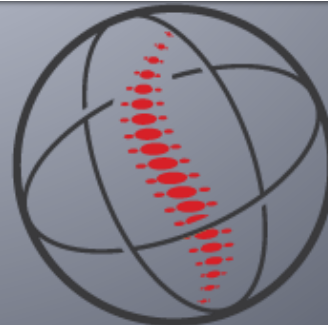


The Surgical Management of Cervical Myelopathy



Daniel J. Blizzard, MD, MS

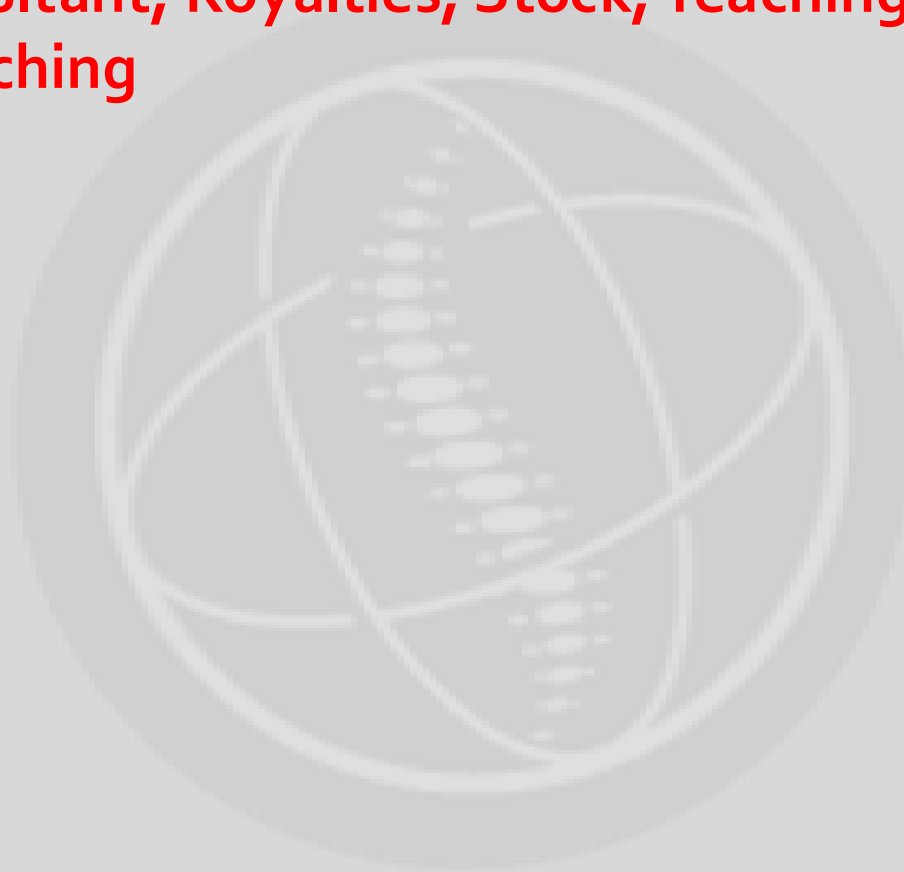
AXIS



SPINE
C E N T E R

Disclosures

- ATEC: Consultant, Royalties, Stock, Teaching
- Globus: Teaching



Cervical Myelopathy

- Common degenerative (usually) condition caused by compression on the spinal cord that is characterized by clumsiness and difficulty with fine motor tasks in the hands and gait imbalance/ataxia



