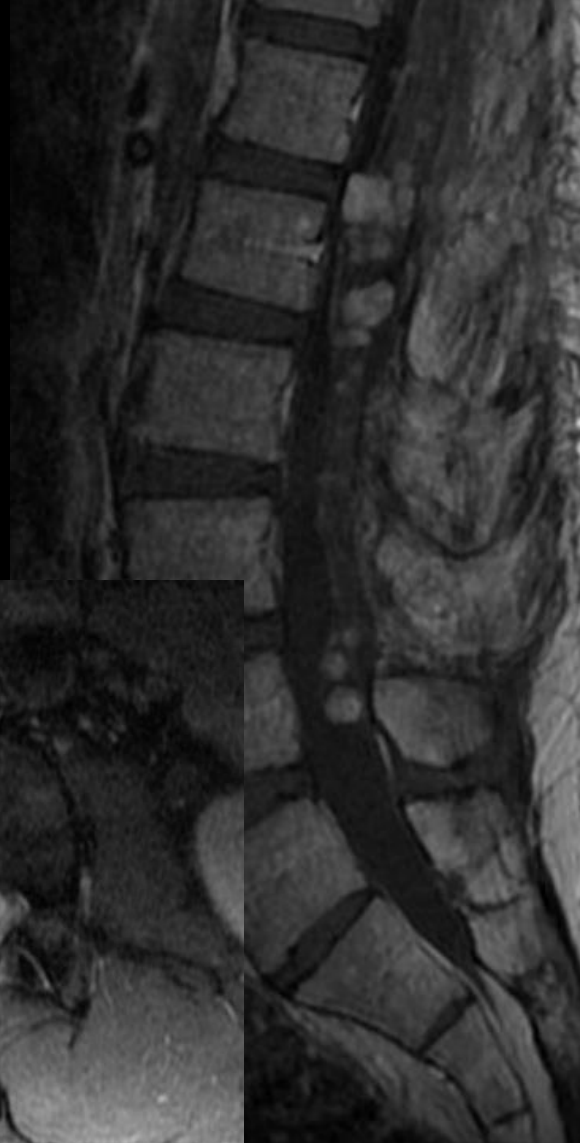
What is different?

Another 29-year-old, but this
time severe leg pain



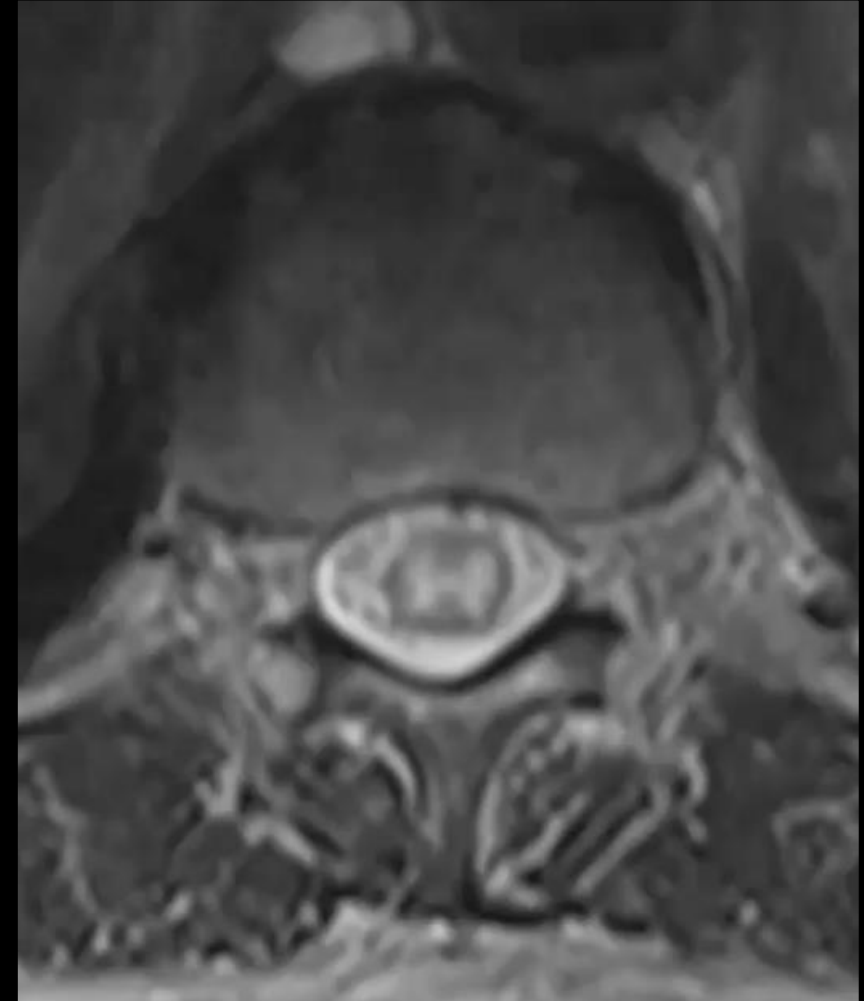
Schwannomatosis

- Spectrum of schwannoma predisposition syndromes (overlap with NF1 and 2)
- Younger
- Very painful





60 yo with gradually increasing
myelopathy



Dural AVF

- 80% of all spinal vascular malformations
- 80% male in fifth or sixth decade
- Insidious progression of myelopathy most common
 - Average of two years of symptoms before diagnosis
- Postulated to be acquired lesions, uncertain etiology





What if it's
this?! 🤔

Hemangioblastoma

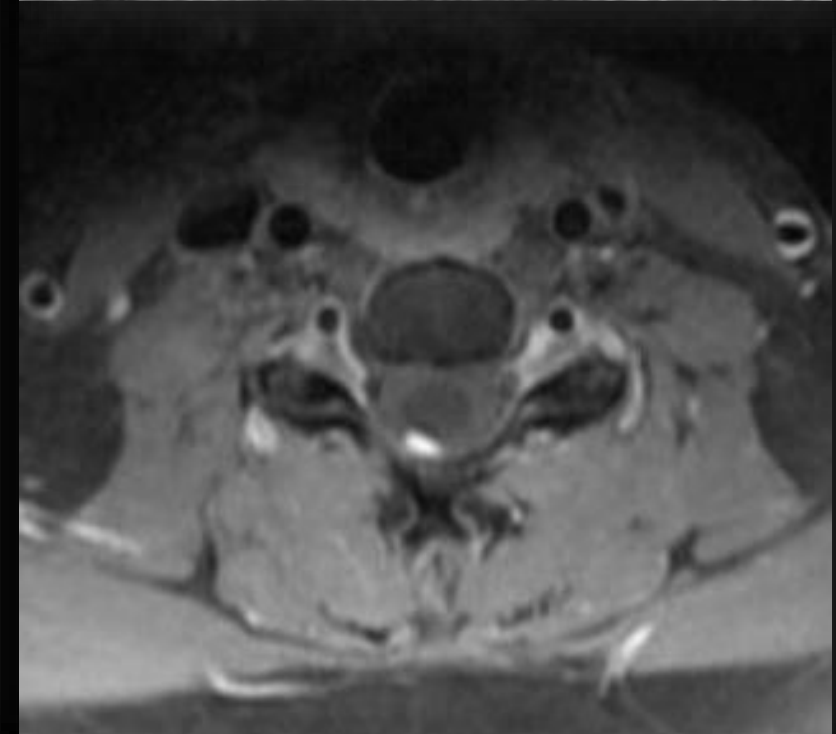
2% of cord tumors

Enhancing mass/ nodule
on pial surface

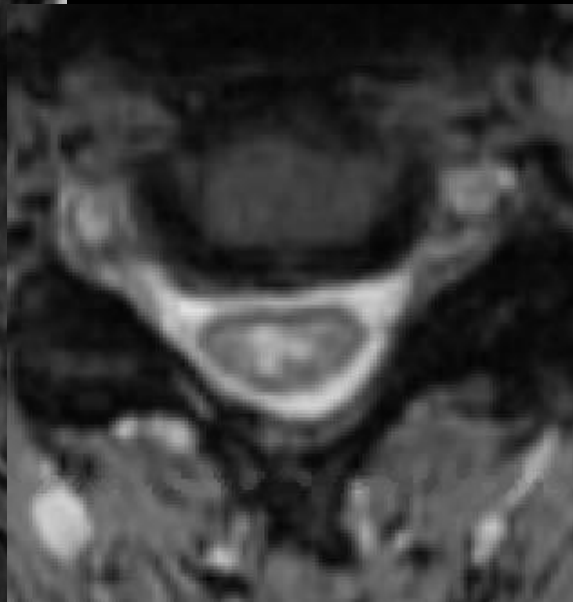
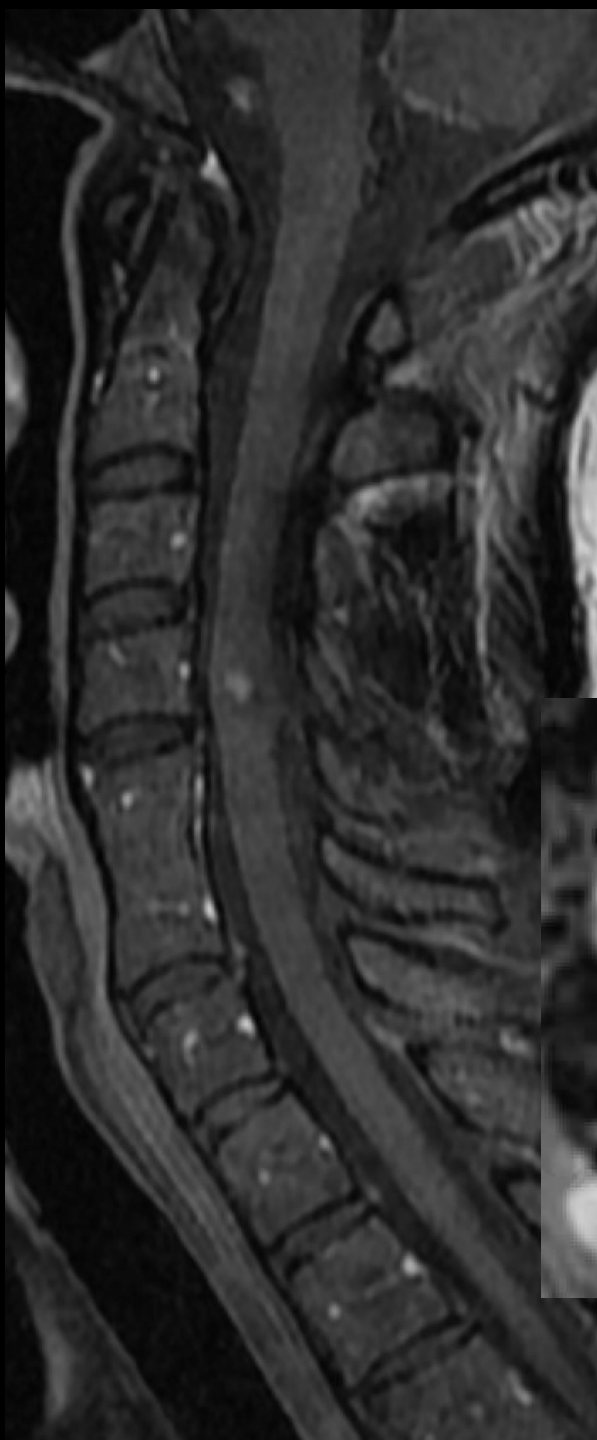
Thoracic spine 50%

Cysts, syrinx, flow voids

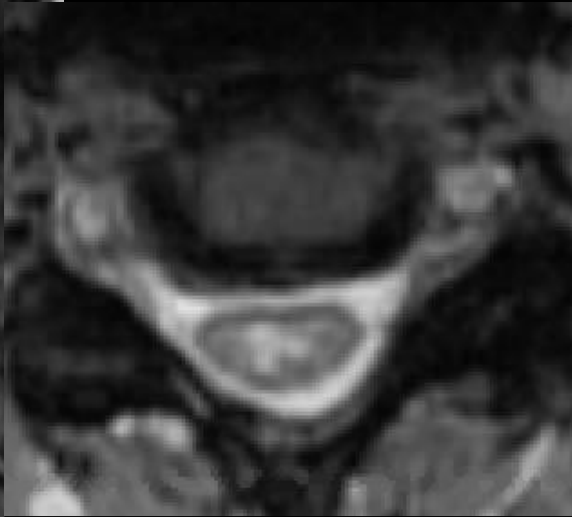
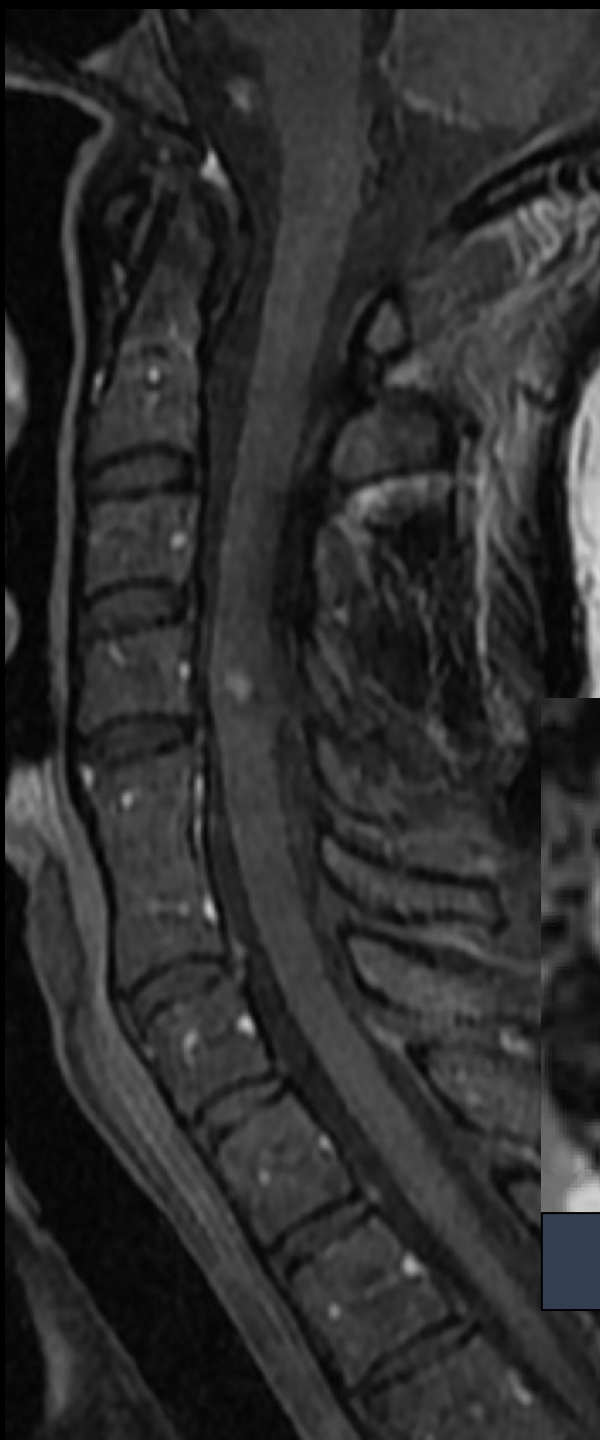
80% solitary, 30% VHL



Two 60-year-olds with arm weakness



Ependymoma



Central canal



Cap sign



Ependymoma



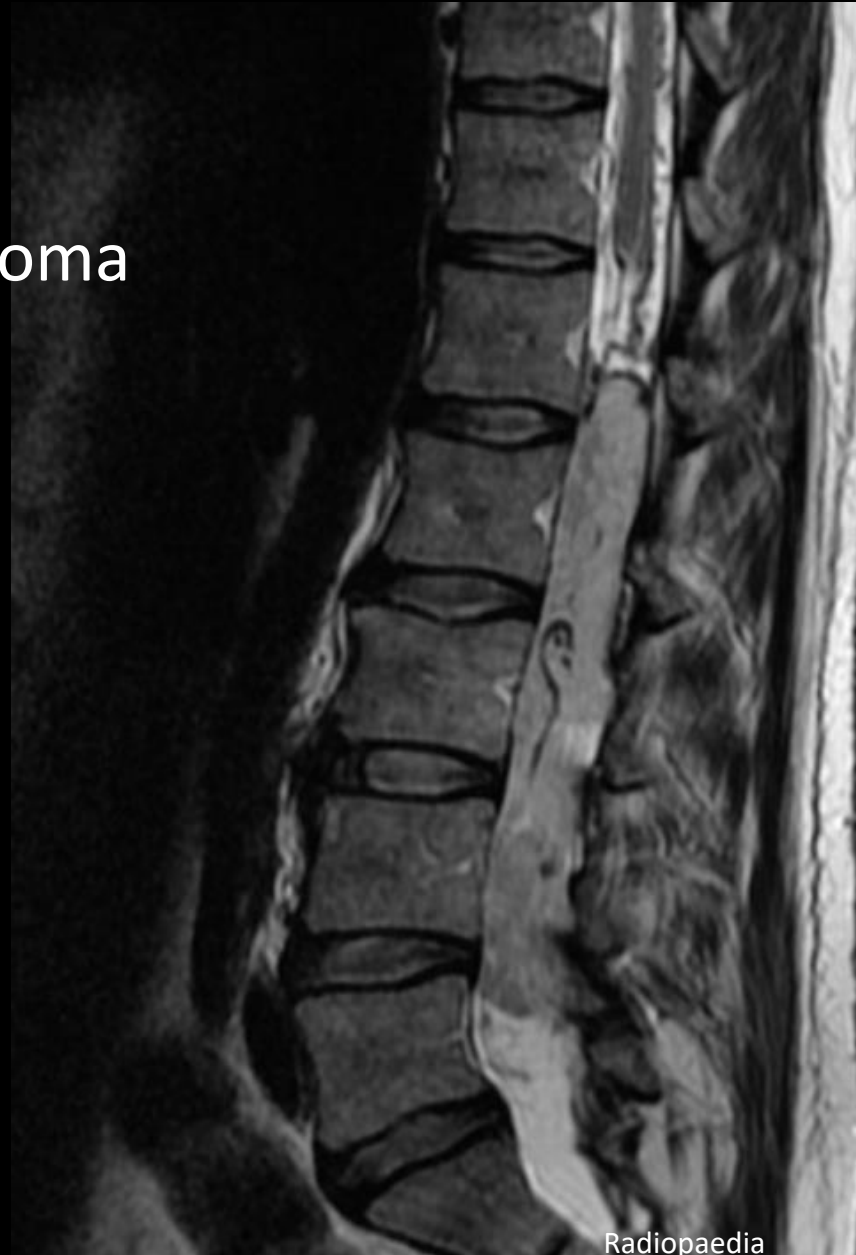
- Adults
- Central location (ependyma)
- Well circumscribed
- Hemorrhage is common
- May present with subarachnoid hemorrhage
- Cysts (intratumoral, polar)

