MAYO CLINIC

OPTIMAL SURGICAL APPROACHES FOR CERVICAL SPONDYLOTIC MYELOPATHY - RADICULOPATHY SYNDROMES

- A CASE-BASED APPROACH

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DEGENERATIVE CERVICAL MYELOPATHY (DCM)

No disclosures

Goals

- Discuss the nature of this pathology
- Clinical symptomatology guiding to surgical approach

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Cervical spondylosis with resultant myelopathy and/or radiculopathy
- Increasingly prevalent disease in our growing aging population
- Anywhere from 20 to 63% of patients with DCM
- Worsening neurological function 3 to 6 years from diagnosis

DEGENERATIVE CERVICAL MYELOPATHY (DCM) - EPIDEMIOLOGY

Cascade of degenerative changes in the aging spine

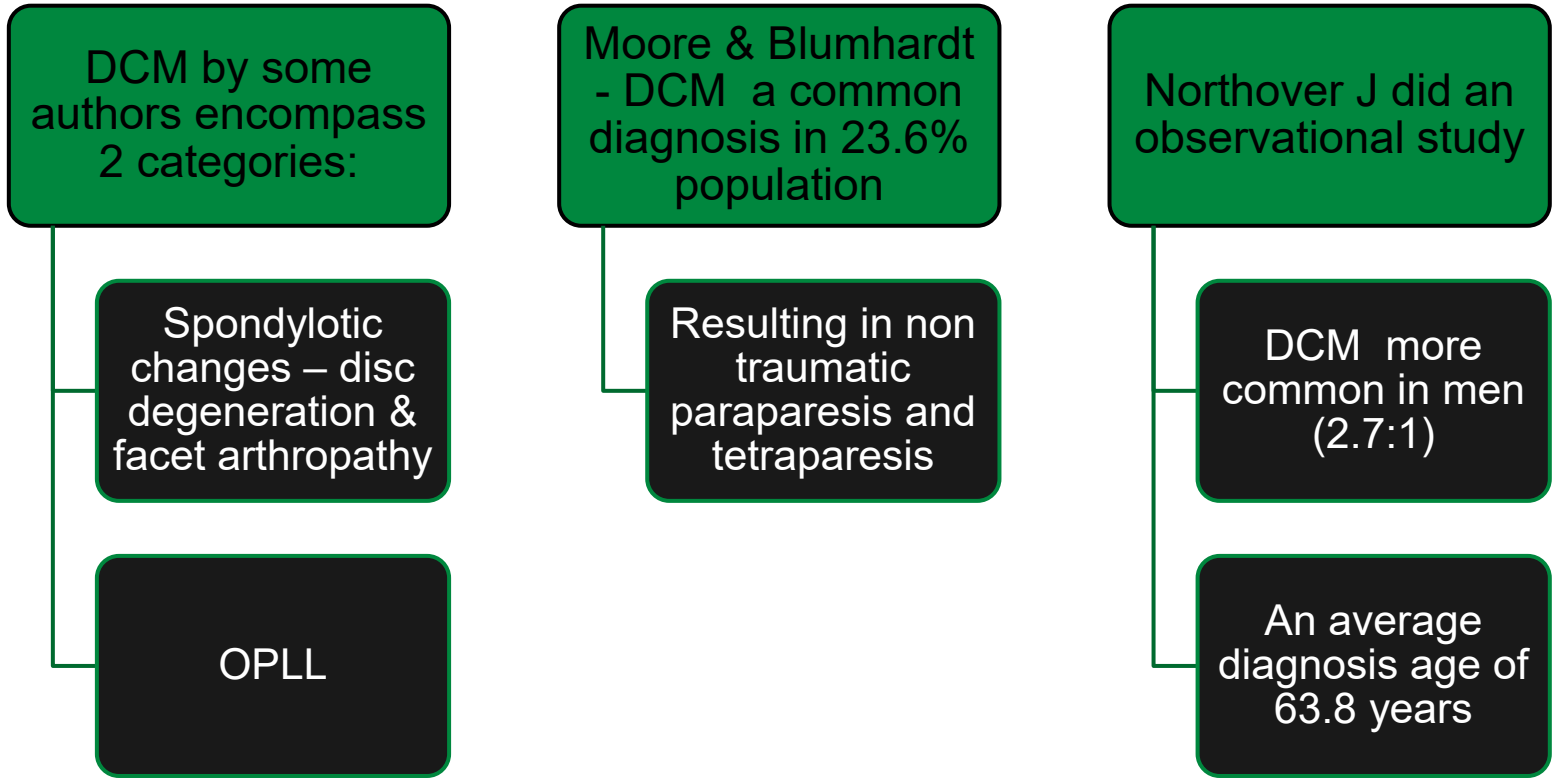
↓

Result of chronic compressive forces on the spine

↓

Most common cause of spinal impairment in the elderly worldwide

DEGENERATIVE CERVICAL MYELOPATHY (DCM) - EPIDEMIOLOGY



DEGENERATIVE CERVICAL MYELOPATHY (DCM)

Natural history of DCM - stepwise deterioration

And proven resistance to nonoperative treatments

DCM results in spinal cord level dysfunction

Clinical symptoms

- loss of dexterity,
- poor coordination,
- motor weakness,
- and/or sensory loss

A detailed and thorough neurologic examination is the current standard to diagnose the presence of cervical myelopathy

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

Degenerative changes in the cervical spine include

- disc herniation,
- osteophytosis,
- ligament hypertrophy, and
- ossification

DCM is a clinical syndrome

- Arises when these changes result in spinal cord compression

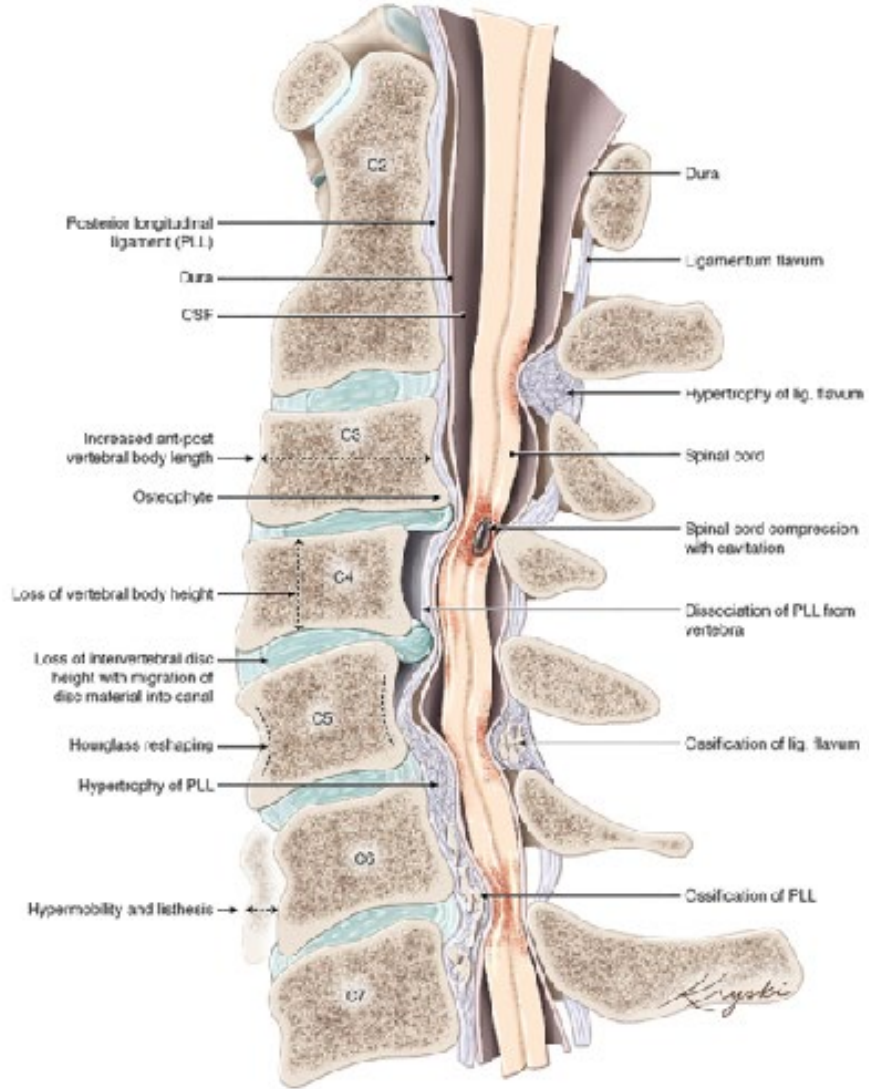


Figure 1. Illustration of the various gross anatomic pathophysiologic changes that contribute to degenerative cervical myelopathy. PLL, posterior longitudinal ligament; CSF, cerebrospinal fluid. Originally published by Nouri *et al.* (2015) [2], medical illustration by Diana Kryski (Kryski Biomedia).