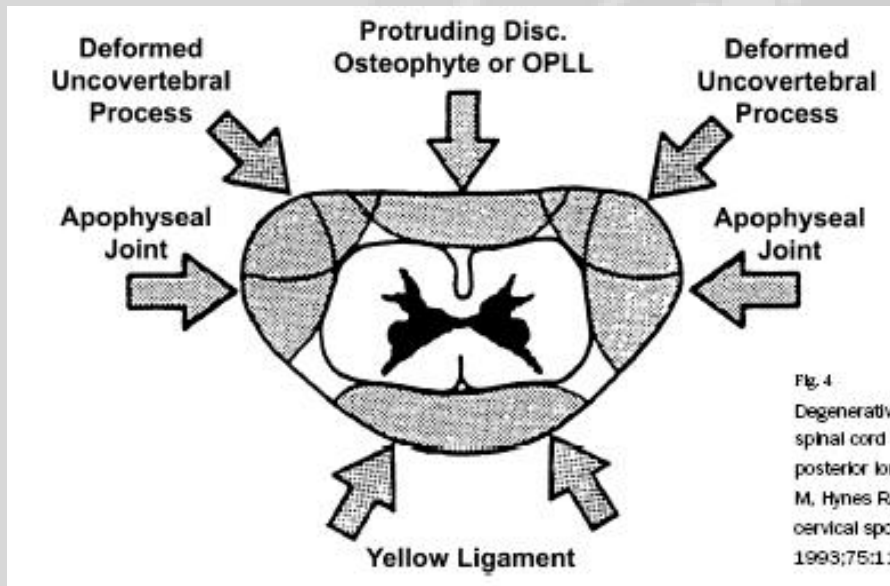
Why I am Talking About Cervical Myelopathy?

- **Isn't this a pain conference?**
 - I thought cord compression is/can be painless
- **Doesn't cord compression mean automatic surgery?**
 - What exactly is the “non-surgical management of cervical myelopathy”?
- **Well....**
 - Neck & back pain are the #1 reason for primary care visits and missed days of work in the U.S.
 - Everyone here is on the front lines treating spine-related pain
 - Symptomatic Tandem (Cervical + Lumbar) stenosis occur in 25-36% of patients¹
 - Painful lumbar stenosis can present with concurrent painful or painless CSM
 - Low back patients are at substantially increased risk of CSM
 - A complaint of pain often demands primary or all attention during a visit
 - Funicular/Tract Pain is a thing

¹Yamada et al., JOSR 2018

Pathophysiology

- **Cervical spondylotic myelopathy (CSM)**
 - Degenerative
 - Most common cause of cervical myelopathy



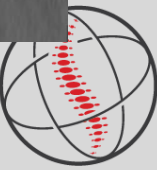
Pathophysiology

- **Congenital Stenosis**

- Congenitally narrowed canal → predisposed to develop myelopathy with minimal degenerative changes
- < 13mm diameter (17-18mm nl)

- **OPLL (Ossified Posterior Longitudinal Ligament)**

- Male > Female
- Most commonly effects C4-C6
- Cause is unclear but associated w/ obesity, DM, poor calcium absorption

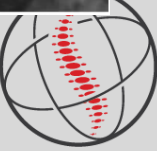
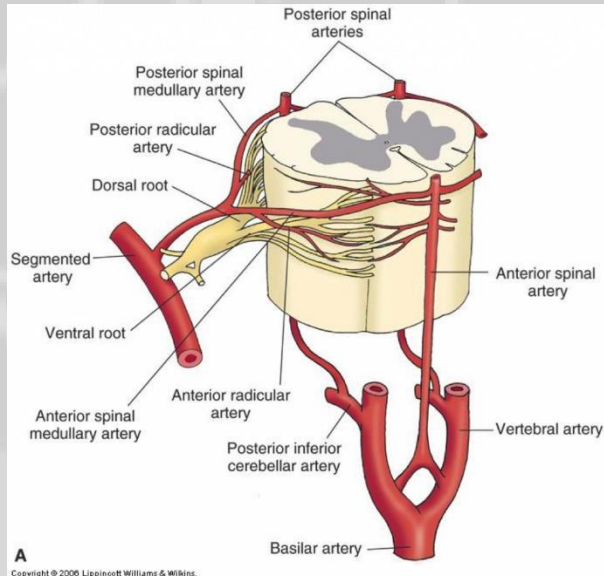


Pathophysiology

- **Less Common Causes**
 - Rheumatoid arthritis
 - MS
 - Trauma
 - Spinal cord infarction
 - Infection
 - Tumors