Myxopapillary Ependymoma

- 30-50 year olds
- Slow growing in conus / filum terminale
- Can scallop/ expand canal
- Mucin, hemosiderin, cysts
- Benign but can metastasize and/or recur without total resection (Who 2)



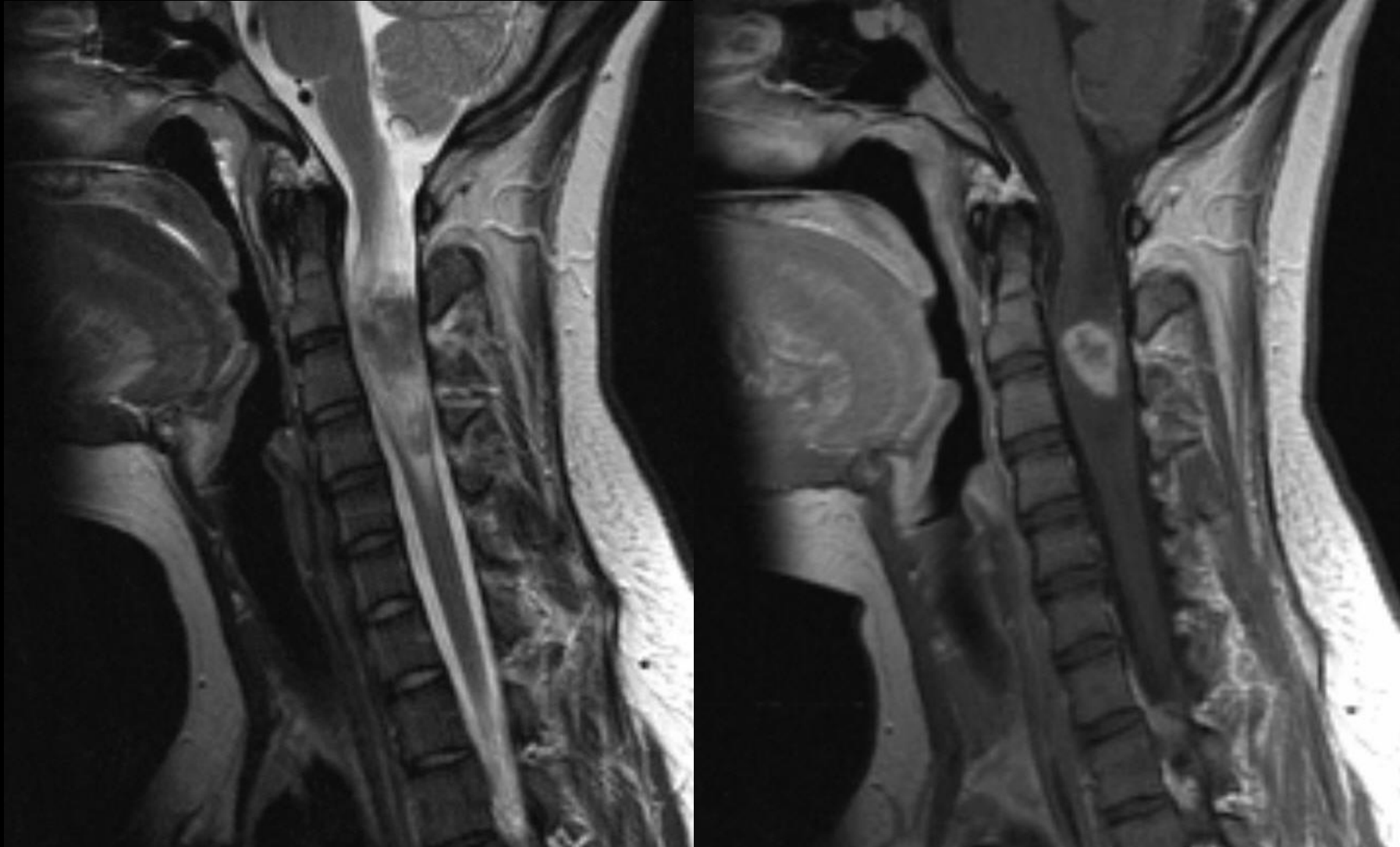
Paraganglioma



Radiopaedia



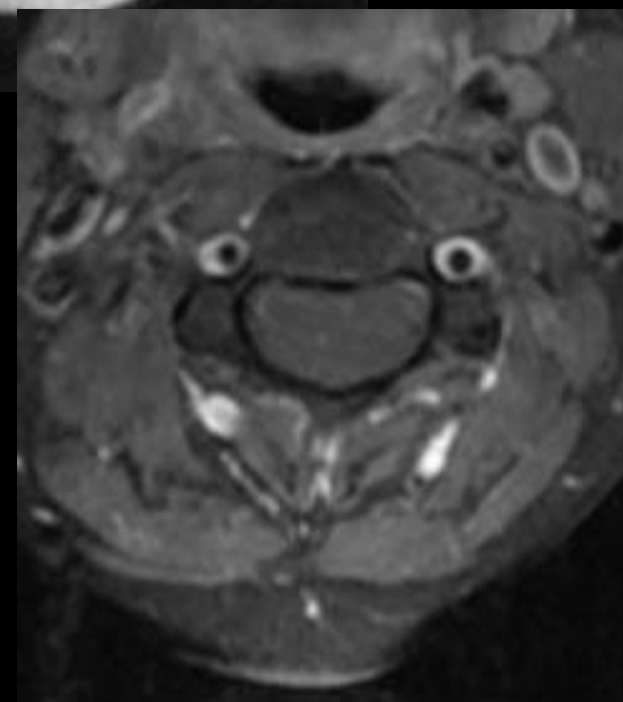
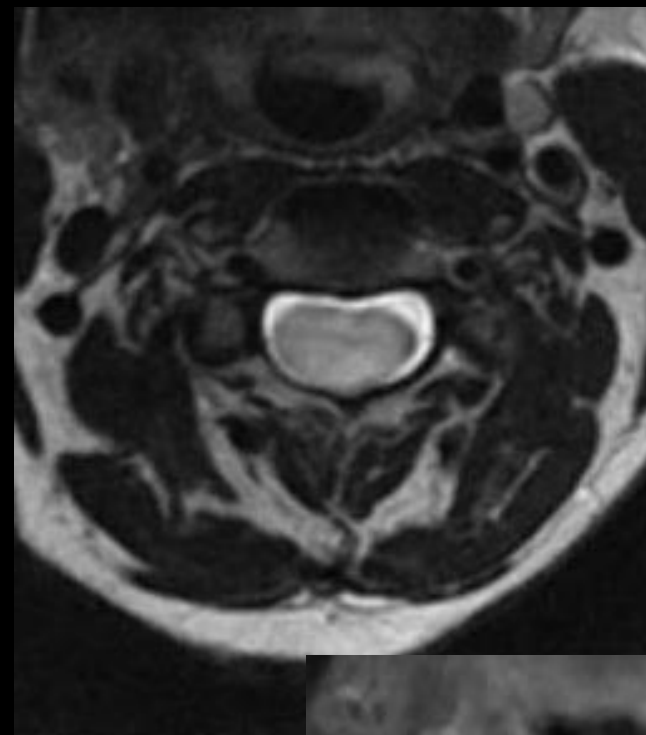
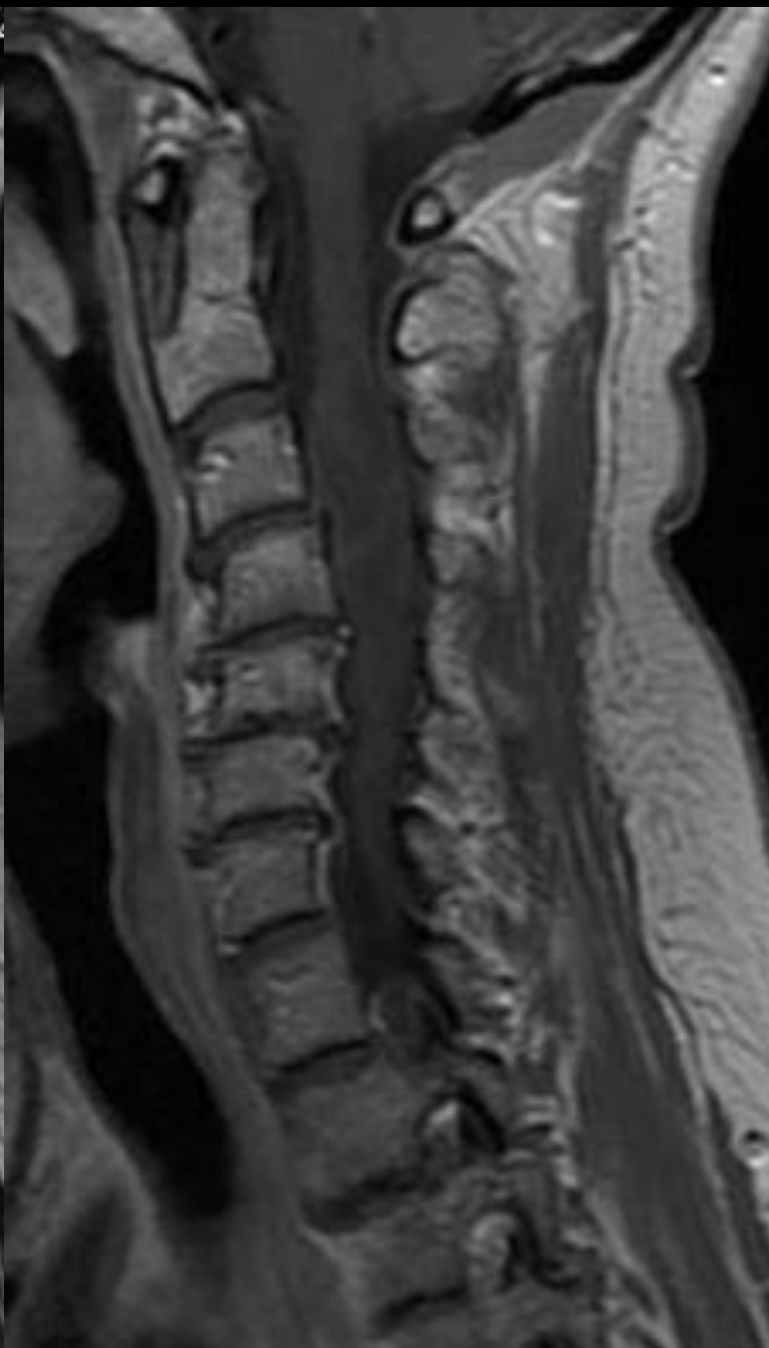
10-year-old with neck pain



Astrocytoma



- Eccentric in cord
- Poorly defined margins
- Hemorrhage uncommon
- Patchy enhancement
- Peds or adults (60% of peds tumors)