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Signs
  - Inverted brachioradialis
  - Hoffmans +
  - Ankle clonus
  - Babinski sign
  - Romberg's sign
  - Lhermitte’s phenomenon
- Typical clinical symptoms
  - Motor deficits
  - Hand numbness
  - Thenar atrophy
  - Hyperreflexia
  - Spasticity
  - Impaired gait
  - Incontinence
  - Clumsy hands
  - Weakness & paresthesias

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- No clarity on which patients will deteriorate ?
- No classification system to help guide?
- Does OPLL get included ?
- Term CSM (cervical spondylotic myelopathy) has evolved to a more over arching Degenerative Cervical Myelopathy–Radiculopathy (DCM-R)
- Progressive degenerative changes that result in chronic compression and dysfunction of the spinal cord
- How to deal with symptoms changing over time ?
- Correlating this with evolving imaging findings?
- Challenging aspect is the timing of any surgical management?

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- **Differential Diagnosis**
  - For Lower limb weakness, imbalance, and calf ache there are upper and lower motor neuron patterns of weakness
    - Upper motor neuron pattern include pathologies in the brain and spinal cord
      - Demyelinating disorders such as multiple sclerosis,
      - Vascular disorders such as stroke,
      - Space-occupying lesions such as a parasagittal meningioma or abscess, and
      - Motor neuron diseases such as amyotrophic lateral sclerosis
      - Spinal cord disorders includes
      - demyelinating disorders such as transverse myelitis,
      - myelopathies such as DCM,
      - space-occupying lesions, for example, tumor or abscess, trauma, syringomyelia, and spinal stenosis (spinal claudication)

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Lower motor neuron pattern include
    - drugs such as alcohol,
    - metabolic disorders such as vitamin B12 deficiency,
    - diabetes mellitus,
    - inherited disorders such as Charcot-Marie-Tooth,
    - infections such as HIV or syphilis, and
    - autoimmune disorders such as vasculitis and
    - chronic inflammatory demyelinating polyneuropathy
    - The causes of calf aches include
        - trauma,
        - vascular disorders such as peripheral vascular disease (intermittent claudication), and
        - inflammatory disorders such as myositis.
-

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Radiographic assessment X rays
- DCM is associated with deformity important in determining a treatment plan
- Upright and dynamic (flexion-extension) radiographs,
- 36-inch standing scoliosis films (with visualization of the skull base and femoral heads)★
- Deformity is fixed or flexible
- Enables a look at local and global spinal alignment.

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Radiographic assessment CT scans:
- Computed tomography (CT) is used to assess bony quality, osteophyte bridging, auto fusion

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

Magnetic resonance imaging (MRI)

- Defining the anatomy of the cervical spine based
- Able to differentiate neural, osseous, and soft tissue structures
- High-resolution
- Magnetic resonance imaging (MRI) is valuable inevaluating compression of neural structures

Enables visualization of spinal cord parenchymal abnormalities

- neoplasms,
- demyelinating lesions,
- fluid collections,
- and/or edema

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

T2 weak signal hyperintensity (more intense than normal spinal cord but less intense than CSF)

- Appears diffuse no clear bordering associated with potentially reversible changes
  - such as edema,
  - Wallerian degeneration,
  - demyelination, and ischemia

T2 imaging substantial hyperintensity with sharp bordering

T1 hypointensity represent changes to be irreversible

- such as cavitation,
- neural tissue loss,
- myelomalacia, necrosis, and spongiform changes in gray matter

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

Each patient with DCM-R requires consideration of individual factors

Clinical judgment and / or

Patient preferences result in deviation from guidelines in some circumstances

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Rate of disease progression is highly variable and cannot currently be predicted
- Evidence does not demonstrate an ‘optimal’ surgical approach,
- Not does it demonstrate an optimal surgical time
- Tailored to the individual case depending on
  - location of the pathology,
  - number of cervical levels affected,
  - and the baseline cervical sagittal alignment

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Factors driving the disconnect between clinical and radiological severity unclear
- Davies et al postulates that DCM is a function of
  - (1) mechanical stress,
  - (2) duration of injury, and
  - (3) individual vulnerability.
- Scenario of limited clinical progression and significant radiological progression - decreased vulnerability to injury
- DCM and its clinical features, including severity measured by mJOA.

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Individual's vulnerability to DCM - primary protective mechanisms
  - genetics and age,
  - adaptive protective mechanisms- autoregulation of spinal cord perfusion,
  - functional reserve capacity,
  - and nutritional status
  - We know certain genotypes are associated with increased regenerative capacity,
  - such as the *HIF-1A*polymorphism rs11549467
- This polymorphism is associated with susceptibility to DCM and its clinical features, including severity measured by mJOA

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

Adaptive protective mechanisms - autoregulation of spinal cord perfusion

Umeria et al - Decreased blood flow can result in blood-spinal cord barrier dysfunction,

leading to microglia activation,

neuroinflammation, and neuronal apoptosis

In addition to the ischemia precipitating apoptosis ,

dysregulation of the autoregulatory system can occur from mechanical cord compression in DCM

Reserve capacity within CNS - resilience in the neurological system

Resulting in disconnect between the clinical phenotype and underlying histological pathology and radiology

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Tetreault et al. factors predicting better post-operative functional status:
  - younger age,
  - milder pre-operative myelopathy,
  - non-smoker,
  - fewer co-morbidities,
  - non-impaired gait,
  - shorter pre- operative symptom duration
- Other studies - importance of short time duration between symptom onset and surgery in maximising patients' postoperative function
- pre-operative MRI factors have not shown to add further predictive power
- Influence surgeons with regards to operative approach
- Tetreault et al (2018) symptom duration and baseline disease severity - strongest and most consistent indicators

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Guidelines created based - internationally accepted 18-point scale for the severity of DCM,
- The Modified Japanese Orthopedic Association (mJOA) score.
- The guidelines recommend:
  - 1. Surgery for cases of moderate (mJOA 12–14) or severe (mJOA <12) DCM
  - 2. Surgery or supervised non-operative treatment for mild (mJOA 15–17) DCM
  - 3. Surgery is strongly recommended in the case of progressive deterioration
  - 4. No surgery for asymptomatic cord compression
  - 5. Surgery or close follow-up for non-myelopathic patients with cord compression with radiculopathy symptoms

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- DCM almost always a surgical problem
- Between 20 to 62 percent of patients deteriorating at 3 to 6 years when managed expectantly
- Asymptomatic patient with cord compression
  - Development of symptomatic myelopathy approx. 8 percent at 1 year
  - Nearly 23 percent at 4 years of follow-up

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

- Medical options range from
- Behigh-risk discouragement of high risk activities
- Cervical traction and spinal injections
- Nonsurgical treatment methods described in the literature a combination of techniques
- Kadanka et al intermittent soft collar
- Anti-inflammatory medications, intermittent bedrest
- Avoidance of high-risk activities and environments

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

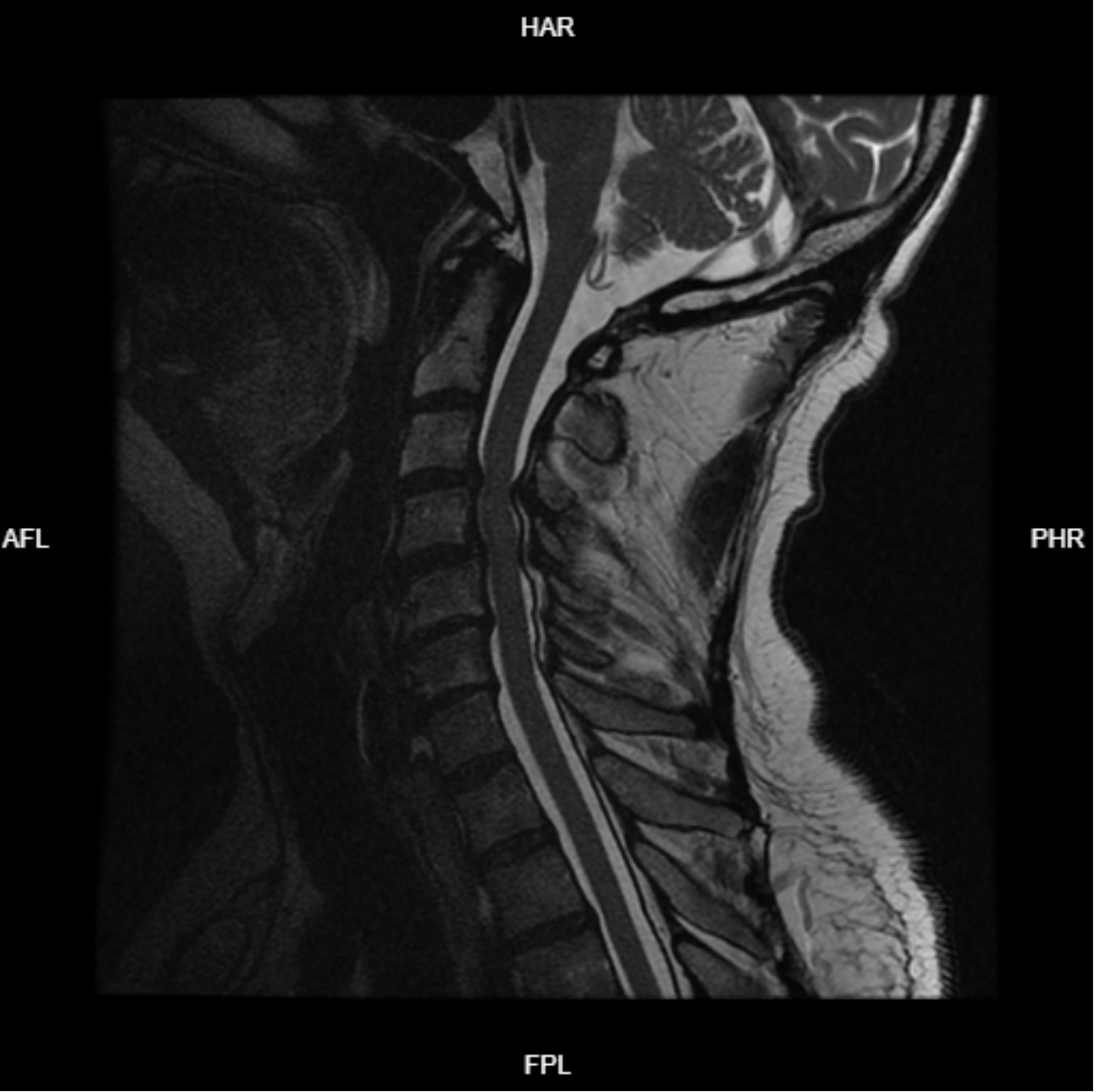
- Sampath et al used pain medications (either narcotic or nonsteroidal),
- Steroids,
- Bed rest,
- Home exercise, Cervical traction, Neck bracing, and
- Various spinal injections (epidural, facet, nerve blocks)
- Yoshimatsu et al utilized cervical traction (3–4hrs per day),
- immobilization with cervical orthosis,
- medications, exercise therapy, and thermal therapy