Neurologic Injury

- **Direct cord compression**
- **Ischemic injury**
 - Compression of anterior spinal a.
 - Decreased flow of pial plexus
 - Venous congestion



Myelomalacia

- Severe compression results in irreversible changes in the cord
- Gray matter and lateral columns show the most changes
- Changes include: cystic cavitation, gliosis, and demyelination caudal to the compression
- These changes can explain why after surgical correction, there may not be any improvement



Funicular Pain

- **Pain from compression of spinothalamic tract**
 - Lhermitte's Sign!
- **Present with false-localizing signs**
- **Burning, tingling, or electric-shock sensation into the extremities**
 - Can be intermittent or continuous
 - Can have LE numbness and weakness
 - Can present with claudicating LE pain
 - Can present with NO neck pain
 - Can present without myelopathic sx or exam findings



Funicular Pain

- **Diagnosis inherently challenging**
 - High rate of ASYMPTOMATIC tandem stenosis
 - High rate of some degree of stenosis in asymptomatic patients over 40
 - Degree of cervical stenosis does not correlate with likelihood of funicular pain
- **Useful adjuncts to imaging:**
 - Cervical ESI
 - SSEPs/MEPs with changes below effected level



Natural History of CSM

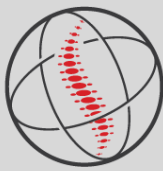
- Slowly progressive
- Rarely improves with non-operative modalities
- Prognosis: early recognition and tx prior to permanent cord damage
- Clarke and Robinson followed the progression of 120 patients until the time of surgery
 - 5% had rapid onset of sx followed by a long period of quiescent disease
 - 20% showed gradual steady progression of S&S
 - 75% showed step-wise deterioration with variable times of quiescence

Classification

TABLE II Nurick Grades for the Severity of Myelopathy¹⁰³

Grade	Findings
0	Signs or symptoms of root involvement but without evidence of spinal cord disease
1	Signs of spinal cord disease but no difficulty in walking
2	Slight difficulty in walking that does not prevent full-time employment
3	Difficulty in walking that prevents full-time employment or the ability to do all housework
4	Able to walk only with someone else's help or with the aid of a frame
5	Chairbound or bedridden

Adapted from Nurick, 1972



Classification

Ranawat Classification

Class I	Pain, no neurologic deficit
Class II	Subjective weakness, hyperreflexia, dyssthesias
Class IIIA	Objective weakness, long tract signs, ambulatory
Class IIIB	Objective weakness, long tract signs, non-ambulatory

Classification

TABLE I Japanese Orthopaedic Association Criteria* for the Evaluation of Operative Results in Patients with Cervical Myelopathy*

I. Upper extremity function
Impossible to eat with either chopsticks or spoon (0 points)
Possible to eat with spoon, but not with chopsticks (1 point)
Possible to eat with chopsticks but inadequate (2 points)
Possible to eat with chopsticks but awkward (3 points)
Normal (4 points)
II. Lower extremity function
Impossible to walk (0 points)
Need cane or aid on flat ground (1 point)
Need cane or aid only on stairs (2 points)
Possible to walk without cane or aid, but slow (3 points)
Normal (4 points)
III. Sensory
Upper extremity
Apparent sensory loss (0 points)
Minimal sensory loss (1 point)
Normal (2 points)
Lower extremity
Apparent sensory loss (0 points)
Minimal sensory loss (1 point)
Normal (2 points)
Trunk
Apparent sensory loss (0 points)
Minimal sensory loss (1 point)
Normal (2 points)
IV. Bladder function
Complete retention (0 points)
Severe disturbance (1 point)
Inadequate evacuation of bladder
Straining
Dribbling of urine
Mild disturbance (2 points)
Urinary frequency
Urinary hesitancy
Normal (3 points)

*Total normal score = 17 points.