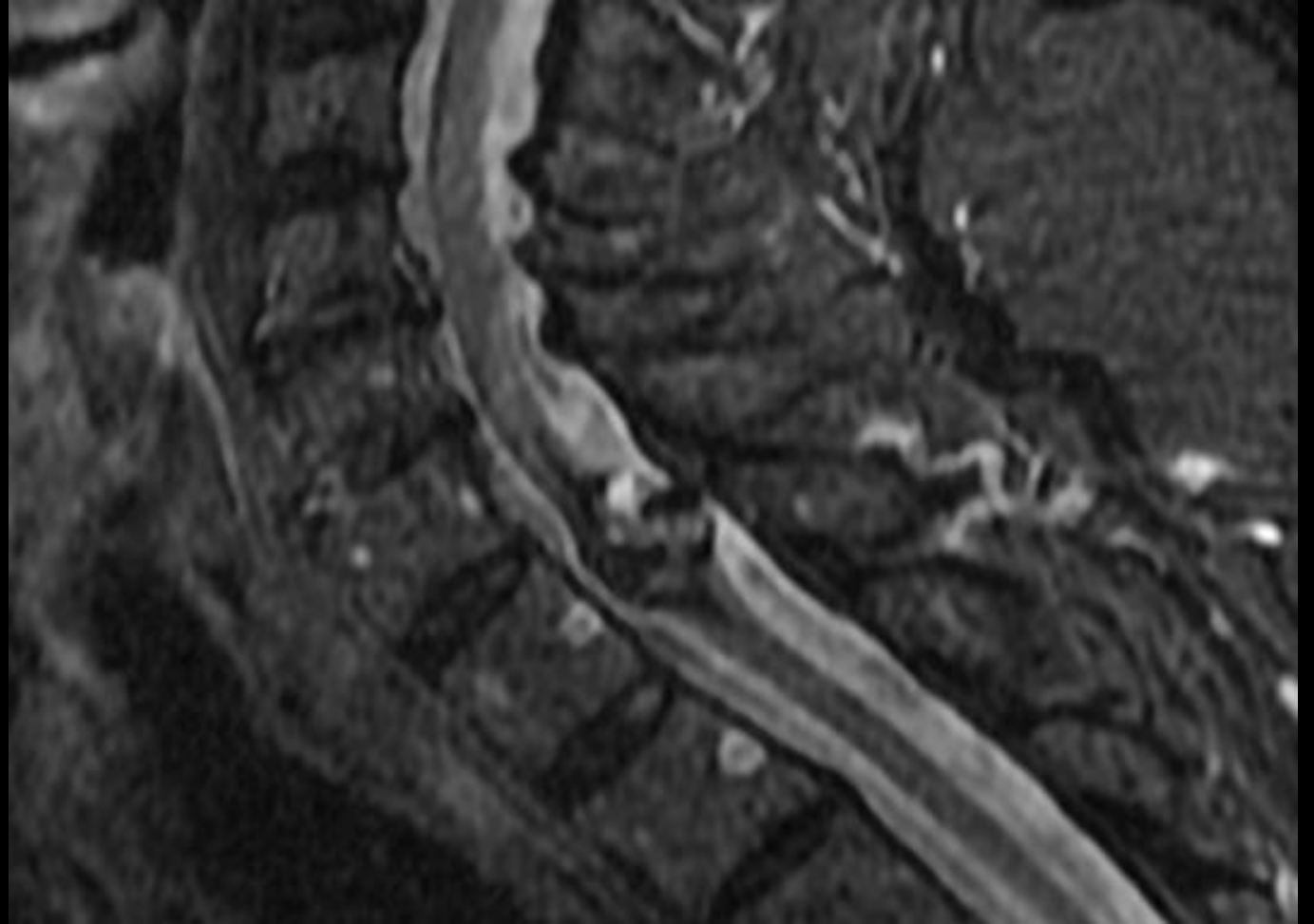


55-year-old with leg weakness

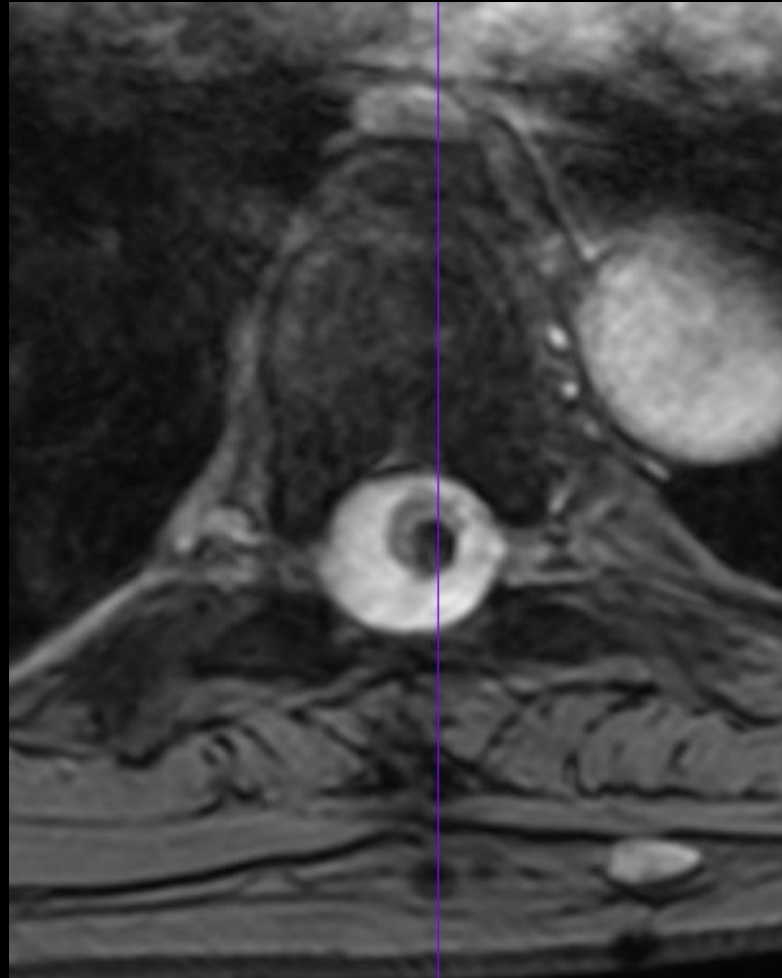


Cavernous Malformation

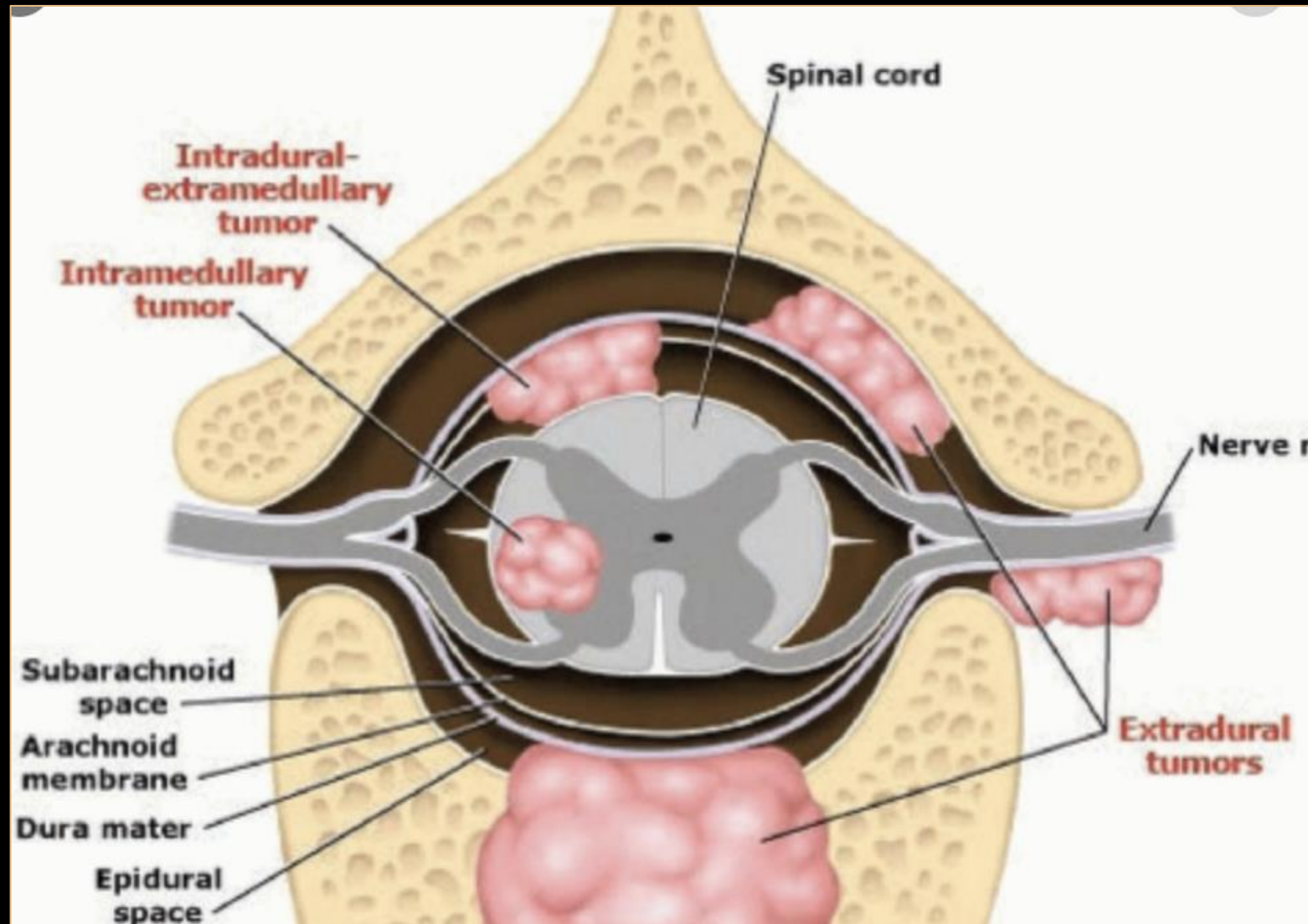
- Low flow vascular malformation with blood filled channels
- Sporadic or familial (look in the brain!)

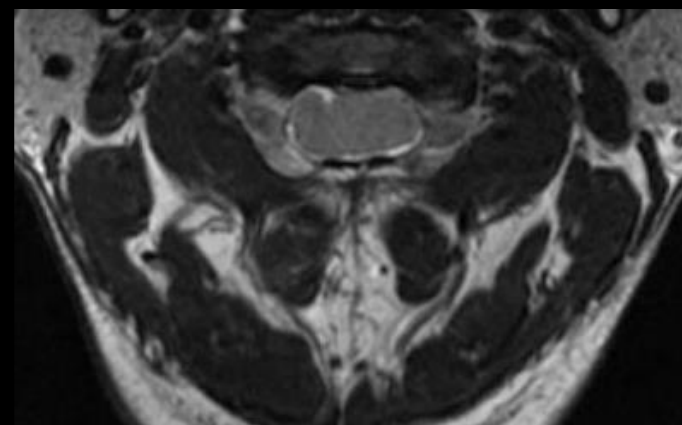
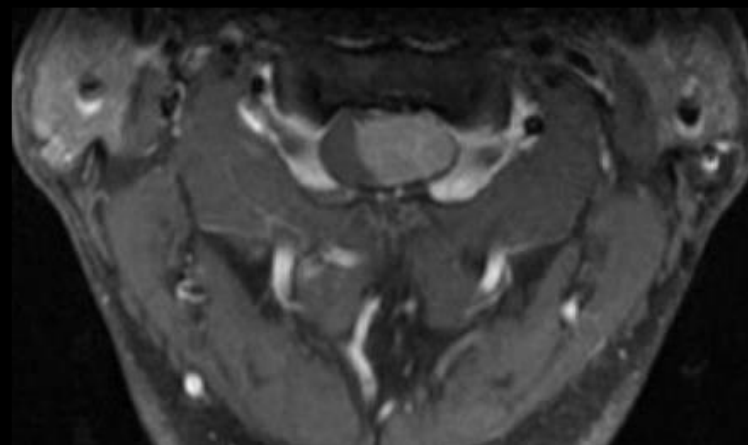


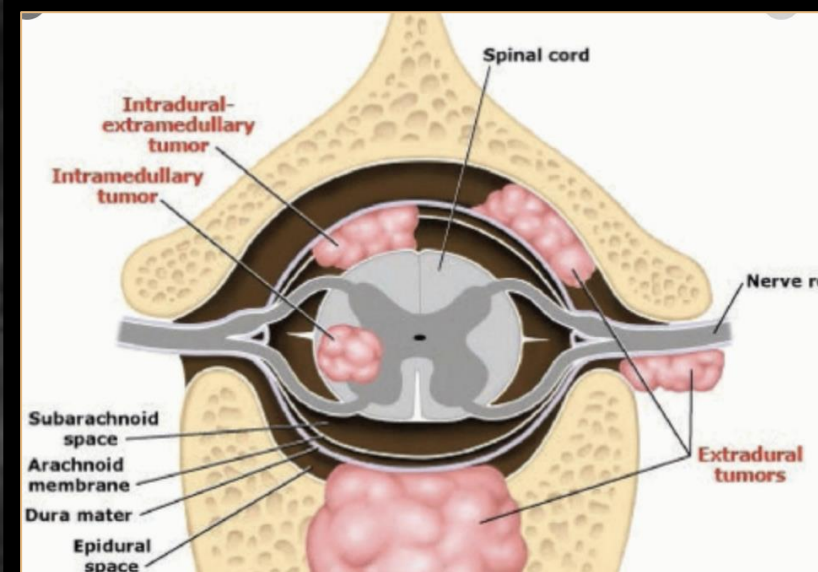
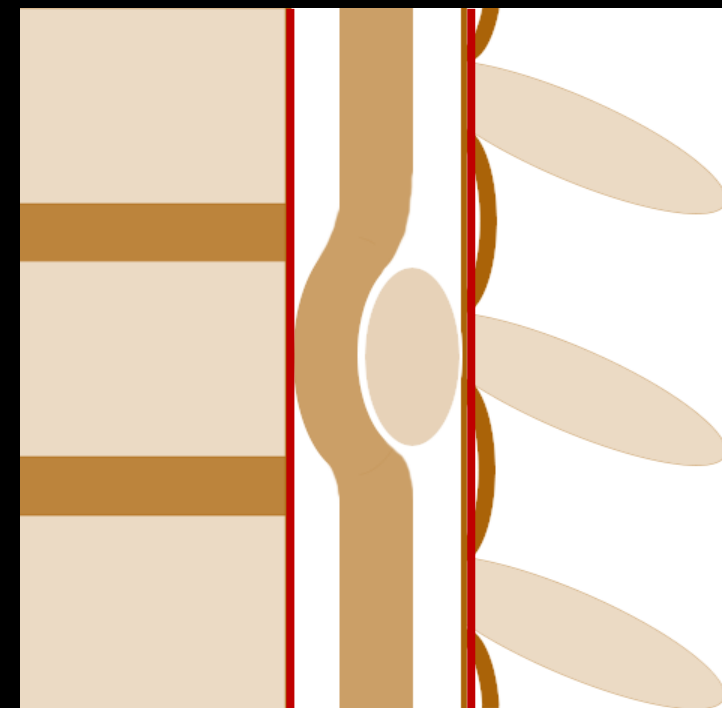
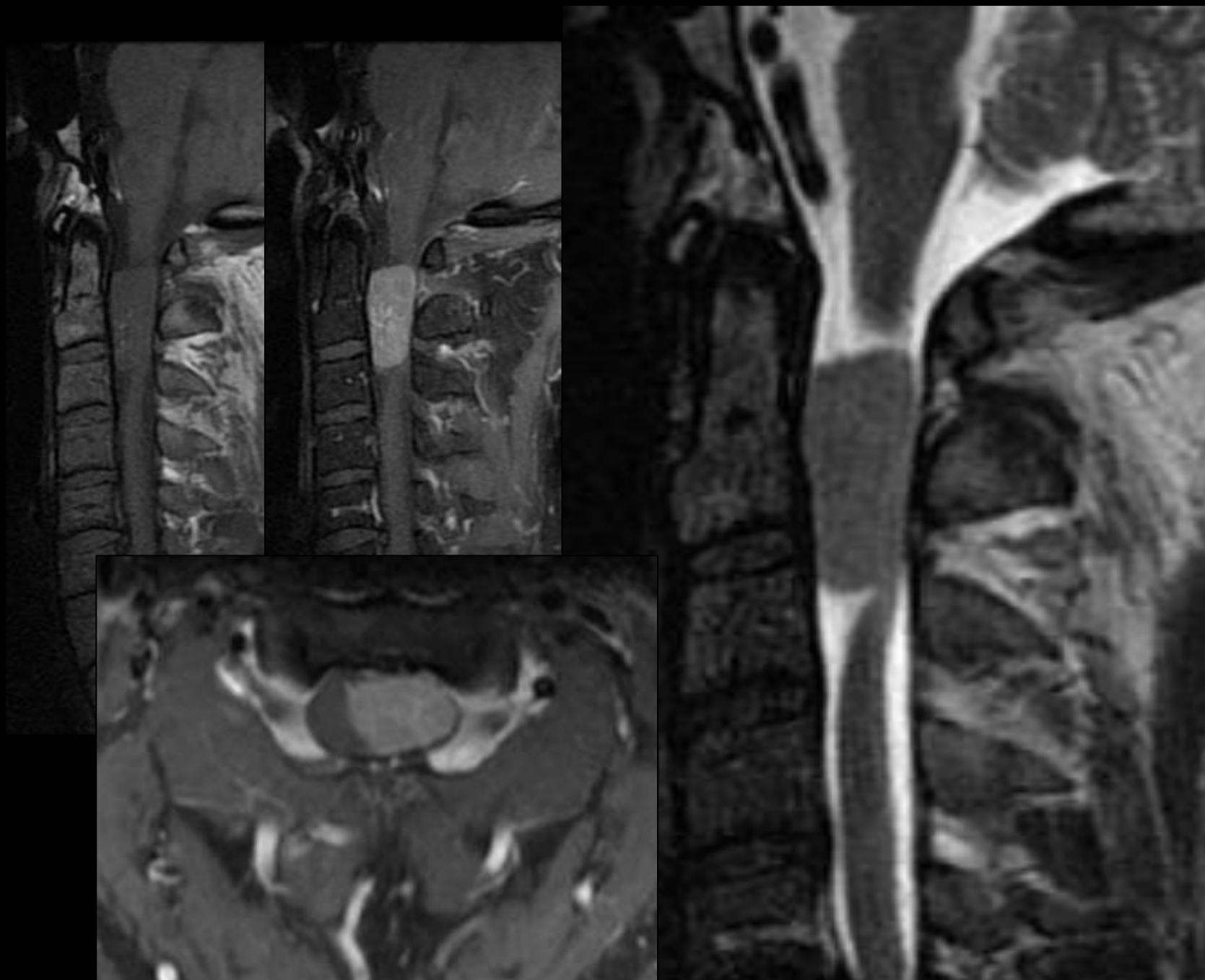
55-year-old with leg weakness

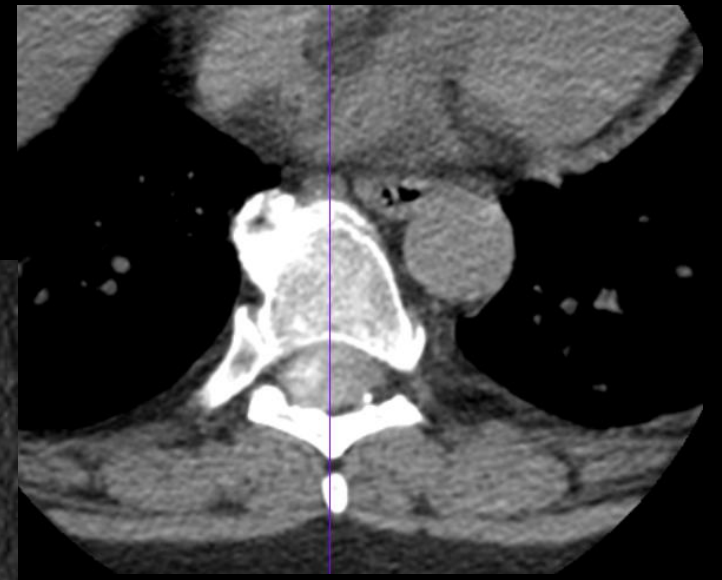
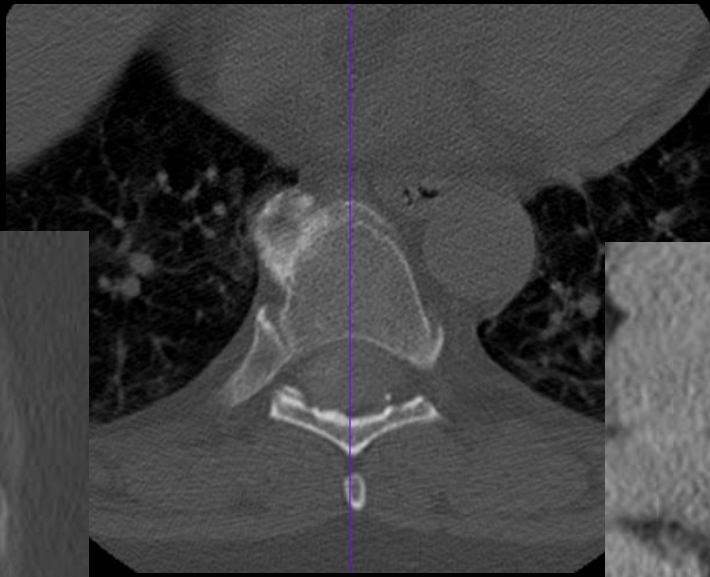