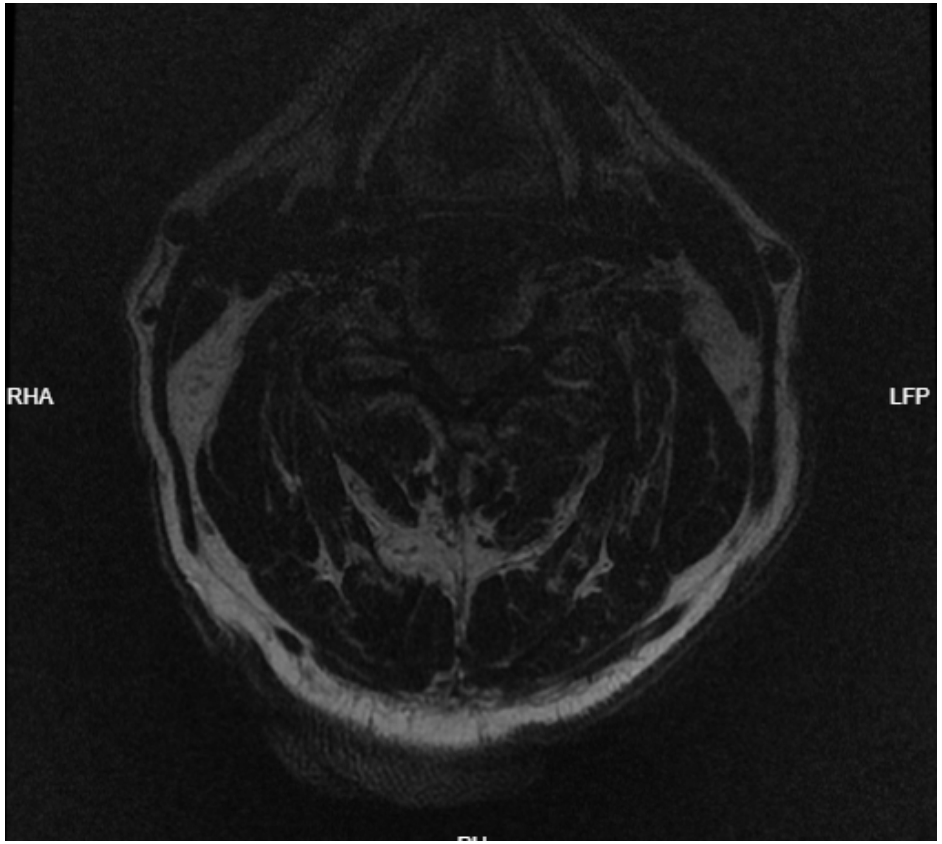
DEGENERATIVE CERVICAL MYELOPATHY (DCM)

CASE DISCUSSION – CASE 1

- 71 yo male patient with progressive right arm and hand weakness 4 month
- Grip weakness worse in right hand compared to the left
- Progressive imbalance
- No radicular pain or cervicalgia of significance
- Examination findings - bilateral grip weakness test, right deltoid weak
- Reflexes – diminished right biceps, brisk trip, brisk LE KJs 4 and AJ 3
- Romberg’s positive, Tandem impairment
- Clinical diagnosis – DCM-R

CASE DISCUSSION – CASE 1





- Significant stenosis with spondylotic changes being worst C3 to C6
- High grade narrowing at C3/4 and C5/6 with anterolisthesis at C4/5

WHAT WOULD YOU DO?

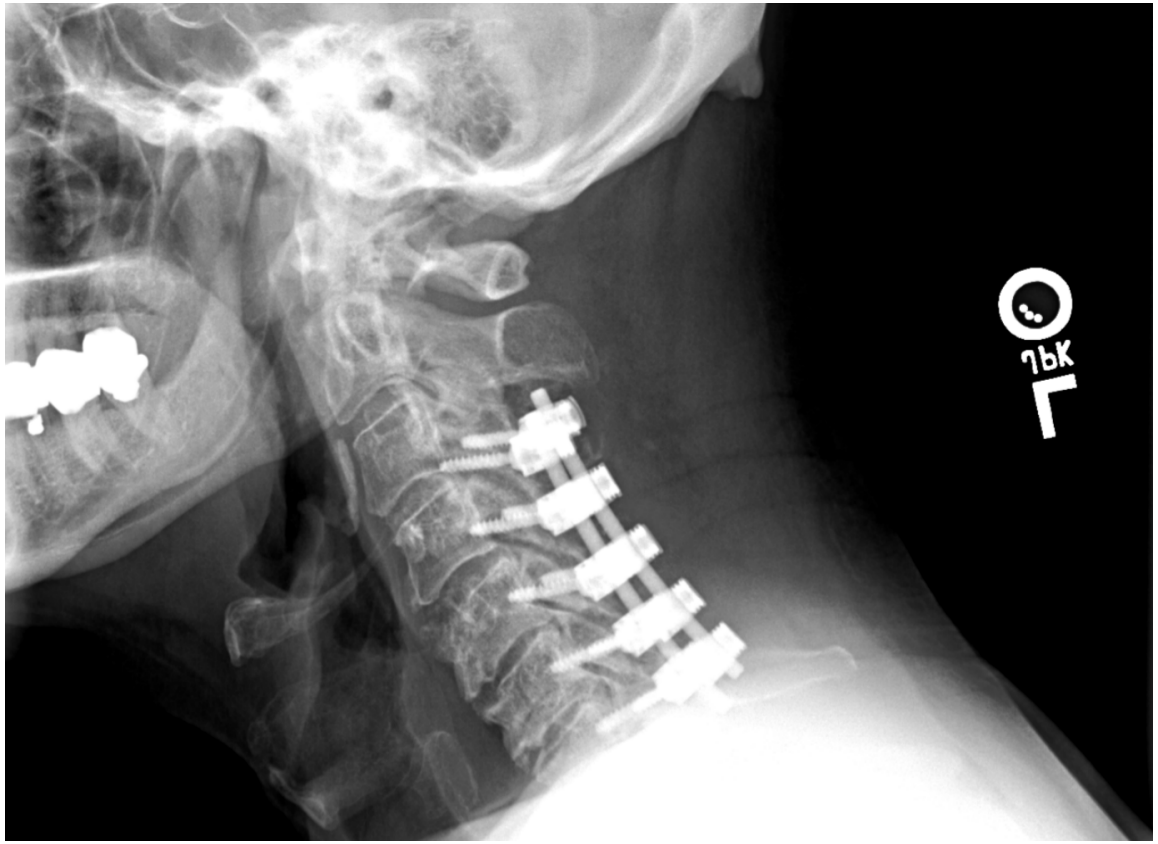
ANTERIOR ONLY

POSTERIOR ONLY

ANTERIOR & POSTERIOR

POST OP 6 WEEKS CXR C3 – C7

Balance improved at 3 month
Strength and grip improved at 9 months
Paresthesias in fingers persisted