Diagnosis

Subtle clinical findings of early myelopathy make diagnosis difficult and it is often overlooked

- **Neck pain and stiffness**
- **Extremity paresthesias**
 - Diffuse non-dermatomal numbness and tingling
- **Weakness & clumsiness**
 - Dropping objects, difficulty with fine motor control
- **Gait instability**
 - Wobbly or “drunk” on feet
 - Most important clinical predictor of severity
- **Urinary retention**
 - Rate and only appears late in disease progression

Physical Exam

- **Motor**
 - LE weakness more concerning finding
 - Finger escape sign (Wartenberg's Sign)
 - Fingers extended and adducted
 - Small finger spontaneously abducts due to intrinsic m. weakness (and unopposed EDM)
 - Grip and release test
 - Should be able to make fist and release 20 times in 10 sec.
- **Sensory**
 - Proprioception dysfunction (dorsal columns)
 - Poor prognosis
 - Decreased pain sensation (lateral spinothalamic)

Physical Exam

- **Upper motor neuron signs (spasticity)**
 - Hyperreflexia
 - can be absent if concurrent radiculopathy or peripheral neuropathy
 - Inverted brachioradialis reflex
 - Tapping BR -> ipsilateral finger flexion
 - Hoffmann's sign
 - Snapping distal phalanx → spontaneous flexion of other fingers
 - More worrisome if asymmetric
 - Sustained clonus
 - > 3 beats of clonus (very low sensitivity, very high specificity)
 - Babinski
- **Gait and balance**
 - Toe-to-heel walking difficulty
 - Romberg
- **Provocative Tests**
 - Lhermitte Sign: extreme neck flexion → electric shock down spine and extremities



Gait Analysis

- **Gait can be confounded by many factors**
 - Age
 - Deconditioning
 - Weight/body habitus
 - LE surgeries or deformities
 - THA, TKA, ankle fracture ORIF, ankle fusion, LLD/amputations
 - Knee and/or ankle/foot valgus/varus
 - Peripheral neuropathy
 - Vision
 - Inner ear
 - CVA
 - MS, Parkinson's, Cerebellar disorders
 - Medications

Gait Analysis

- **Watch patient walk into office and exam room**
 - Wide-based, unsteady, shorten stride, slowed paced, prolong double support, limited ankle extension
- **Foot drop**
 - L4 and/or L5 radiculopathy
 - Anterior tib injury/damage (prior surgery)
 - Peroneal neuropathy
 - Sciatic neuropathy
 - Charcot Marie Tooth
- **Trendelenburg**
 - L4 and/or L5 radiculopathy
 - Gluteus medius injury (THA)
- **Inability to heel-to-toe**

Differential Diagnosis

- Amyotrophic Lateral Sclerosis (ALS): upper and lower motor neurons are affected
- Multiple Sclerosis
- Carpal Tunnel Syndrome
- Diabetic Neuropathy
- Cerebral Issue (injury, stroke, etc.)
- Normal aging