Intradural Extradurellary



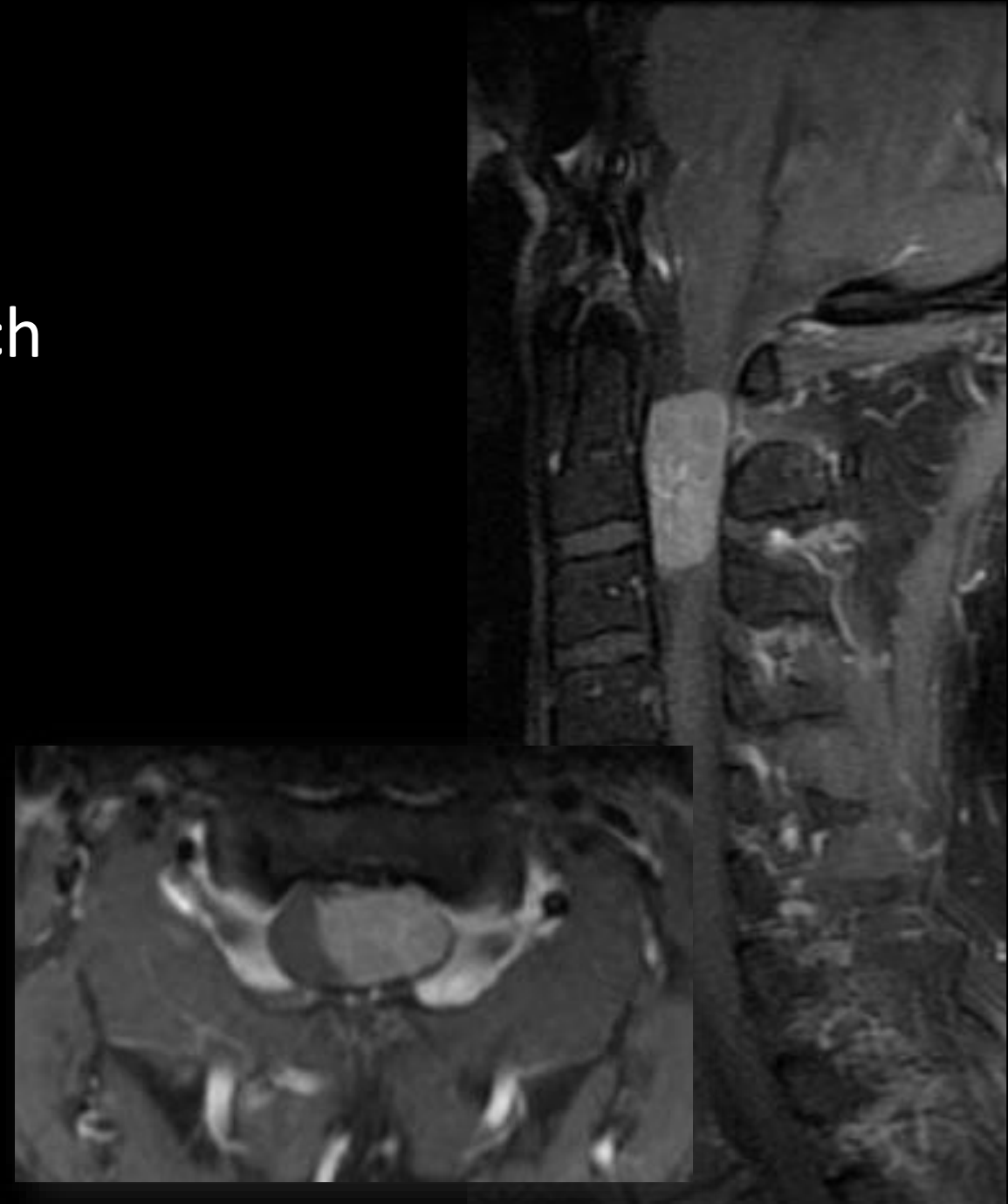


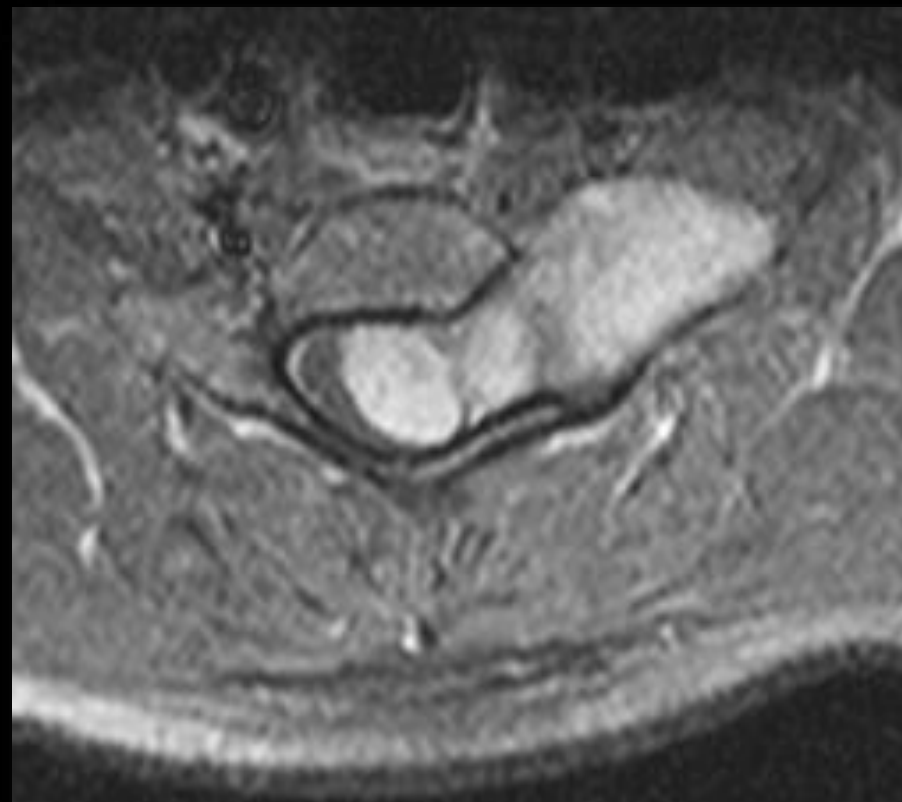




Meningioma

- In the spine, meningioma is much more common women (80%)
- 80% are in the thoracic spine
- Enhancing
- Mildly T2 hyperintense





Schwannoma

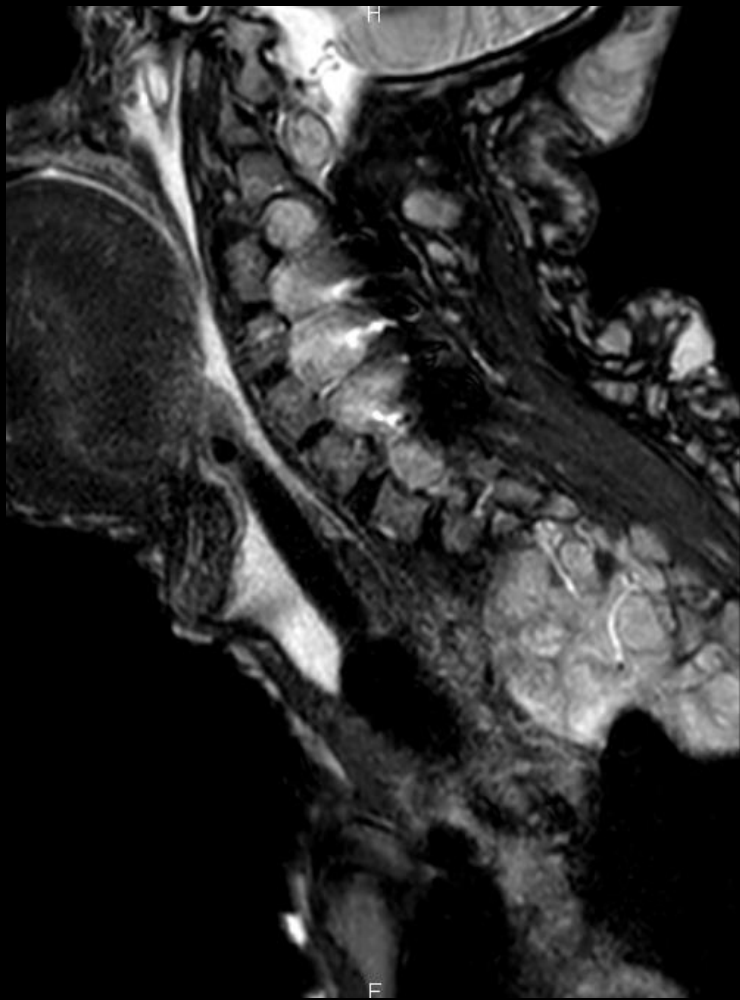
- 95% solitary
- 80% thoracic spine
- Dorsal sensory nerve (pain)
- Slow growing, remodel bone, dumbbell shape
- Cystic change is common
- T2 hyperintense



Neurofibroma

- Encase nerves
- Single sporadic or multiple NF1
- Plexiform: multiple fascicles of major nerve trunk or plexus
- Scoliosis
- Risk of malignant transformation





39

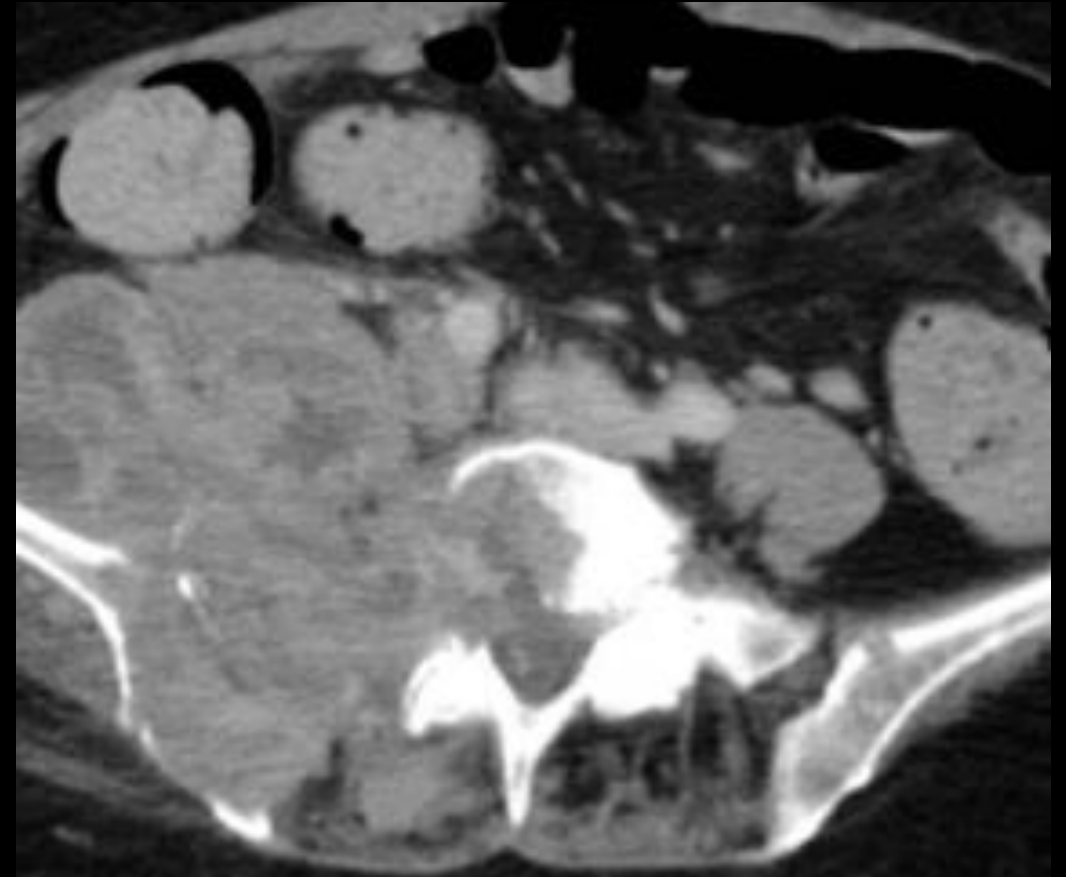
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Malignant Transformation

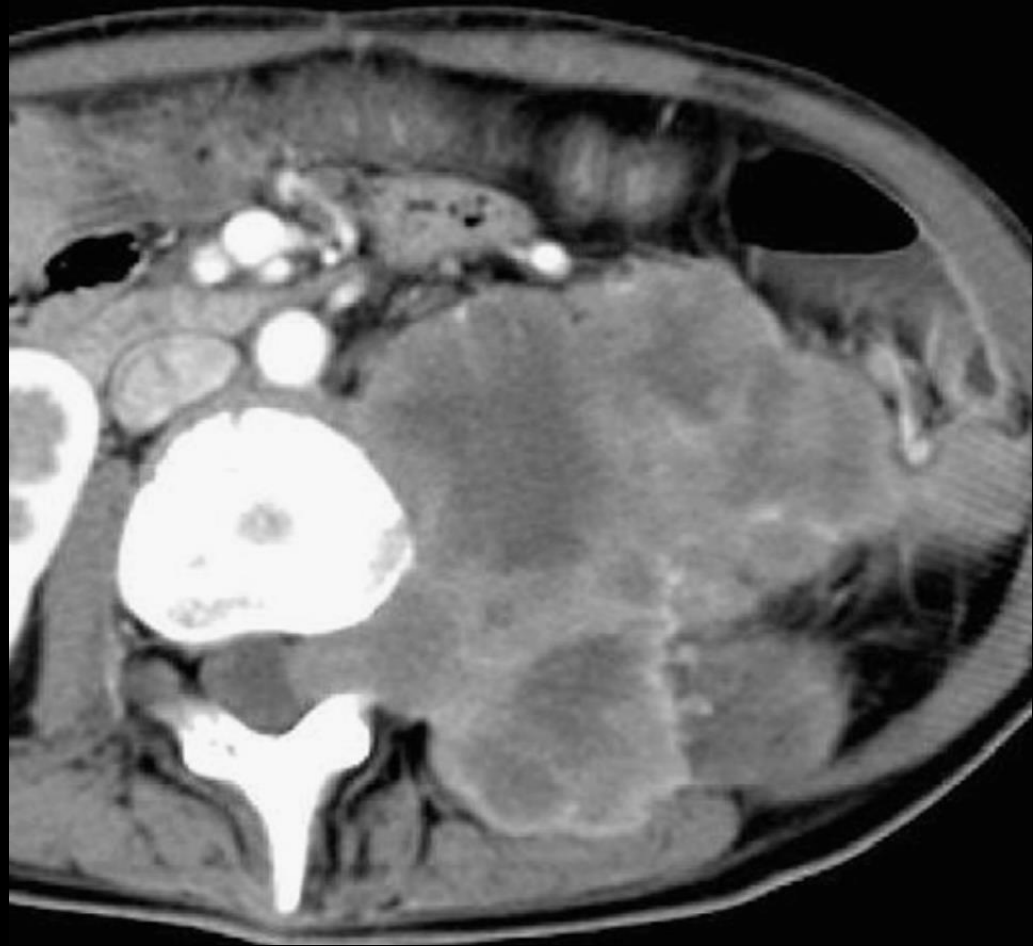
Malignant Peripheral Nerve Sheath Tumor

- Soft tissue sarcoma
- Aggressive and metastasize
- Rare sporadic
- 10% of NF1 get them
- Transformation or secondary after radiation (at least 10 year latent period)
- Heterogeneous with hemorrhage, calcification, necrosis
- Bone erosion and destruction



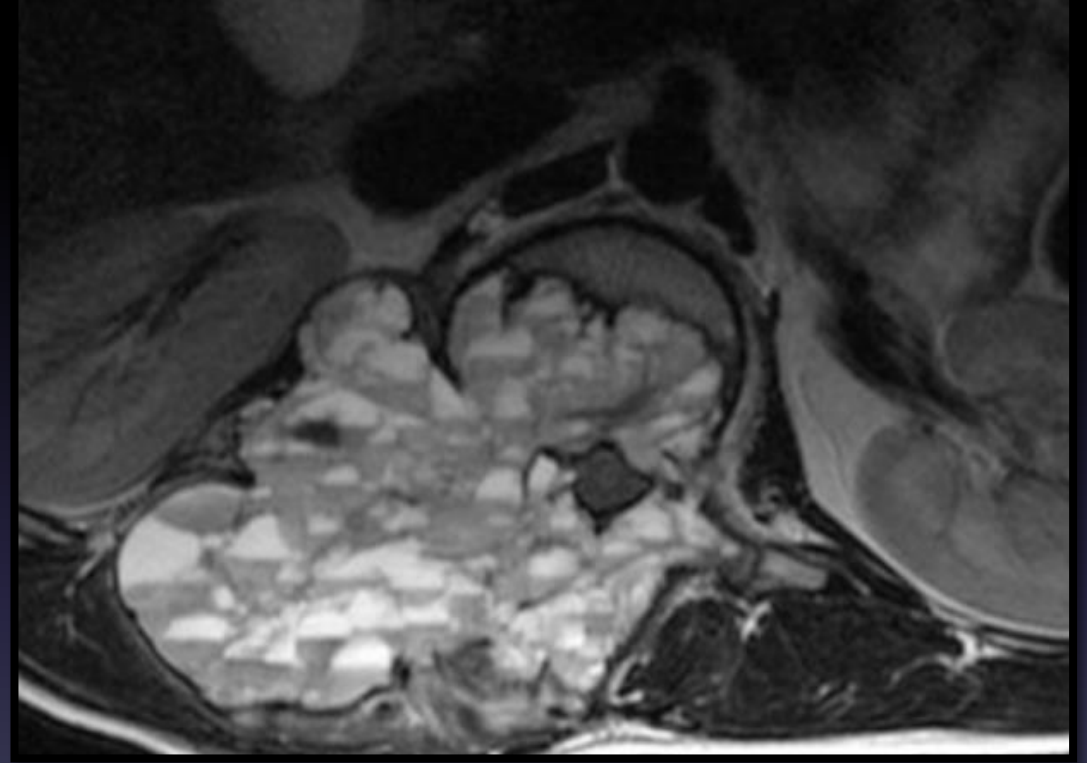
Malignant Peripheral Nerve Sheath Tumor

- PET: FDG uptake helps to distinguish from neurofibroma
- Biopsy is necessary



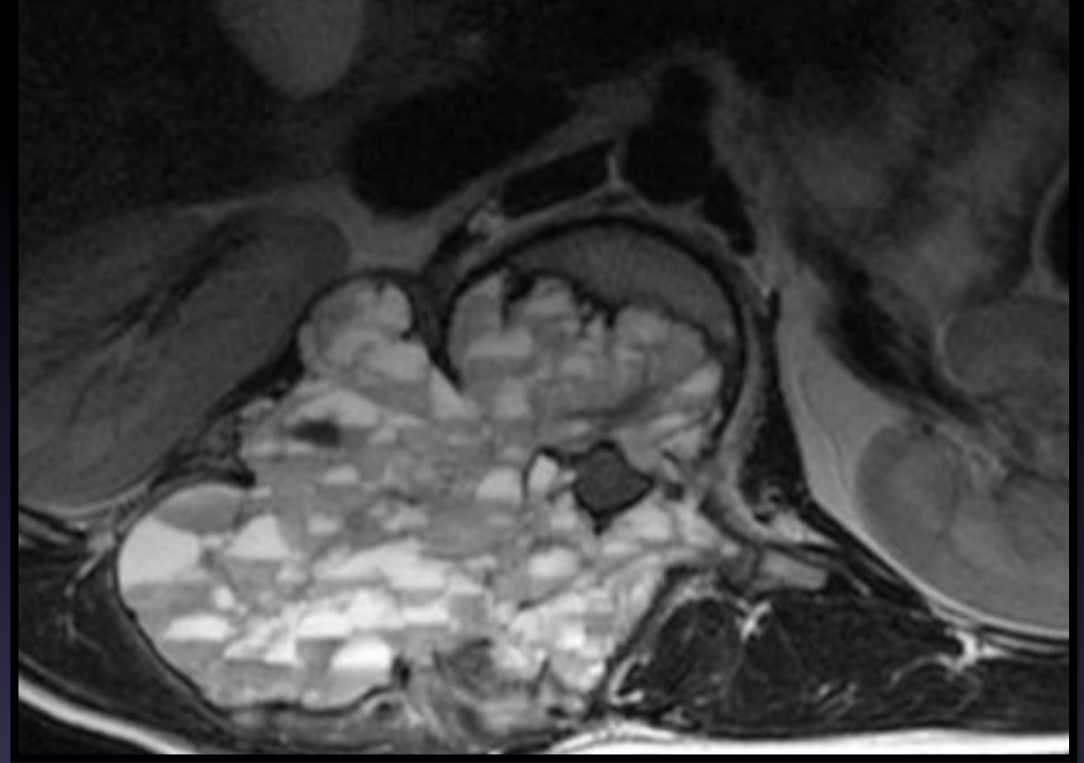
Primary bone tumors

- Giant cell tumor
- Aneurysmal bone cyst
- Chordoma
- Chondrosarcoma
- Osteoid osteoma/ Osteoblastoma
- (Primary osseous) Lymphoma
- Plasmacytoma