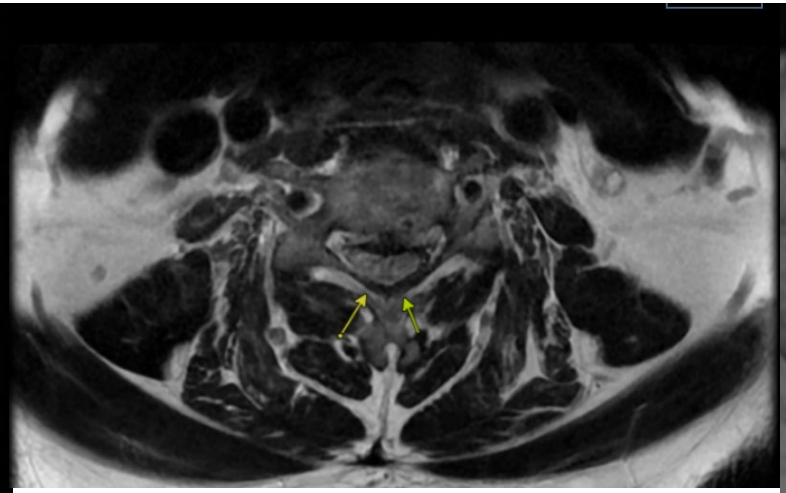


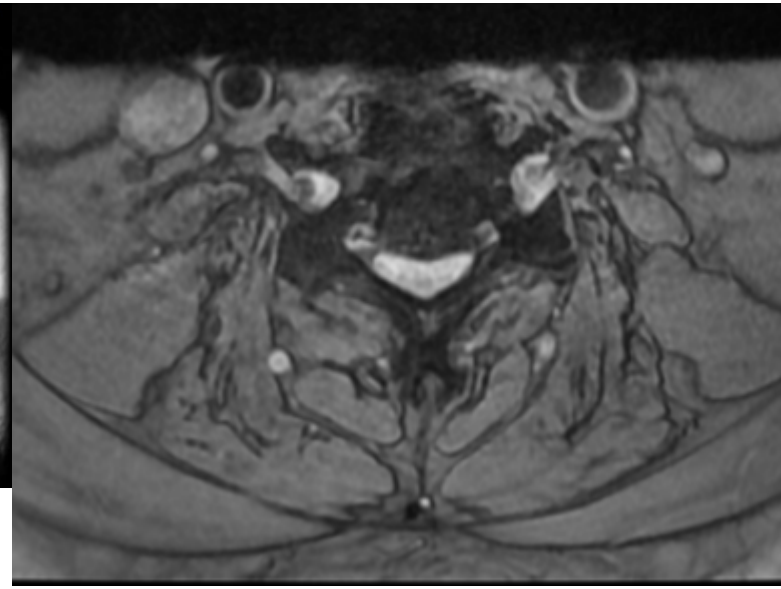
DEGENERATIVE CERVICAL MYELOPATHY (DCM)

CASE DISCUSSION – CASE 2

- 62 yo gentleman , chronic smoker, high BMI
- Numbness and paresthesias in his arms and feet progressive worsening 3-4 years
- Legs felt heavy, weak difficulty climbing stairs and balance issues
- Exam findings- grip strength weakness
- Increased tone in upper and lower
- Brisk reflexes upper and lower
- Tandem impaired , Romberg’s positive, Babinski +
- Recommended surgery after smoking cessation came 5 months later

CASE DISCUSSION – CASE 2





CASE DISCUSSION – CASE 2

- Congenitally narrow spinal canal
- Multilevel disc disease
- Mild lordosis maintained

WHAT WOULD YOU DO?

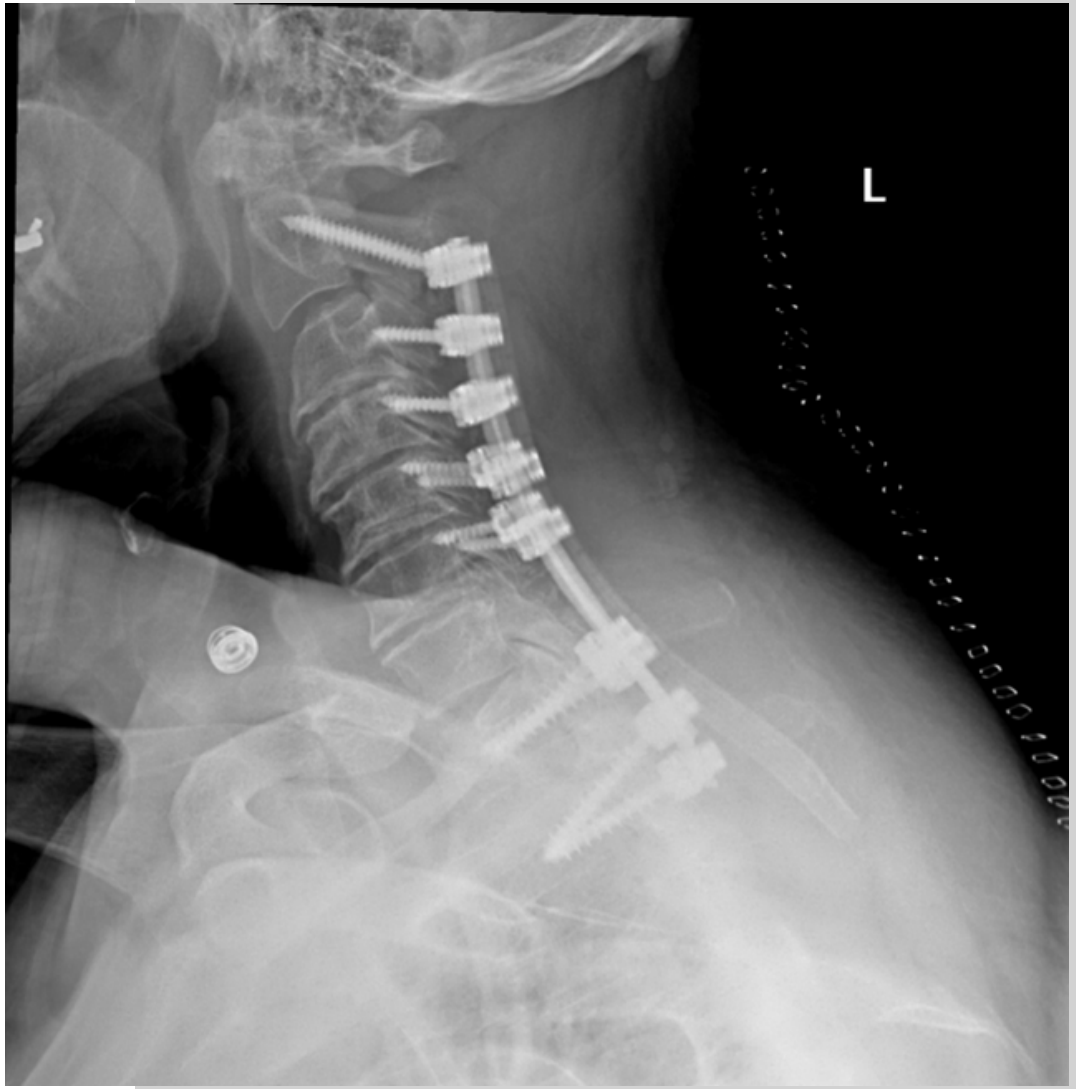
ANTERIOR ONLY

POSTERIOR ONLY

ANTERIOR & POSTERIOR

CASE DISCUSSION – CASE 2

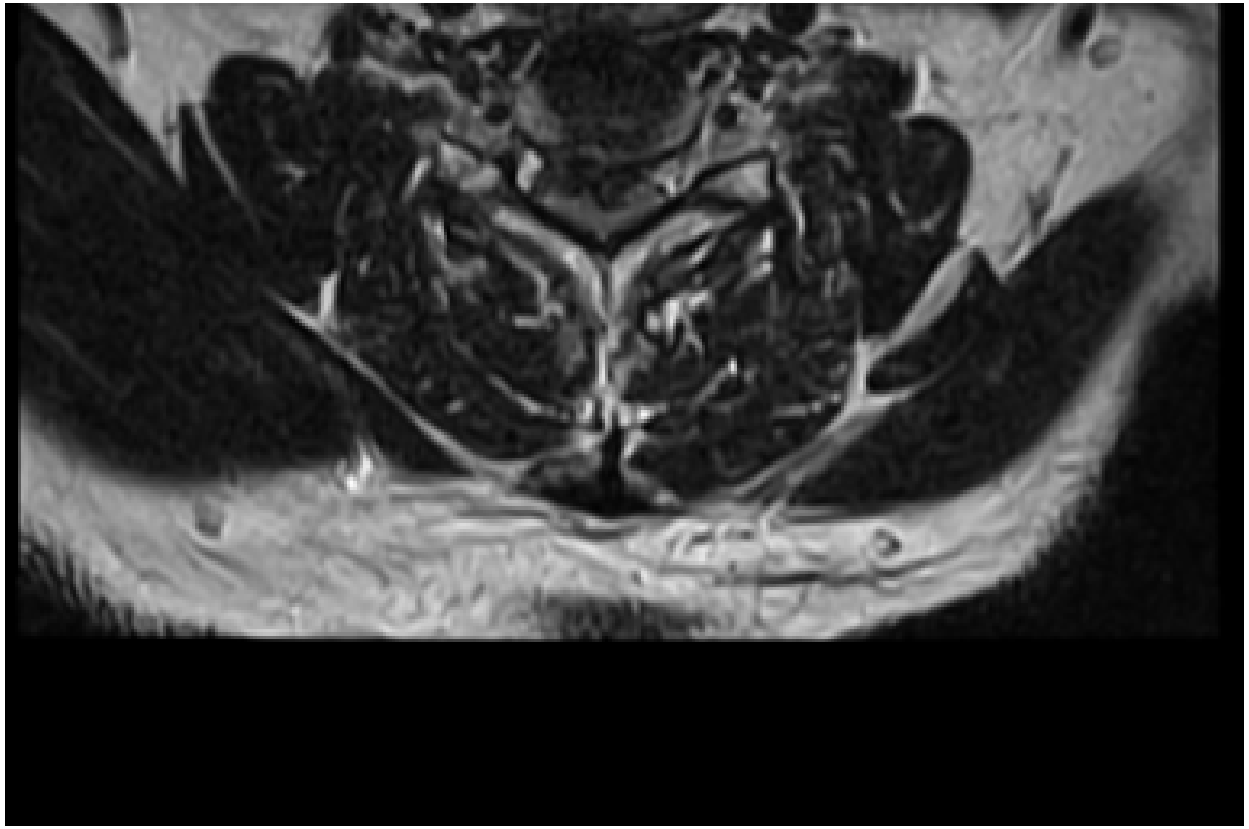
DECOMPRESSION POSTERIOR CERVICAL WITH FUSION C2 - T2 posterior fusion and C3-C6 decompressive laminectomy



CASE DISCUSSION – CASE 2

CASE DISCUSSION – CASE 3

- 68 yo with subacute progressing myelopathy
- Left side c6 and c7 radiculopathy
- Corresponding clinical findings



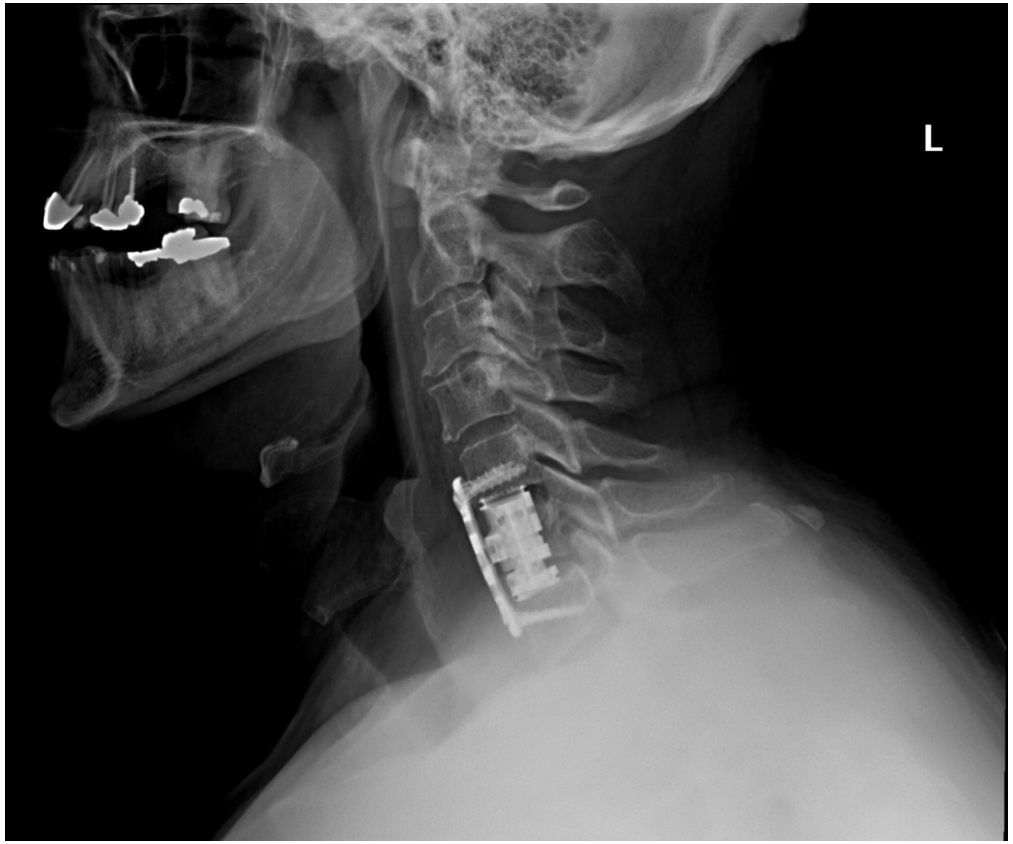

HRA
PRH
FLP

WHAT WOULD YOU DO?