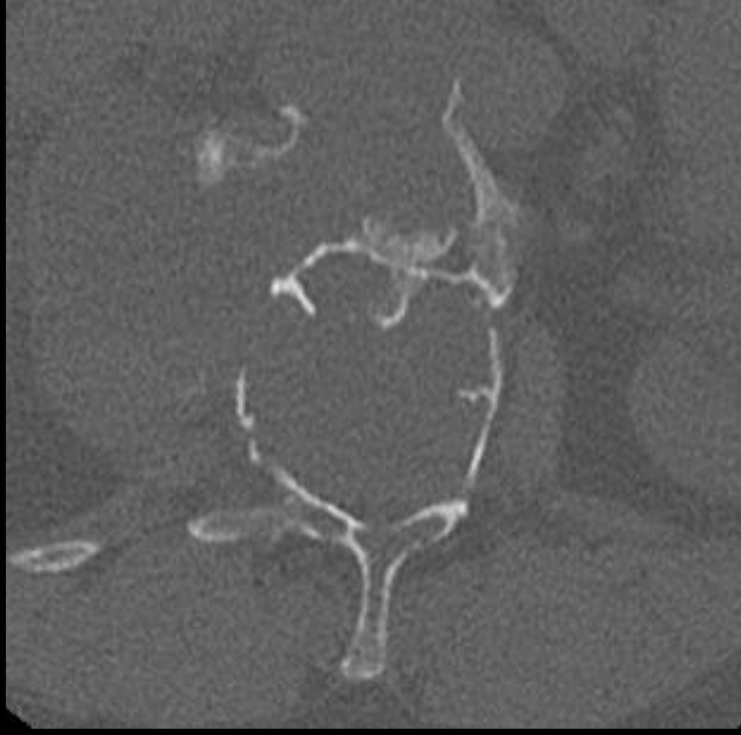
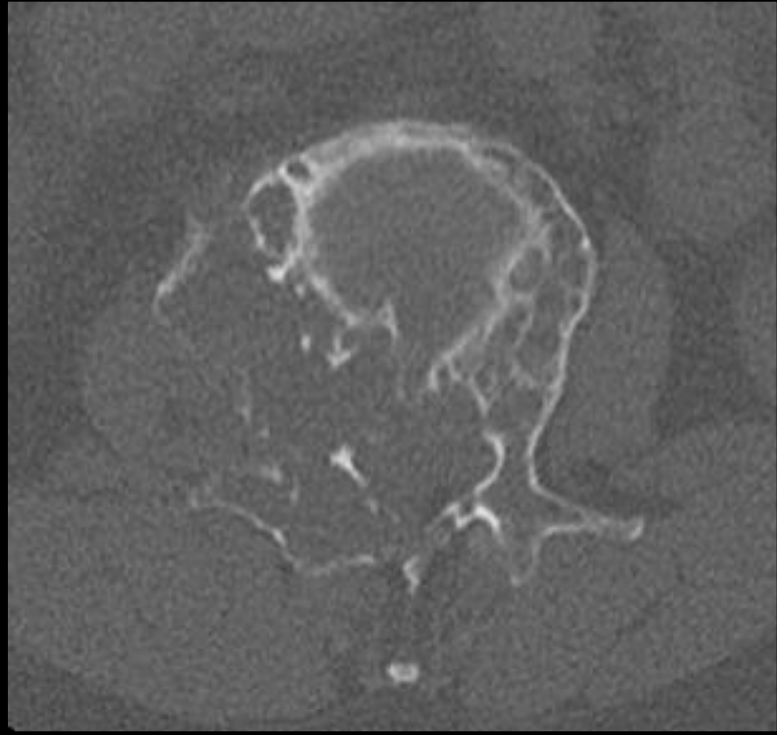


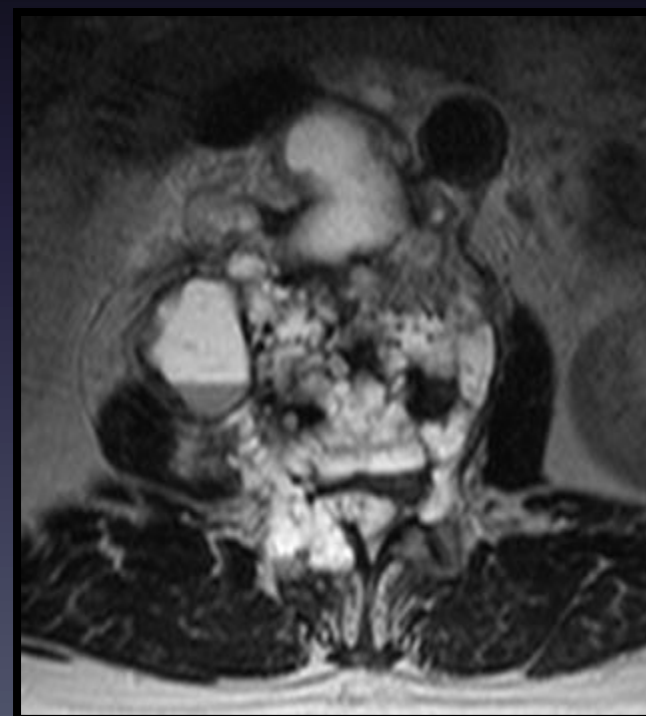
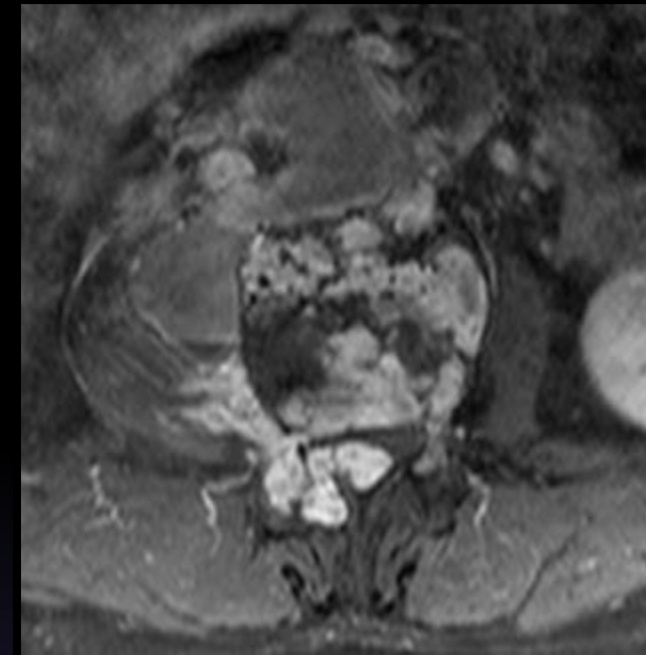
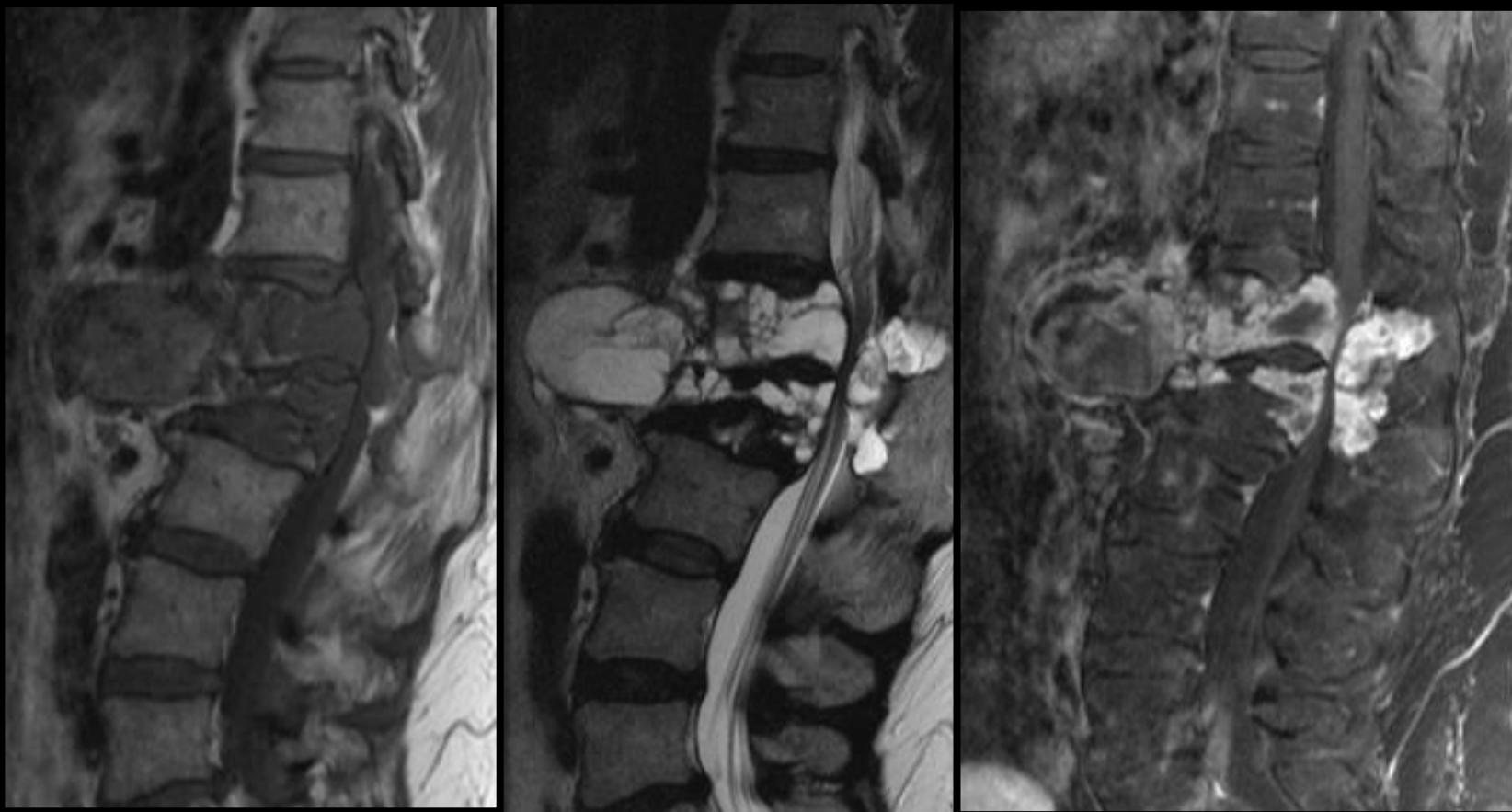
Aneurysmal Bone Cyst

- Thin rim of bone, septations, pathologic fractures
- Benign, locally aggressive
- Only half have fluid levels (as do Giant cell tumor and Chondroblastoma)
- Biopsy required for Dx
- Radical surgical excision
- Still don't know cause!



Primary bone tumors

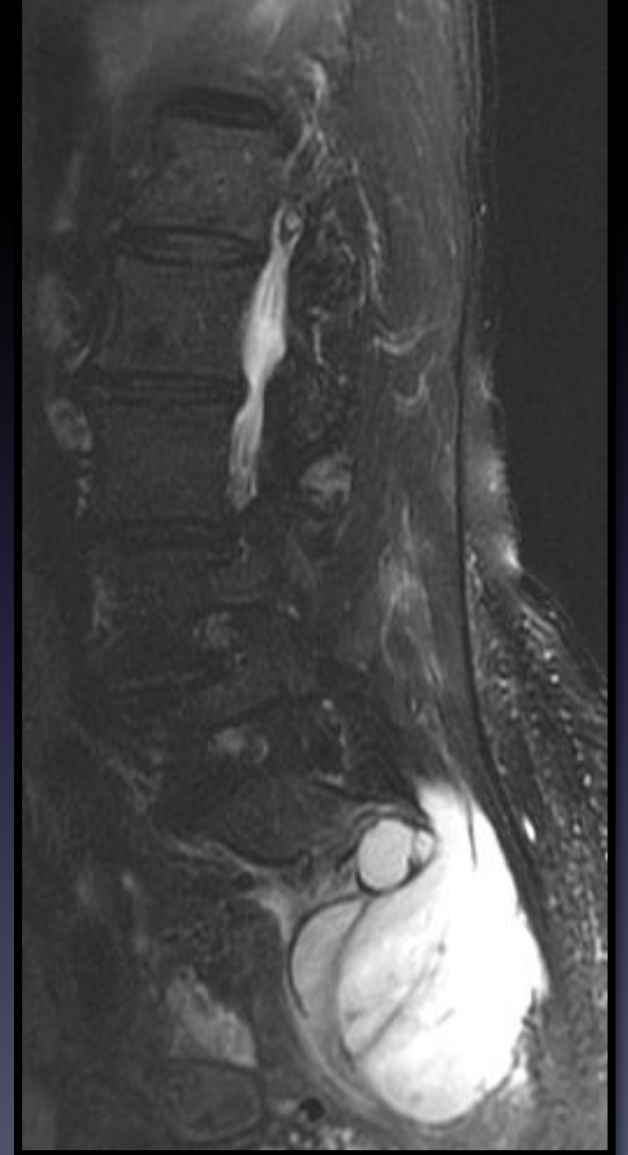
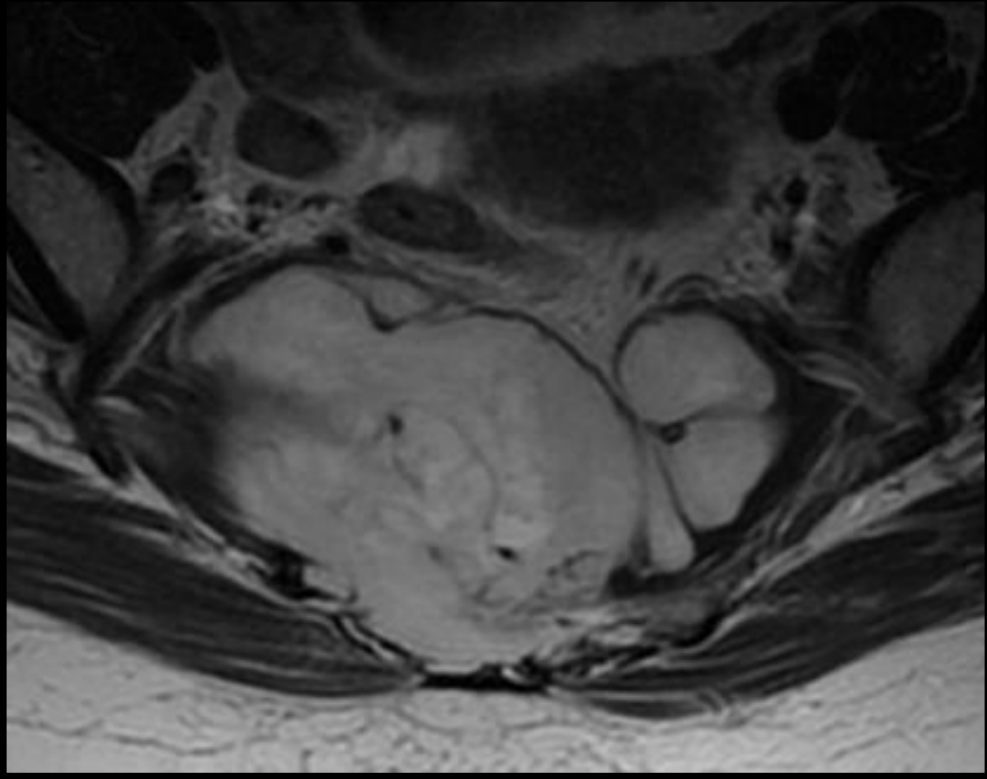