ANTERIOR ONLY

POSTERIOR ONLY

ANTERIOR & POSTERIOR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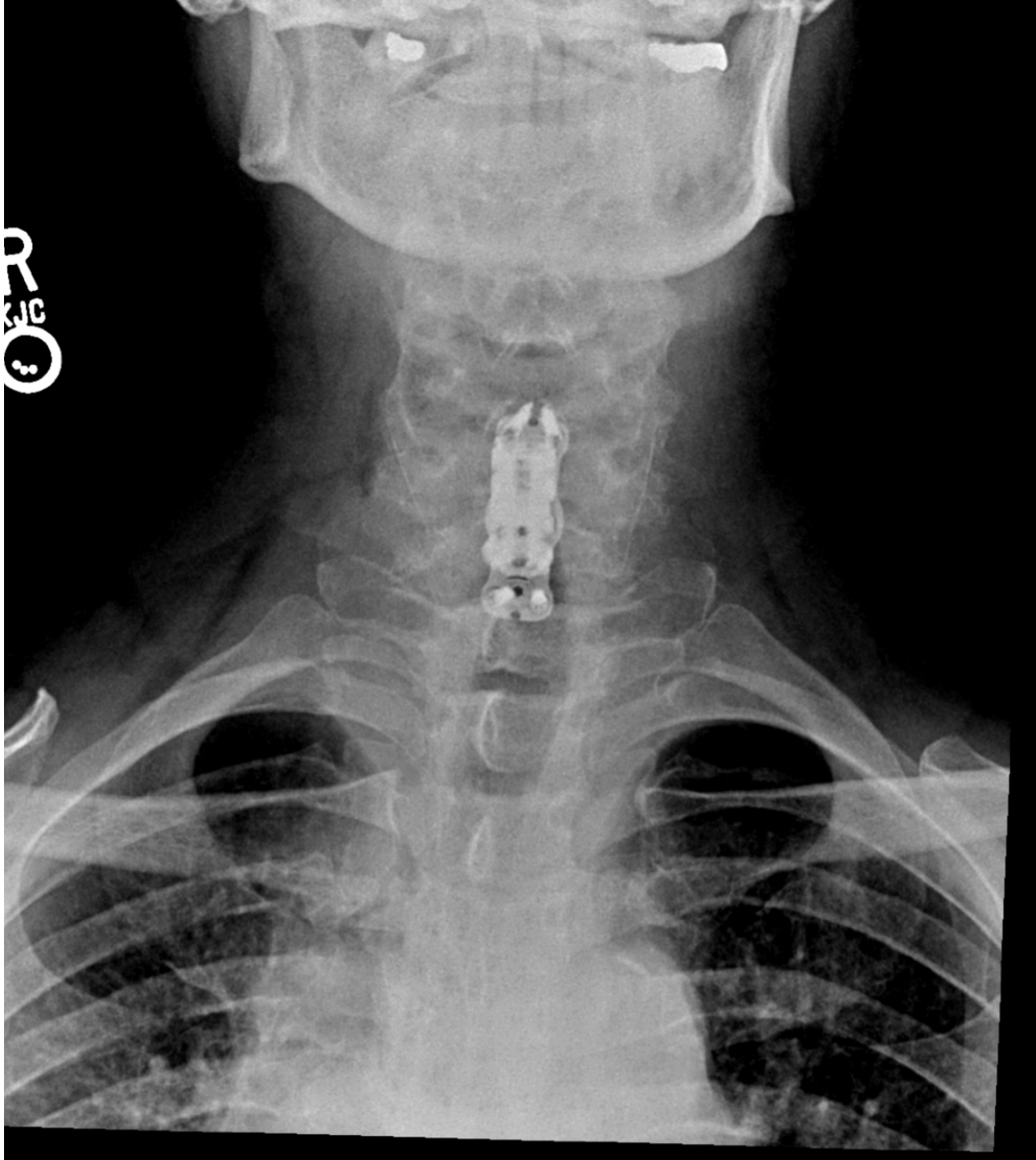
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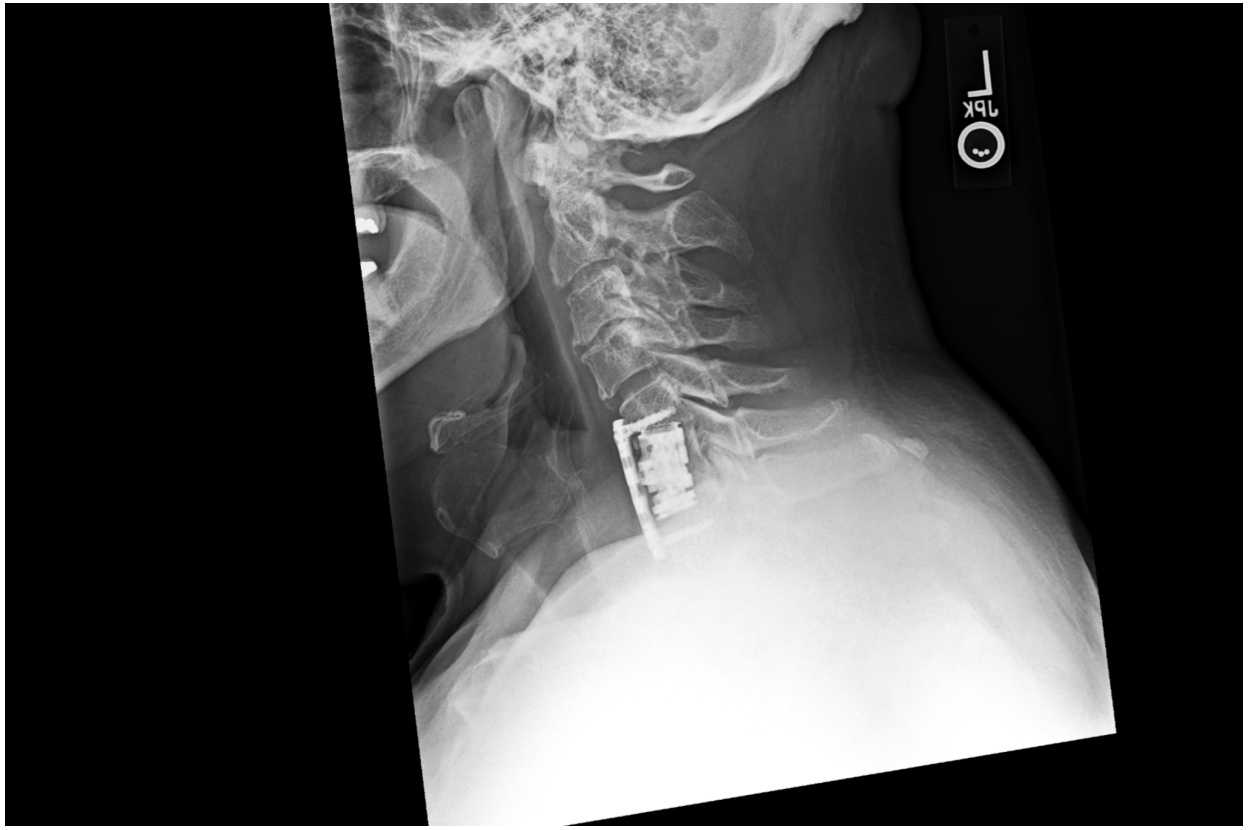
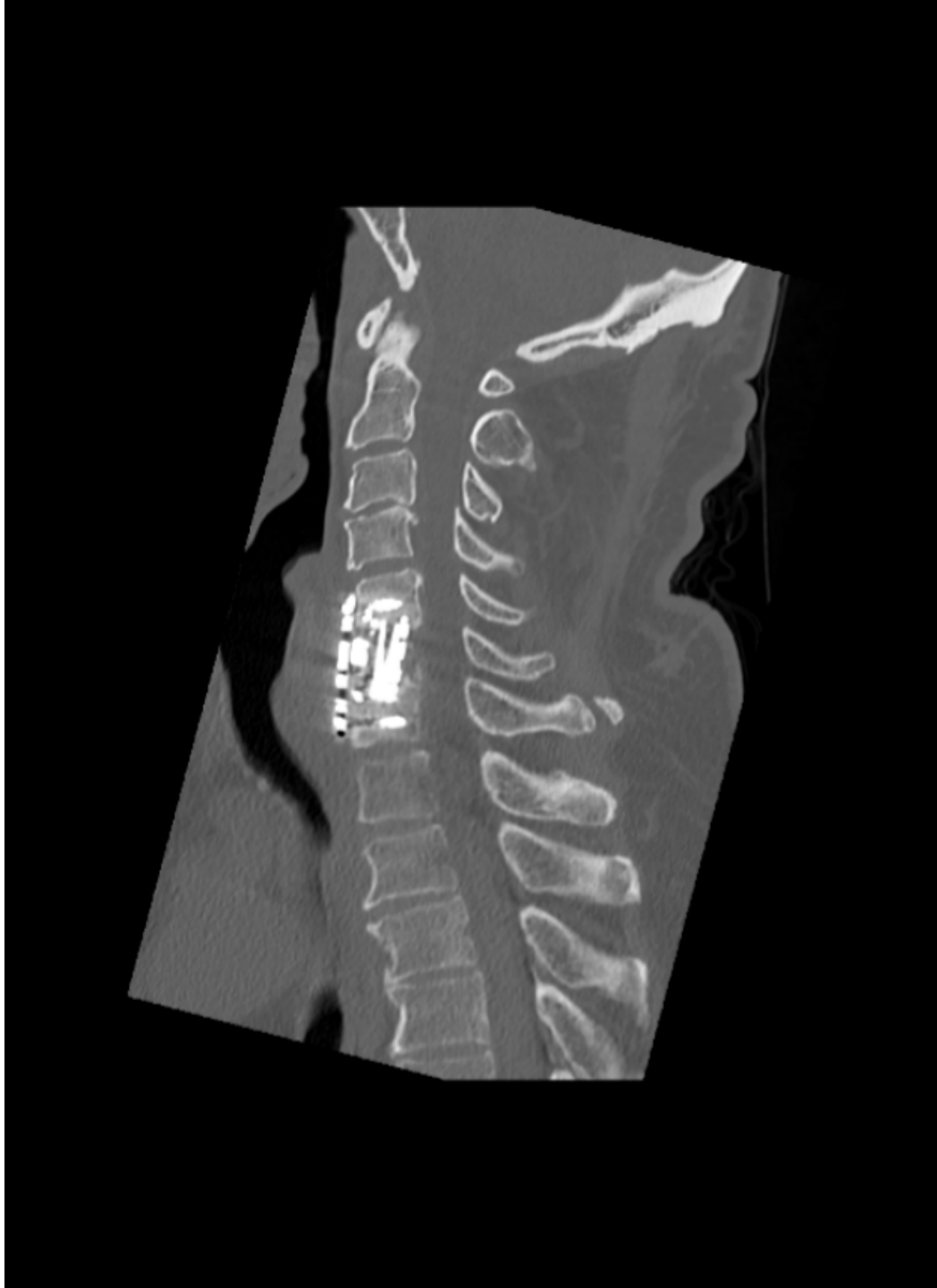
6 MONTHS POST OP

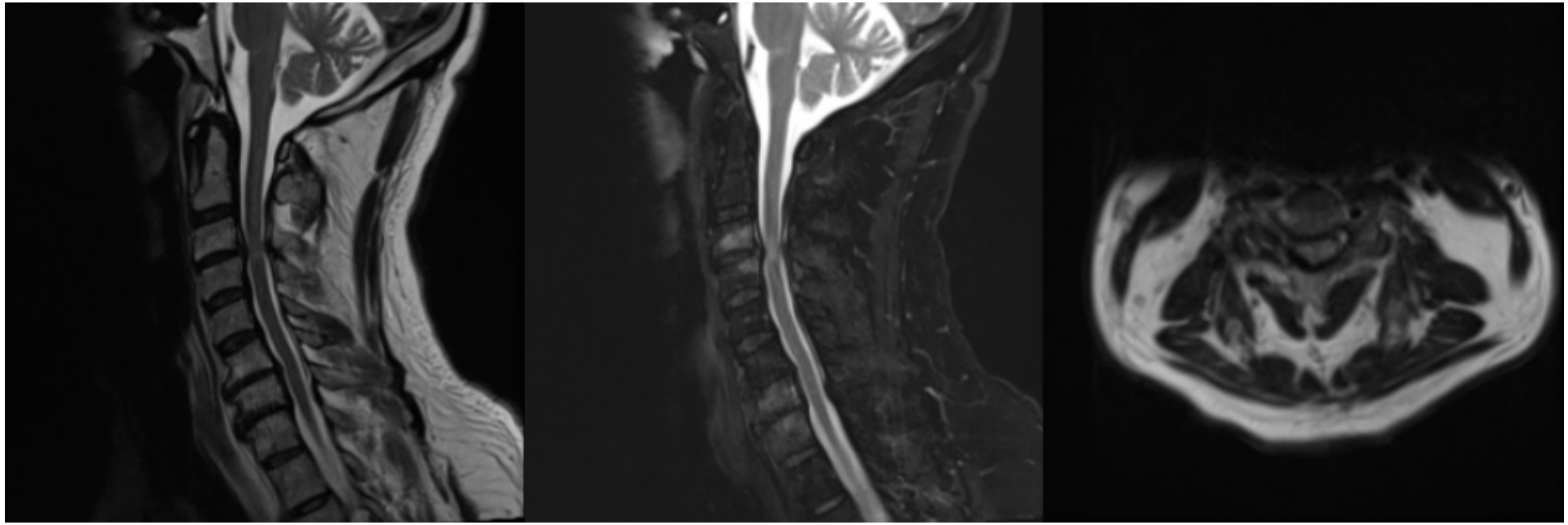




CASE 3

- 55 yo male had a fall 1 year earlier , all symptoms progressively worsening
- Arm and neck pain – radicular symptoms
- Progressive worsening gait unsteadiness
- Lhermitte's phenomenon
- Extending his neck a diffuse loss in tone causing a fall to the ground
- Bowel incontinence

IMAGING REVEALED



WHAT WOULD YOU DO?

ANTERIOR ONLY

POSTERIOR ONLY

ANTERIOR & POSTERIOR

1 YEAR POST OP

CASE 4

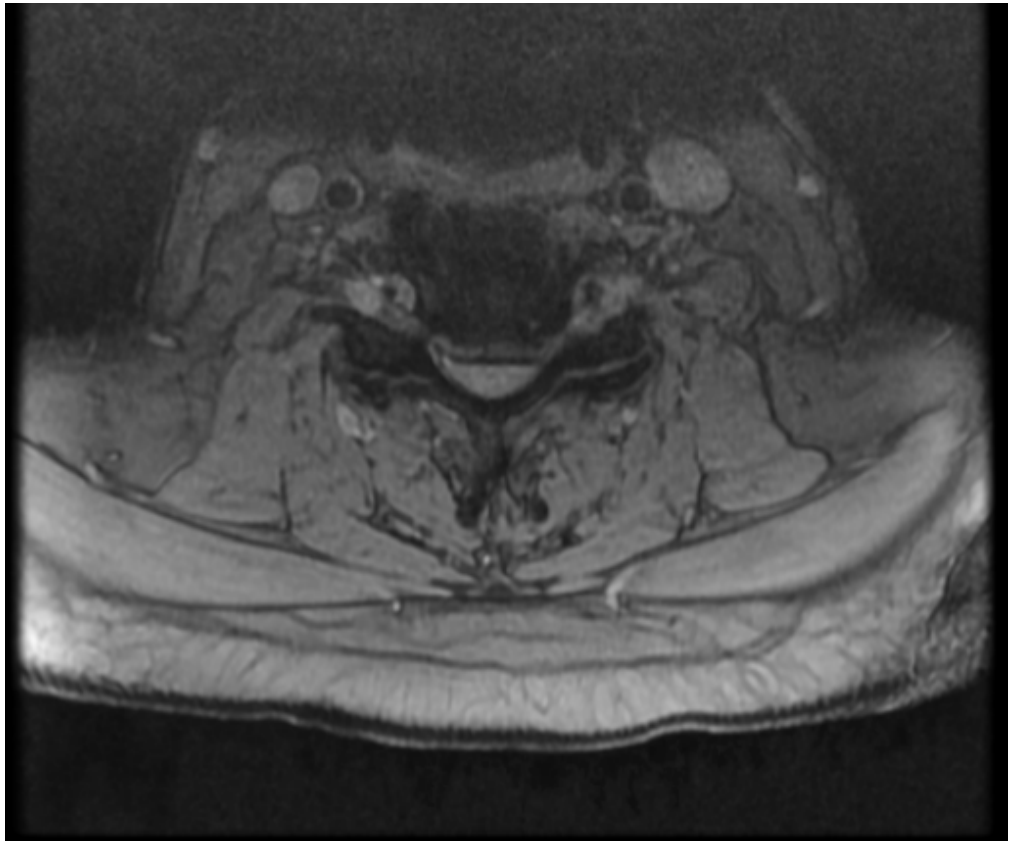
SYMPTOMS

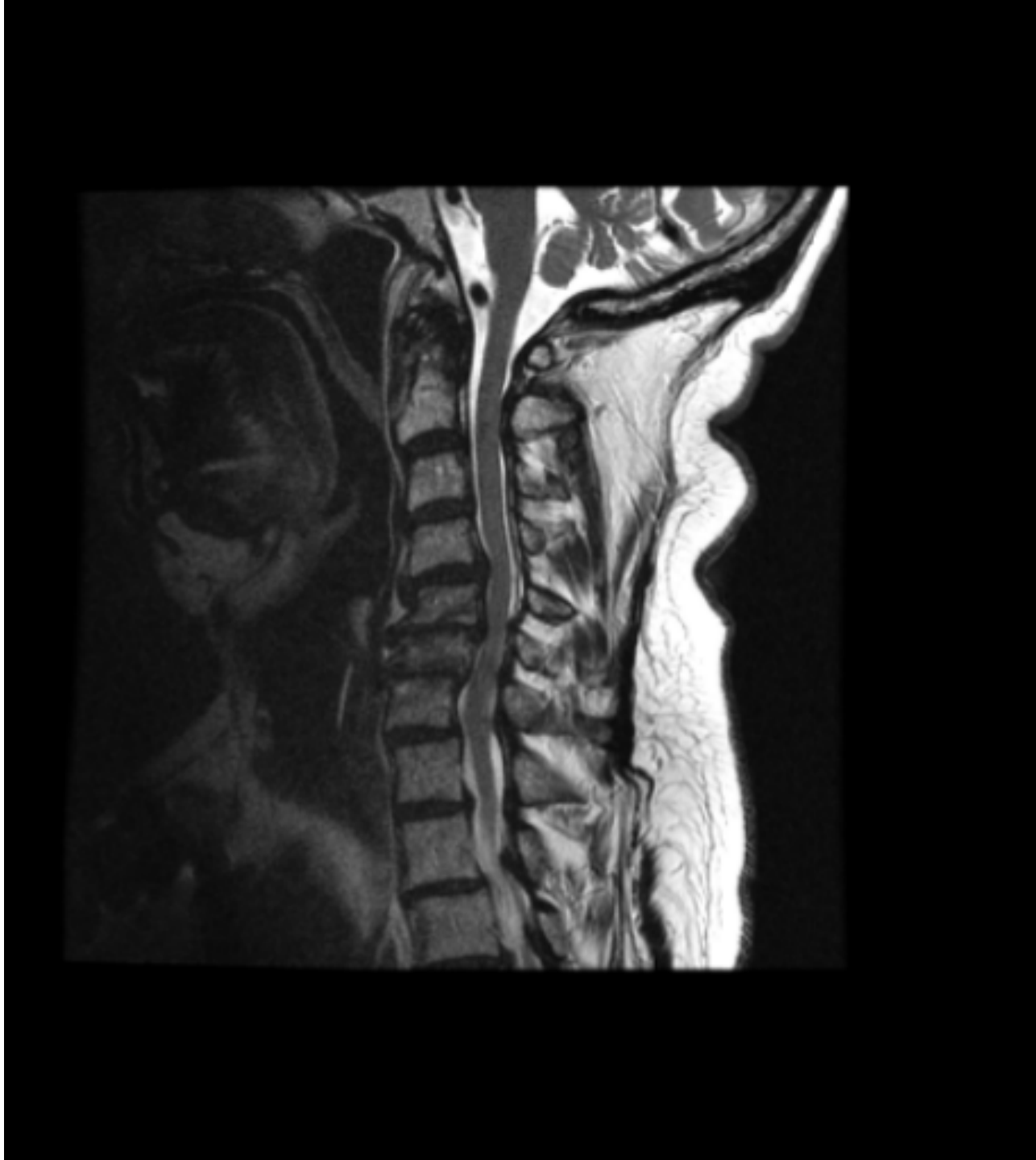
- 68 YO MALE RHEUMATOID ARTHRITIS ON MTX
- CHRONIC WORSENING NUMBNESS AND WEAKNESS IN THE LEFT ARM
- WORSENING BALANCE GRIP WEAKNESS AND RECENT RIGHT HAND WEAKNESS

SIGNS

- MYELOPATHIC
- POSITIVE ROMBERS IMPAIRED TANDEM
- SPASTICITY
- WEAKNESS IN UPPERS

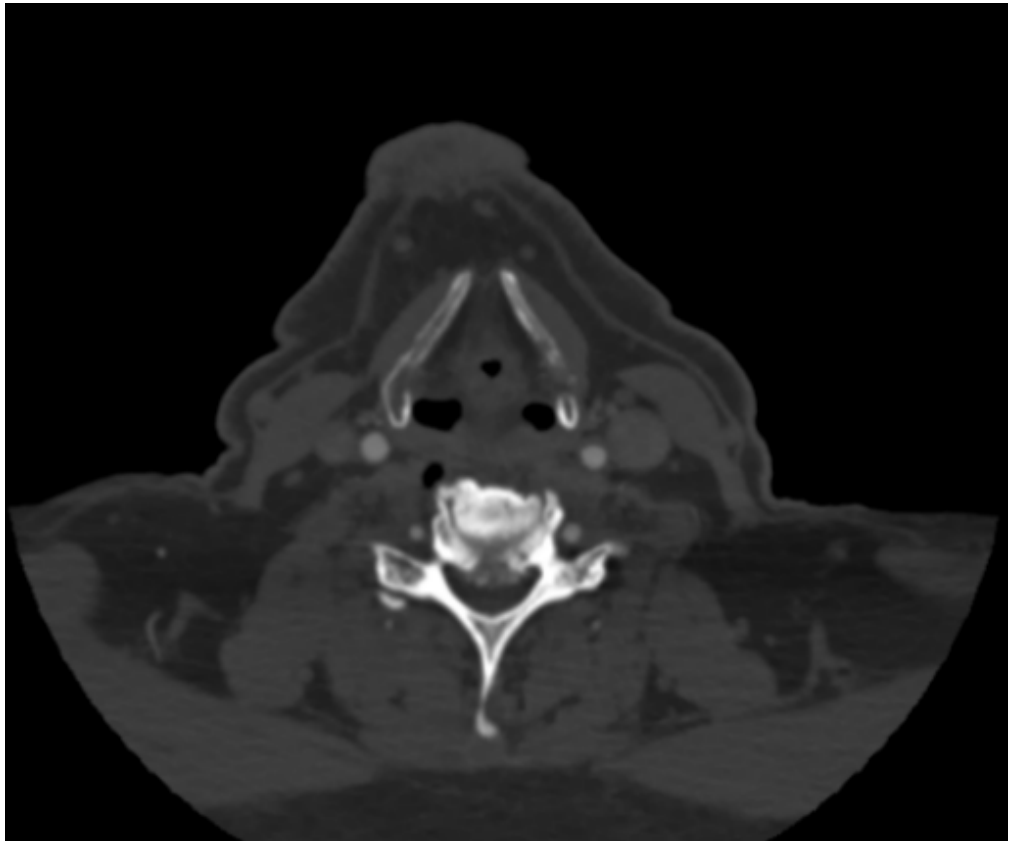
MRI





CERVICAL SPINE X-RAYS

CTA



WHAT WOULD YOU DO?