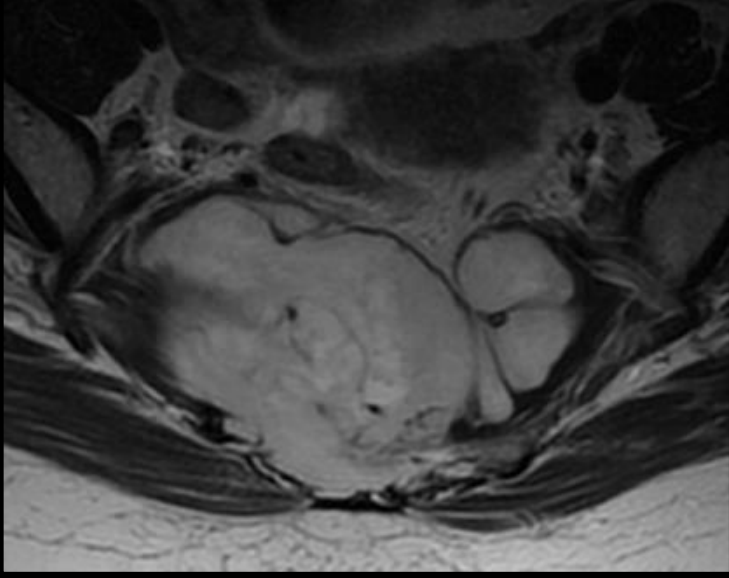
Giant Cell Tumor

- Expansile, lytic
- Collagen, hemosiderin – iso to low T2
- Hypervascular
- One of the few that crosses disc space

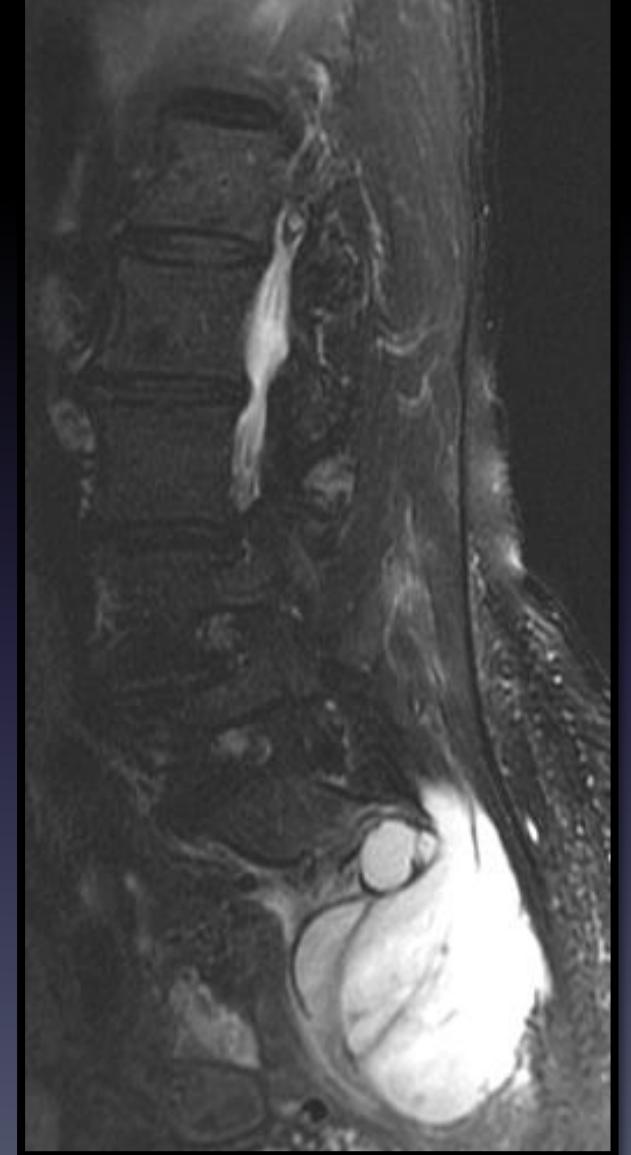
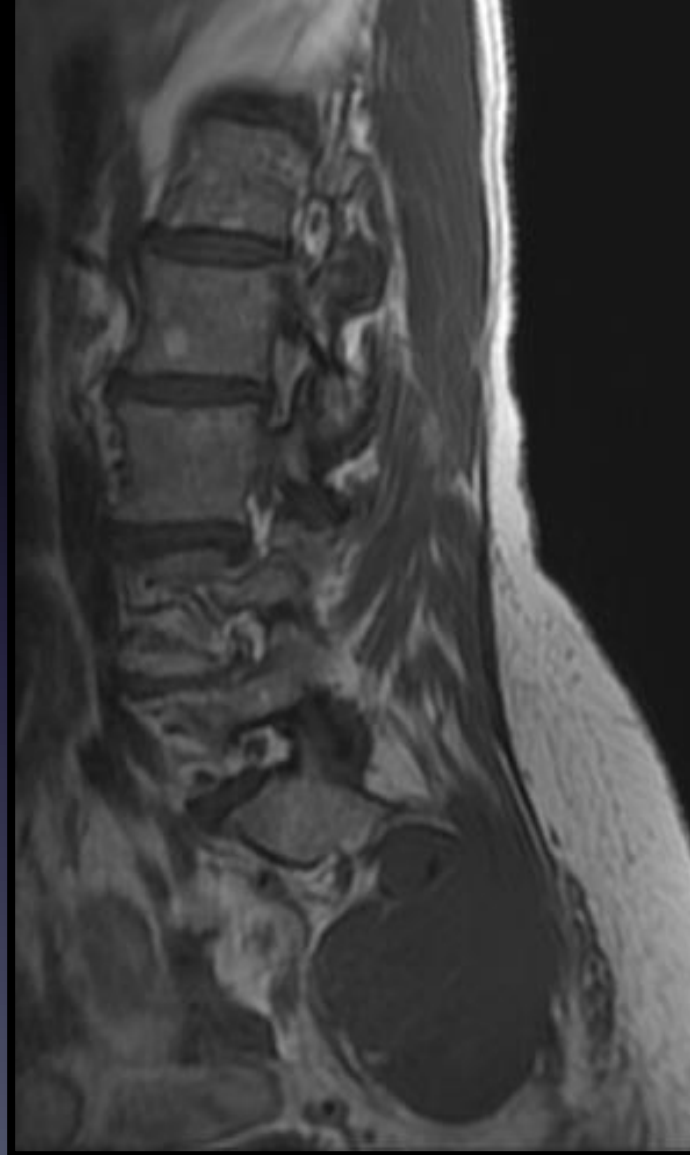
Primary bone tumors

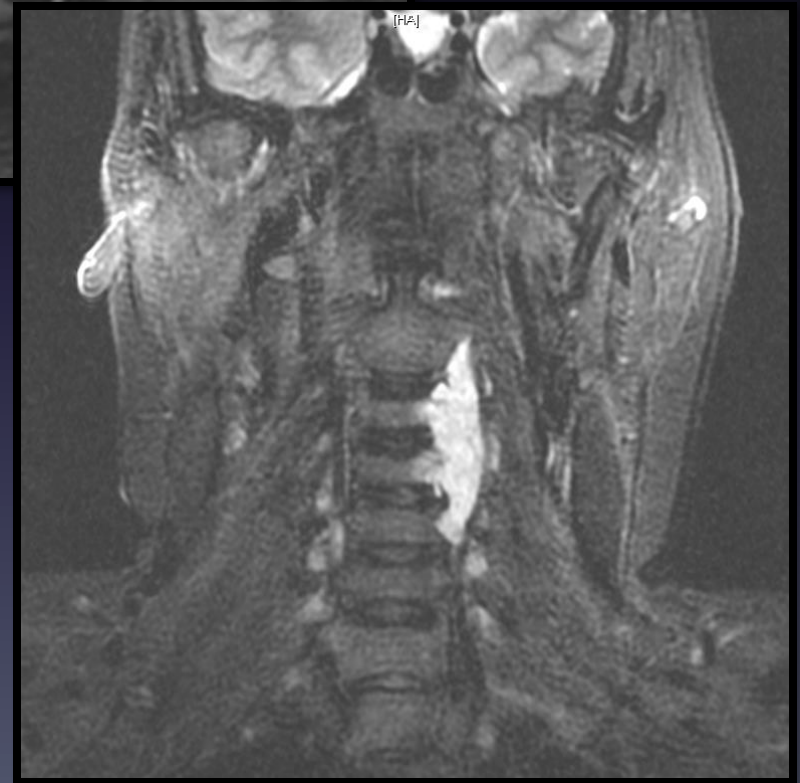
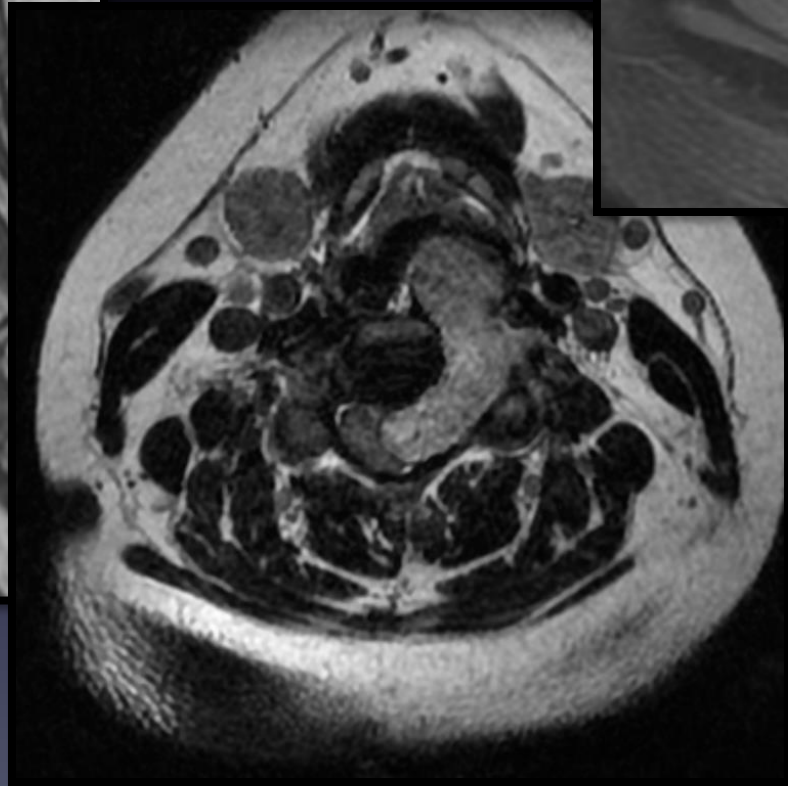
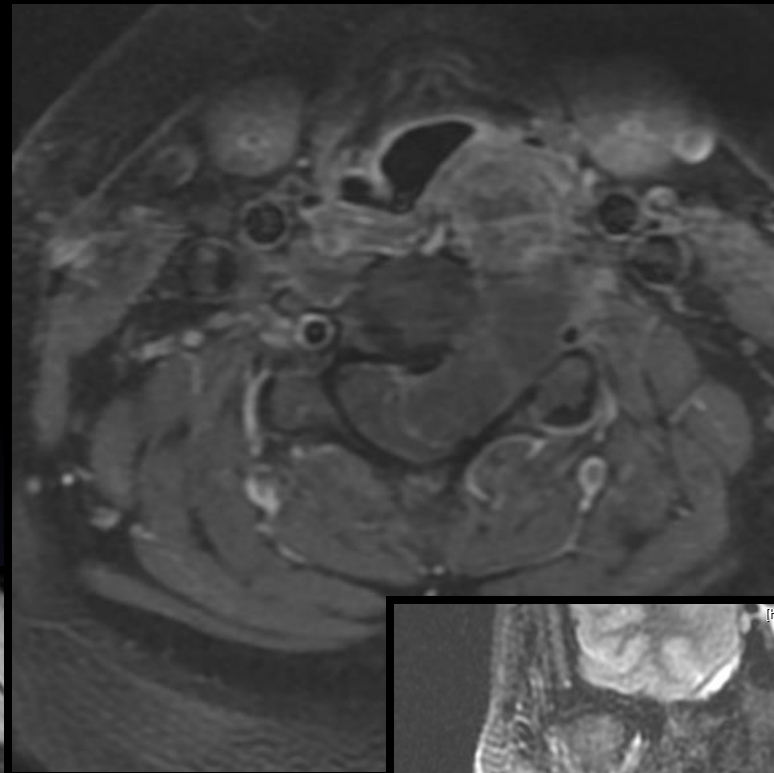
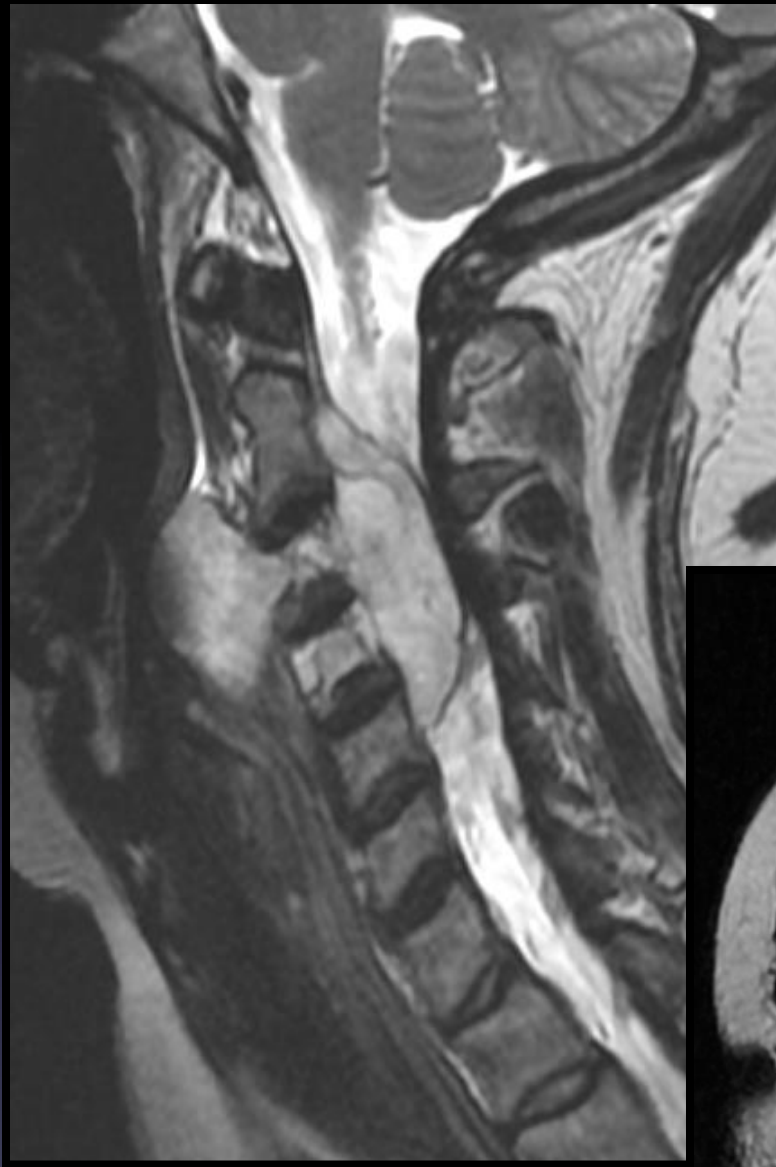


Chordoma

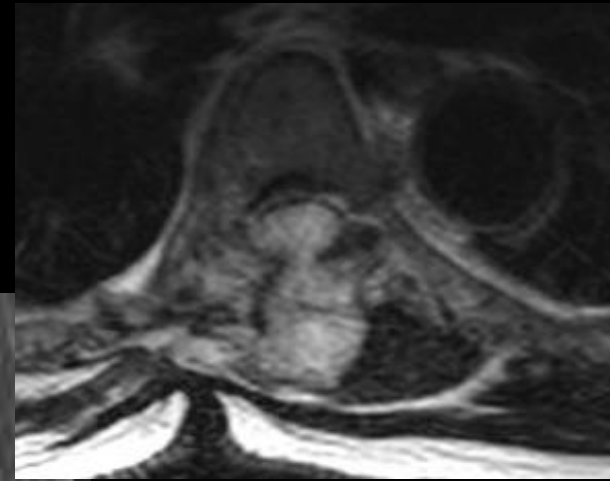


Residual embryonic notochord
Very T2 hyperintense
Variably enhancing
Cross disc space