ANTERIOR ONLY

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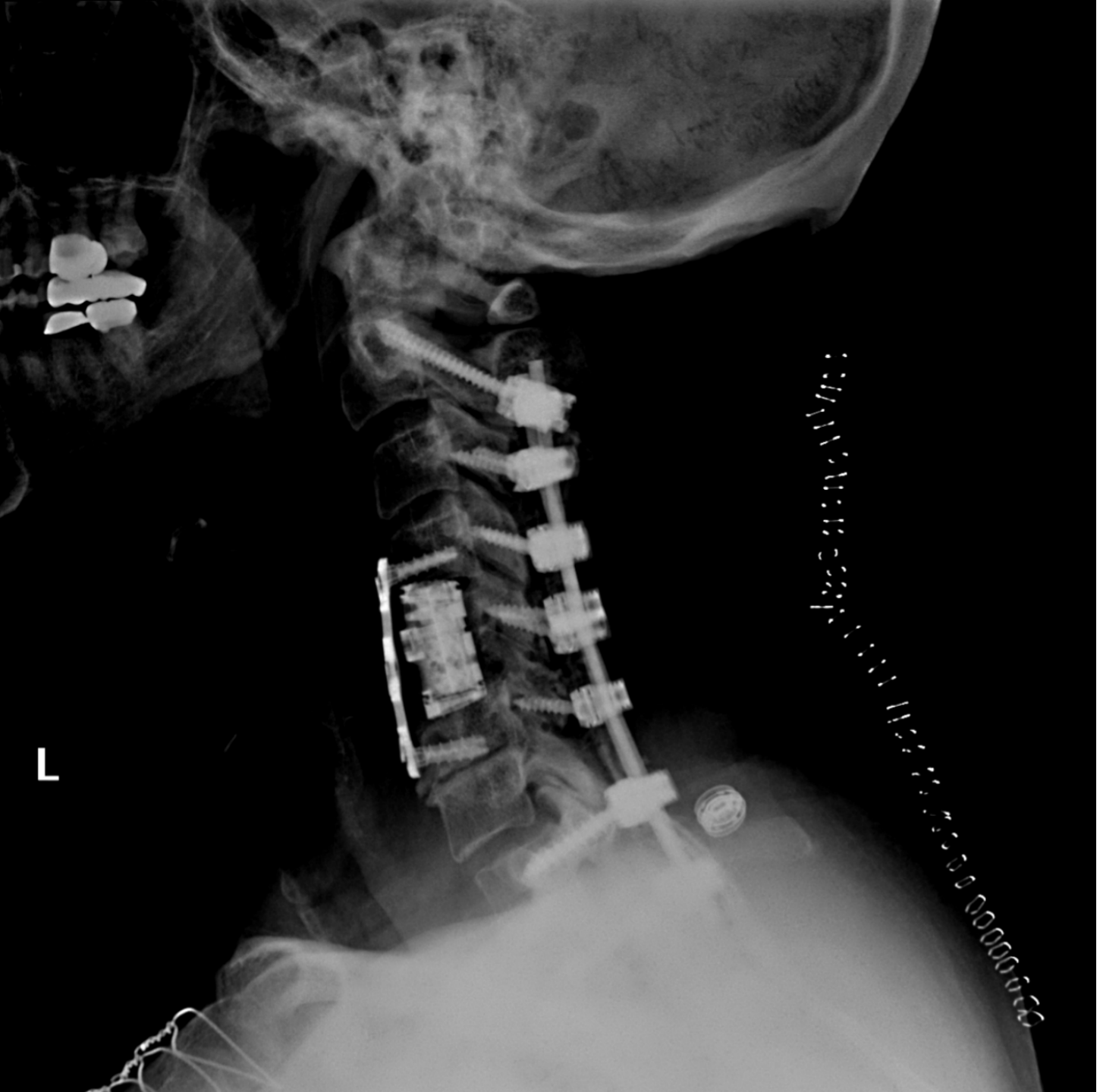
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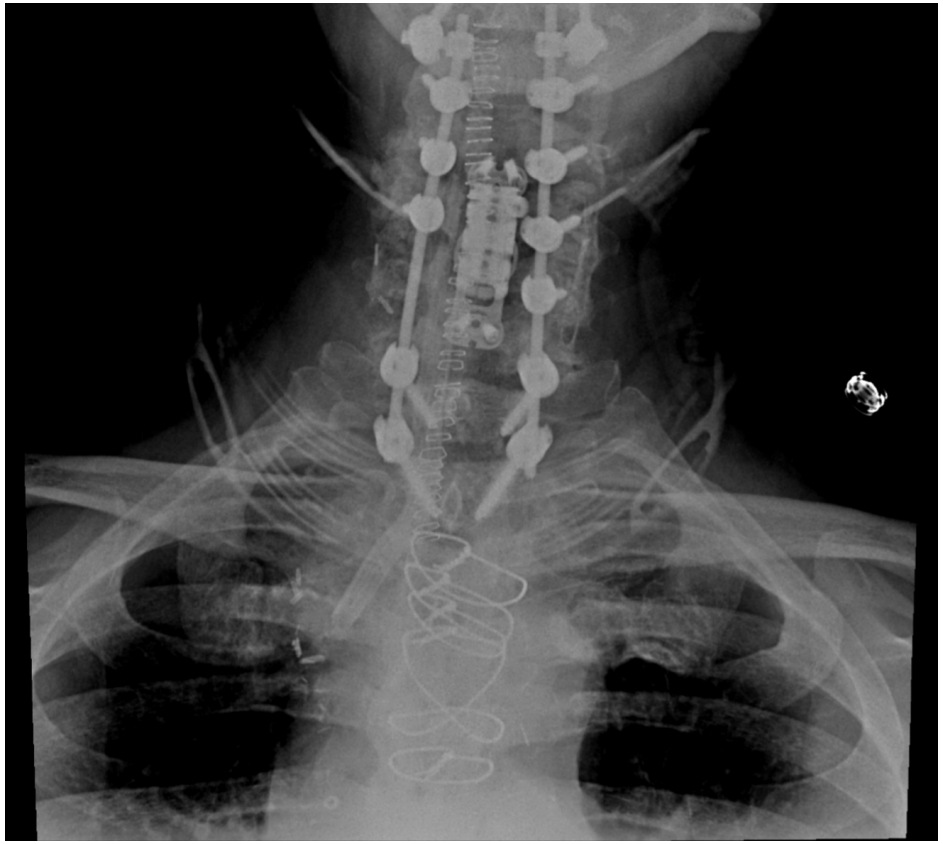

DEGENERATIVE CERVICAL MYELOPATHY (DCM)

"Pearls"

When deciding between nonoperative and operative treatment,

Patients with moderate or severe mJOA scores should, if possible, be offered surgery

Patients with asymptomatic or mild disease should be counseled on known natural history of CSM and

- Offered the options of nonoperative vs. operative intervention

Expectations for surgery, MAKE clear

Primary goal of surgical intervention is prevention of worsening of neurological status,

Improvements in mJOA scores, though likely, are not guaranteed

Selecting the procedure for patients undergoing surgery, those

with significant kyphosis and/or greater than 50% canal compromise

from ventral disease

Benefit from an anterior approach, either alone or combination anterior-posterior

CSM patients have an accompanying deformity

Surgeons consider obtaining standing full spine X-rays

Assess and document sagittal plane derangements

For the cervical region and globally

COMPARISON

Conservative (nonoperative) vs

surgical Treatment

- **Conclusions**
- For moderate-to-severe CSM,
- Surgical treatment may be superior to conservative management
- Surgery may be superior to conservative
- therapy,
- Unclear for which entry mJOA scores
- No significant difference in outcomes for

patients with mild CSM (mJOA > 12)

Comparison

- Rigorous vs. Non-rigorous

Conservative Treatment

Conclusion

- Rigorous nonoperative treatment is more effective
- Compared to non-rigorous or no treatment

Comparison

- Anterior vs. Posterior Surgery

Conclusion

- Anterior decompression greater improvement in postoperative neural function for patients with < 3 levels
- Anterior decompression and laminoplasty similar long-term effectiveness
- Laminoplasty higher rate of postoperative neck pain and kyphosis
- Both procedures effective in improving outcomes

Comparison

- Laminoplasty vs. Laminectomy + Fusion

Conclusion

- Insufficient evidence for superior outcomes or safety of either procedure
- Laminoplasty contraindicated Instability or kyphosis
- All three procedures provide significant improvement in clinical outcomes,
- Radiographic improvement in sagittal alignment

Comparison

- ACDF vs. Corpectomy vs. Hybrid

Conclusion

- Acceptable risk of complications
- Appropriate patient
- Multi-level discectomy in minimal retro-vertebral disease
- Discectomy-corpectomy hybrid (if possible) over
- Corpectomy alone in cases of multi-level retro-vertebral disease

QUESTIONS & ANSWERS