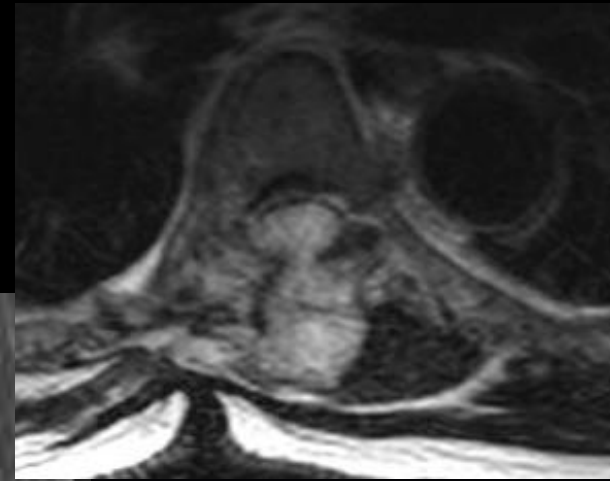




Primary bone tumors

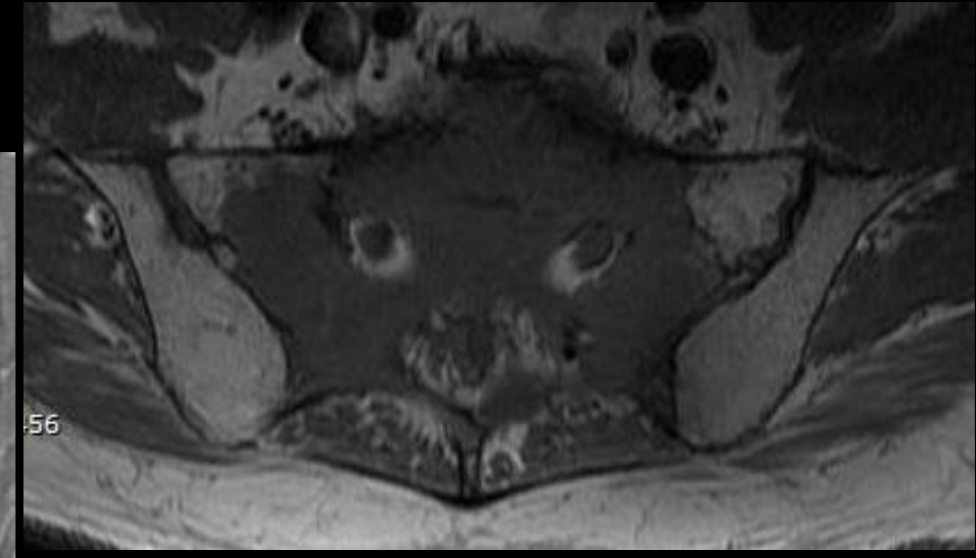
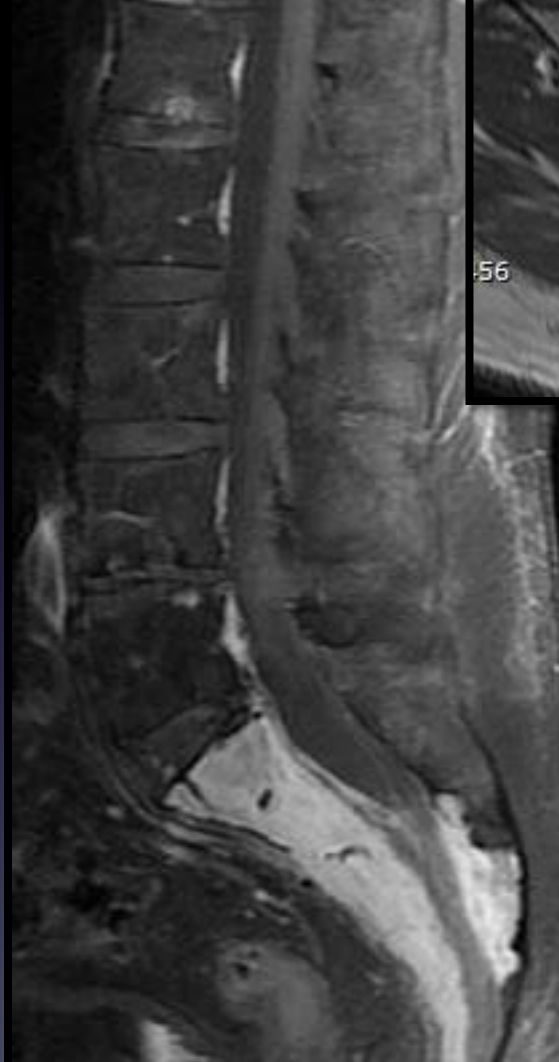
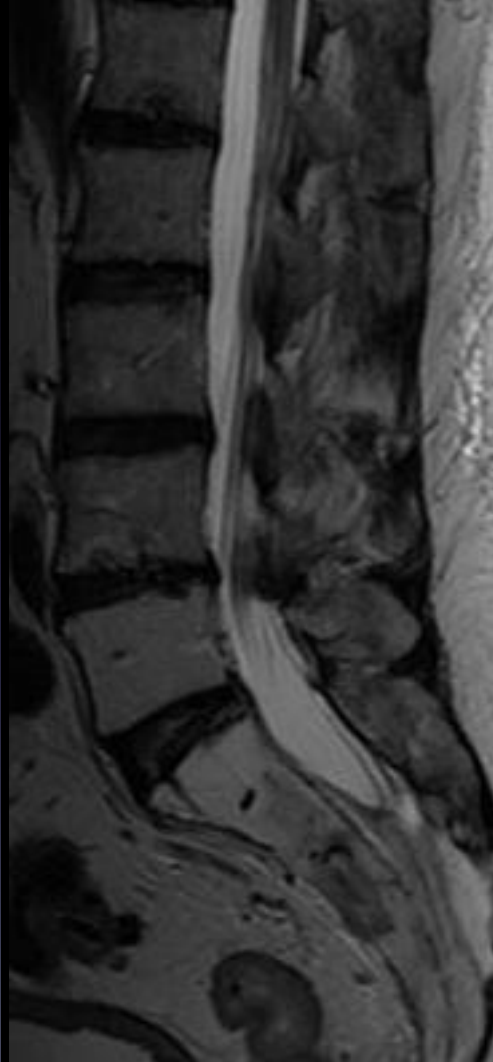


Chondrosarcoma

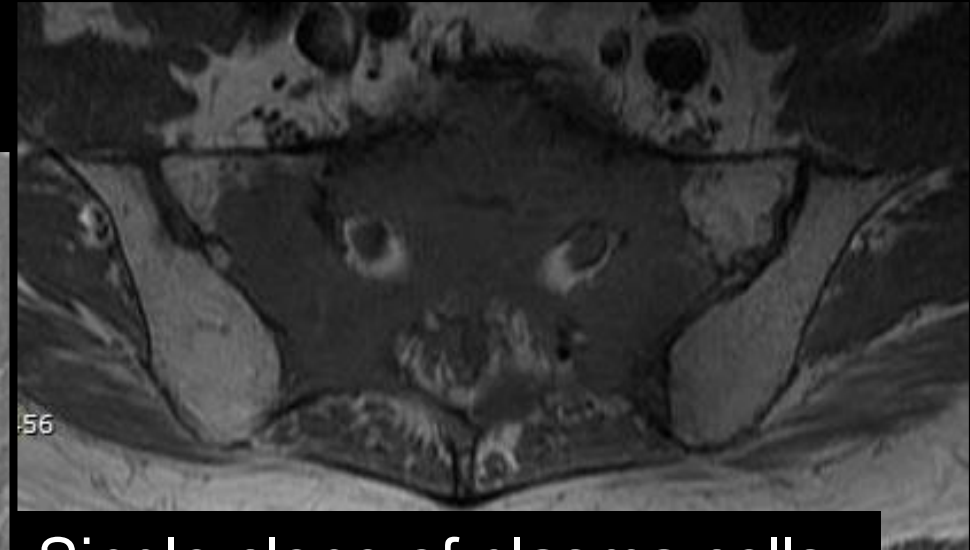
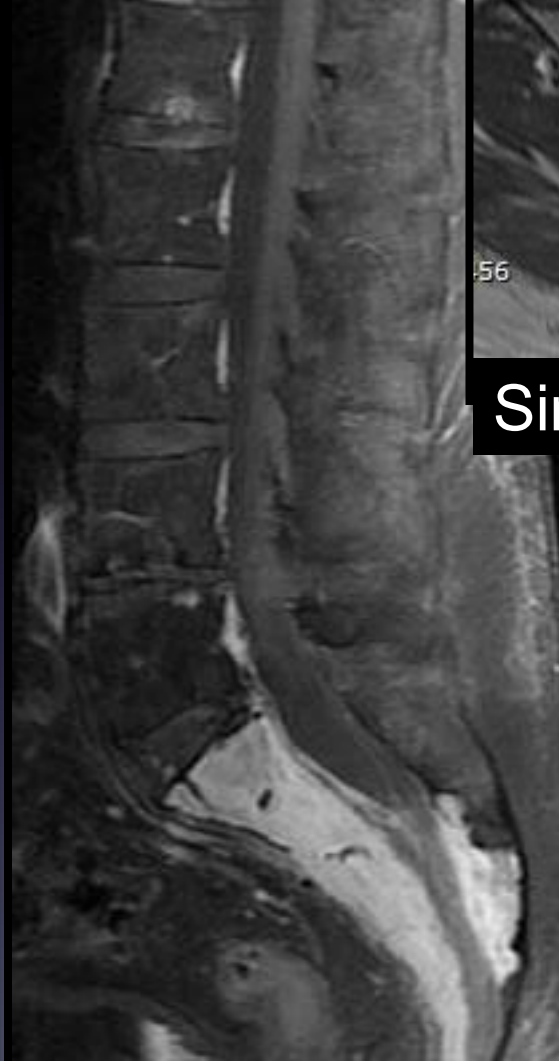
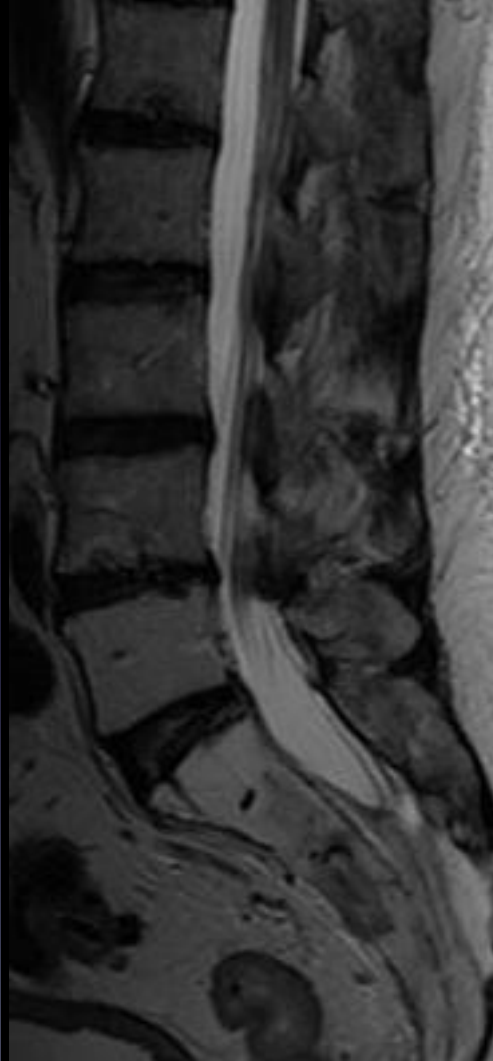
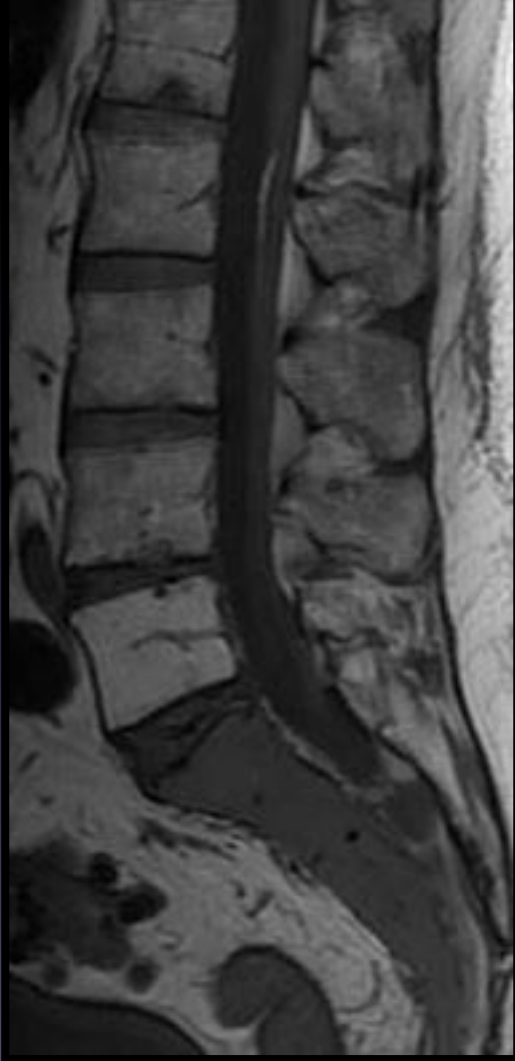


Mineralized and
non mineralized
matrix

Primary bone tumors



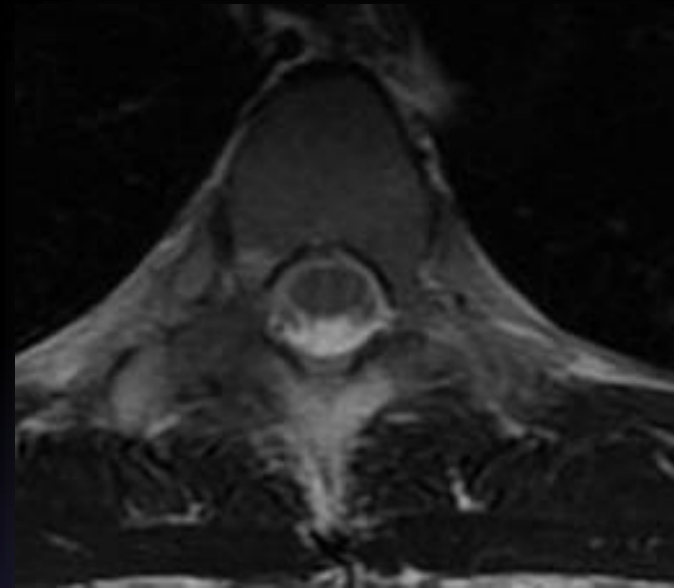
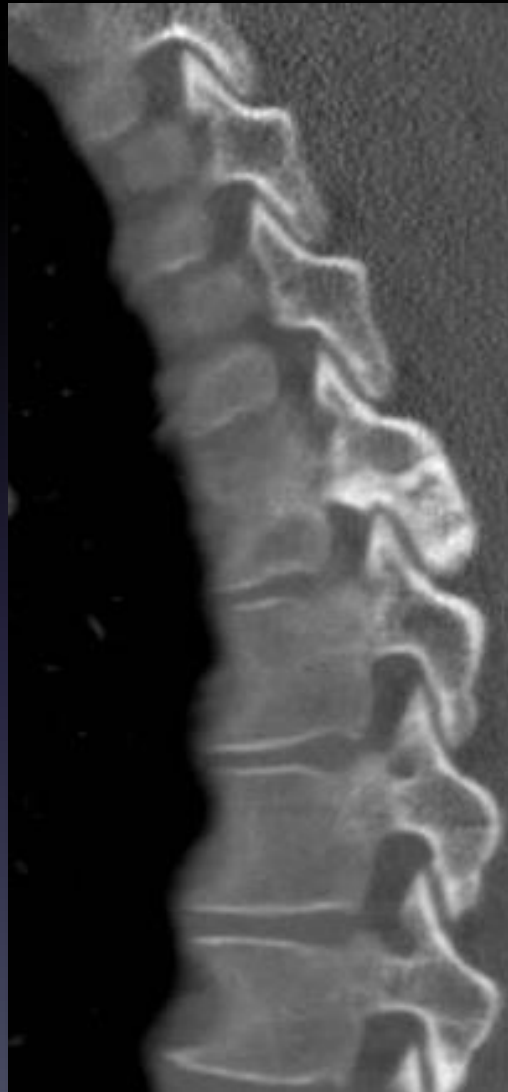
Plasmacytoma



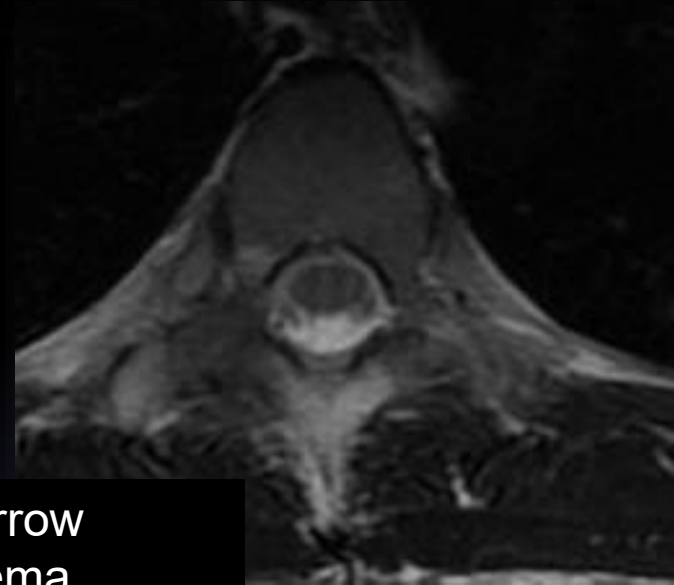
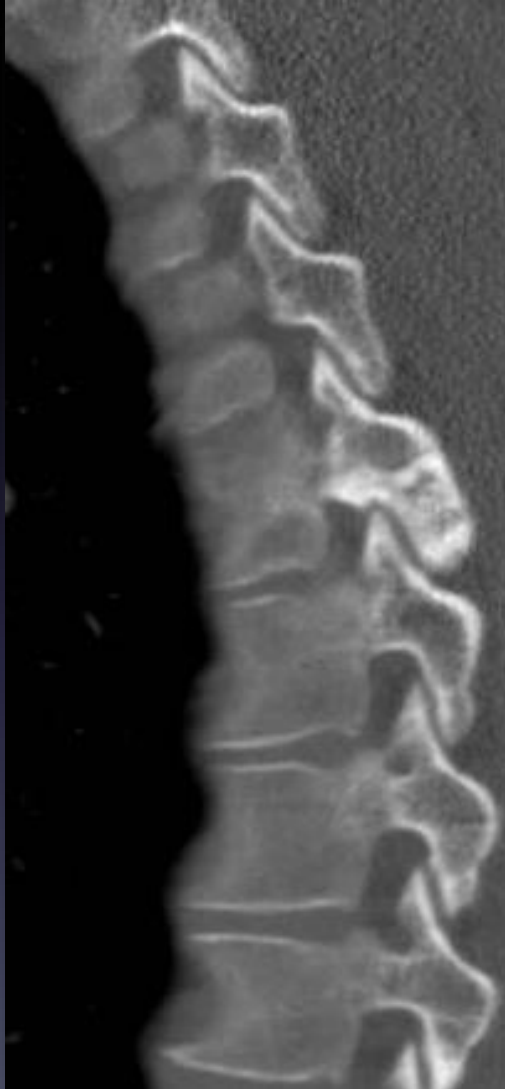
Single clone of plasma cells



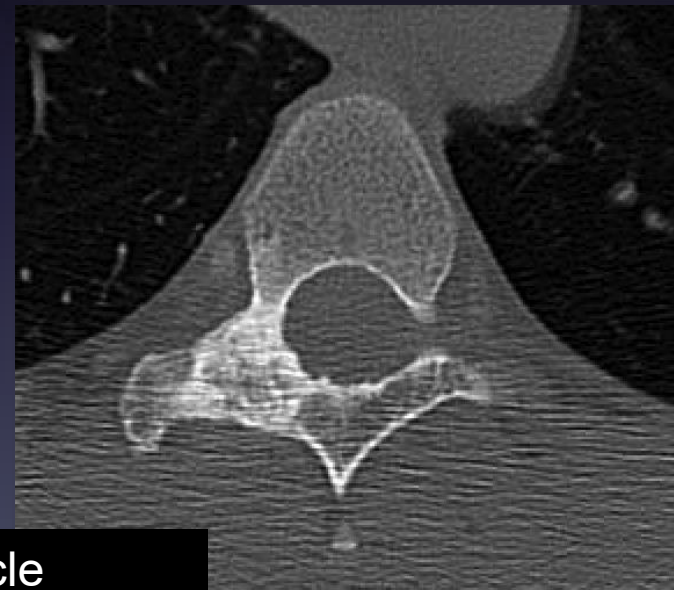
Primary bone tumors



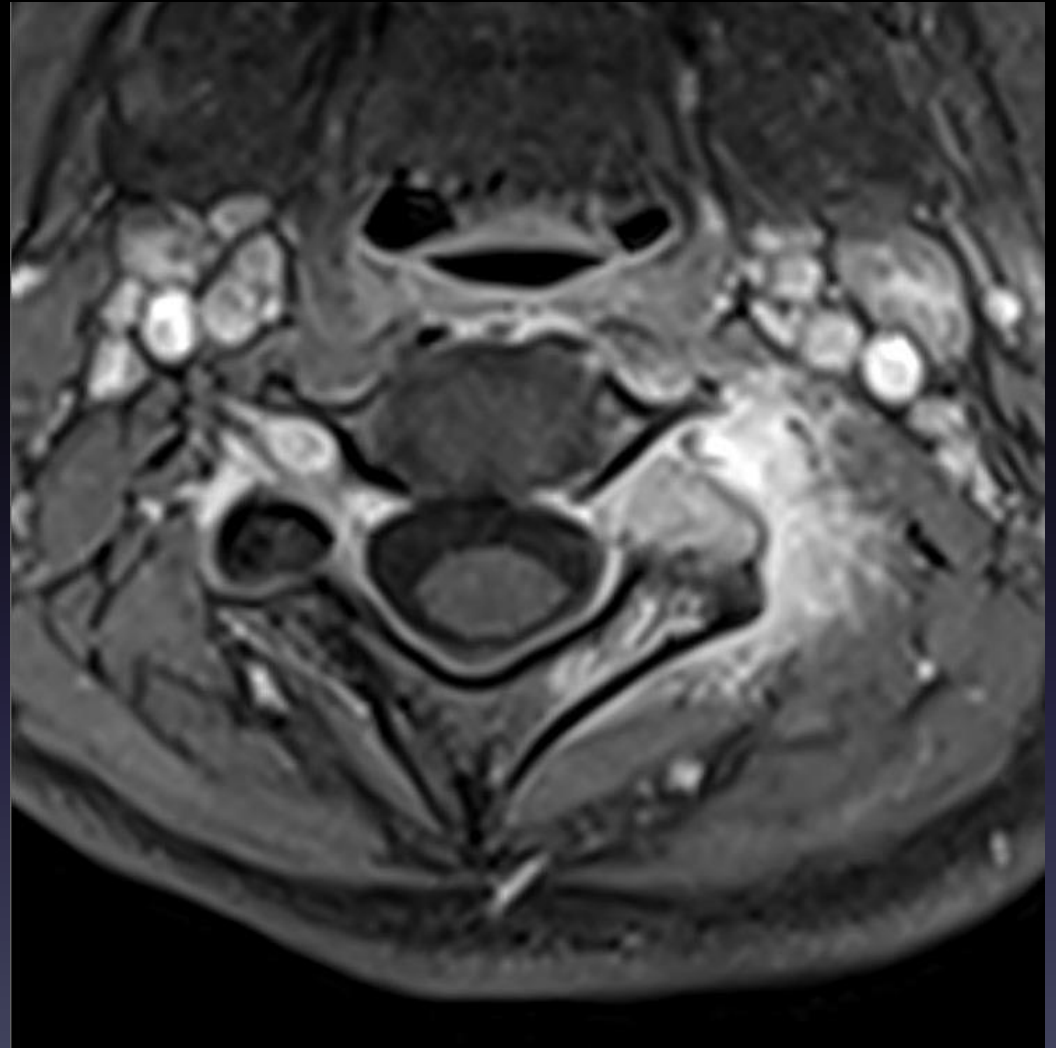
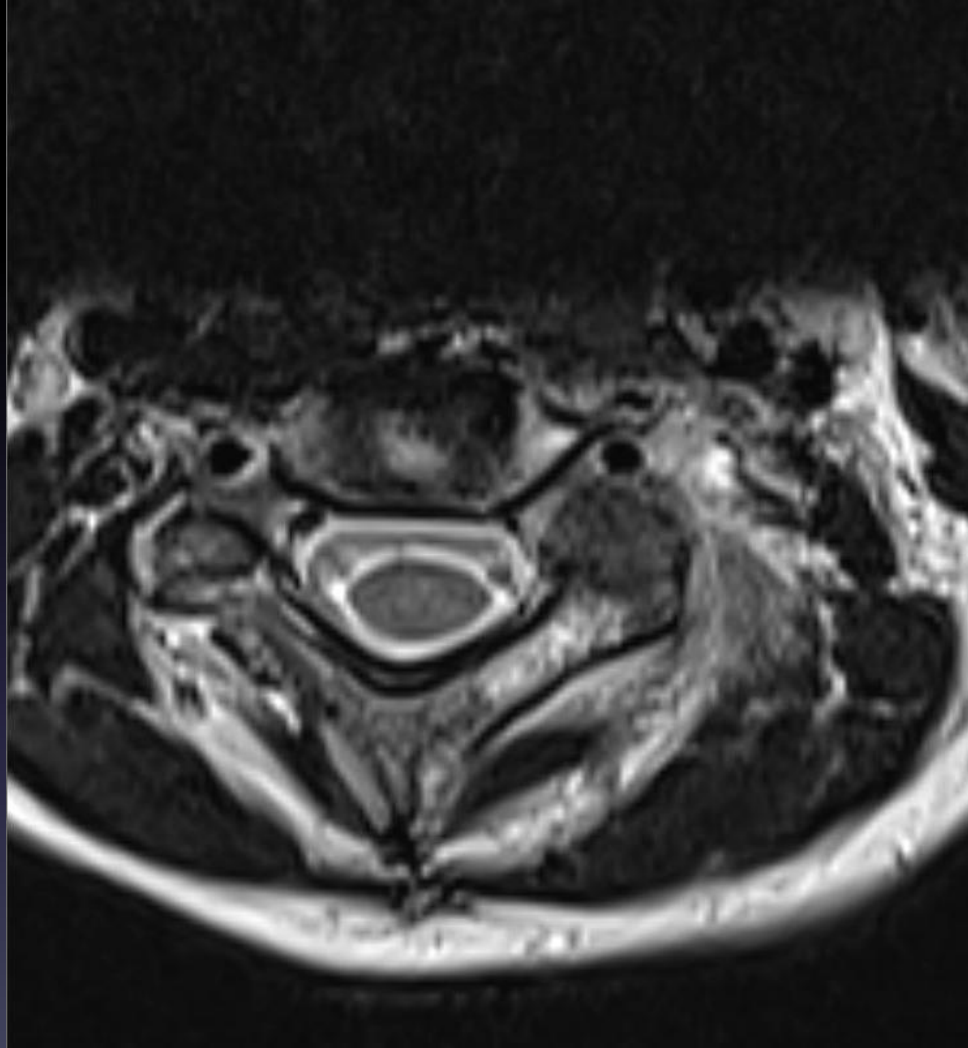
Osteoid Osteoma

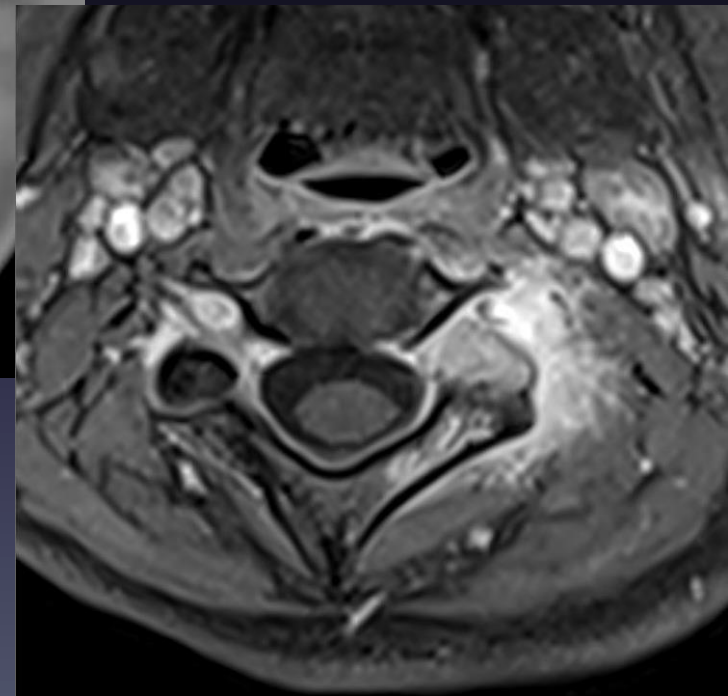
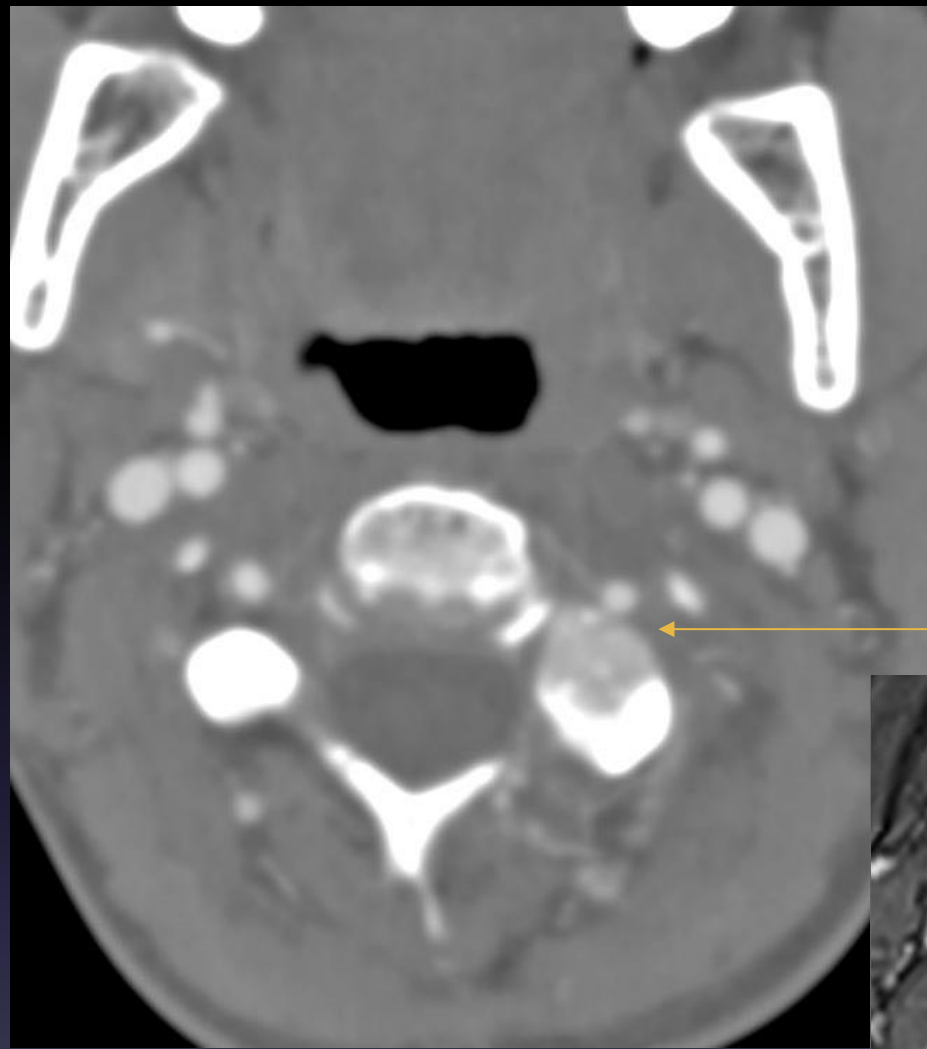
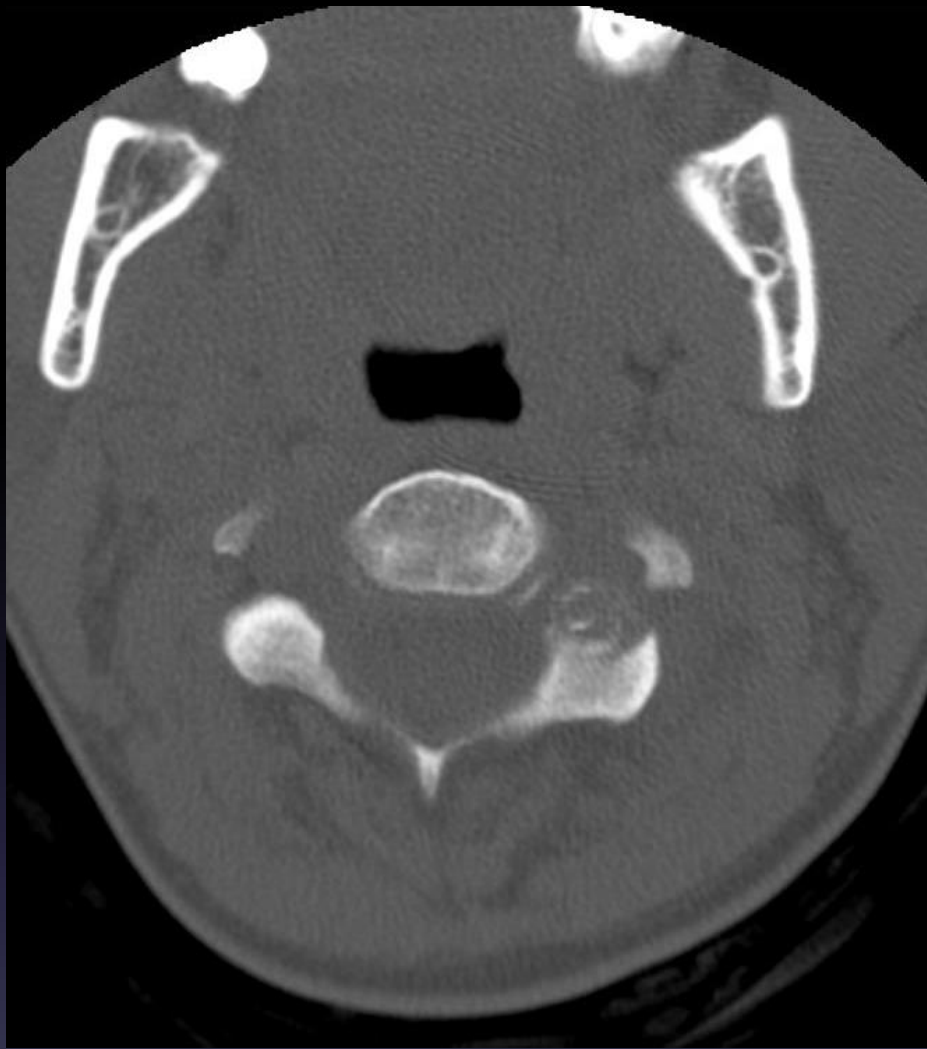


Marrow
edema



Pedicle
common site







Barrow
Neurological Institute

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