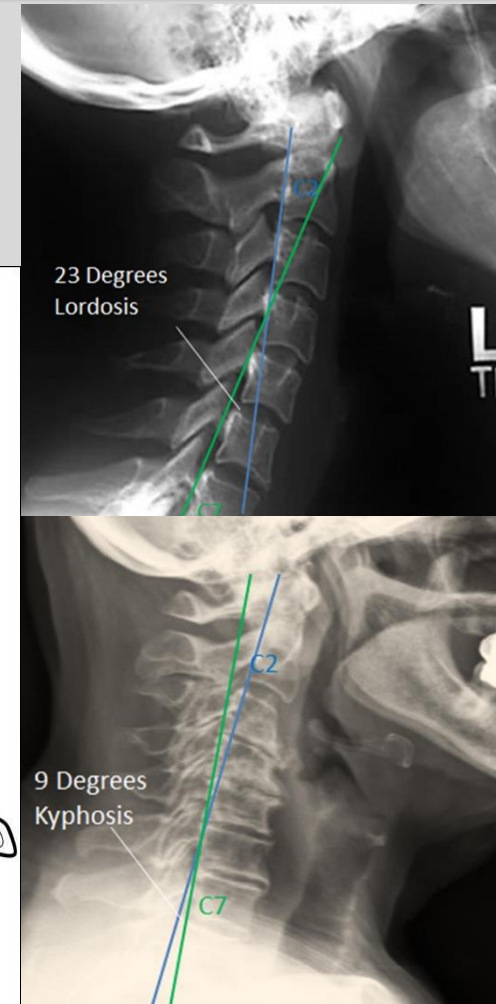
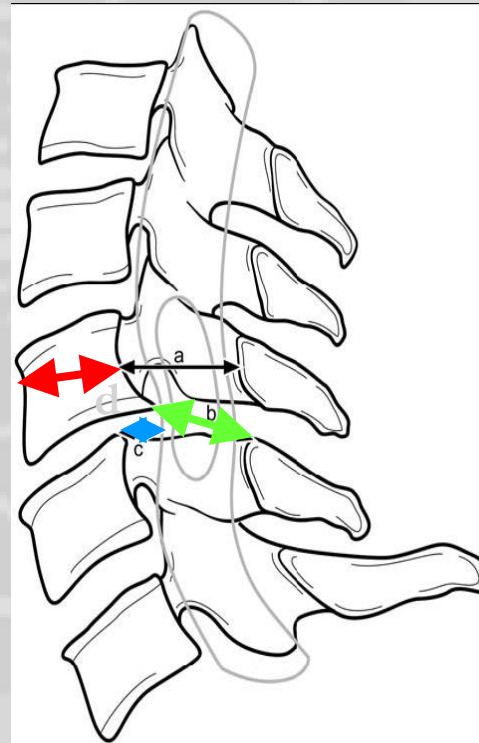
Radiographs

- **AP/Lateral/Flex/Ext.**
 - **Degenerative changes**
 - **Uncovertebral and facet joint arthropathy**
 - **Osteophytes**
 - **OPLL**
 - **Loss of cervical lordosis**
 - **Spondylolisthesis (static or dynamic)**



Lateral Radiograph

- **Decreased sagittal diameter**
 - less than 13mm on lateral XR
 - Torg ratio < 0.8 (a/d)
- **C2-7 alignment**
- **Local kyphosis angle**

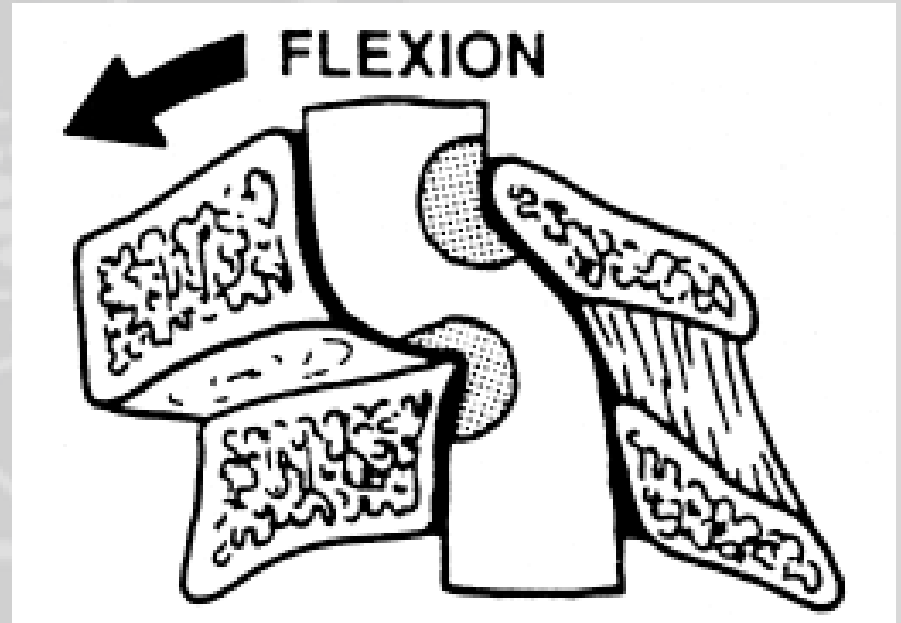
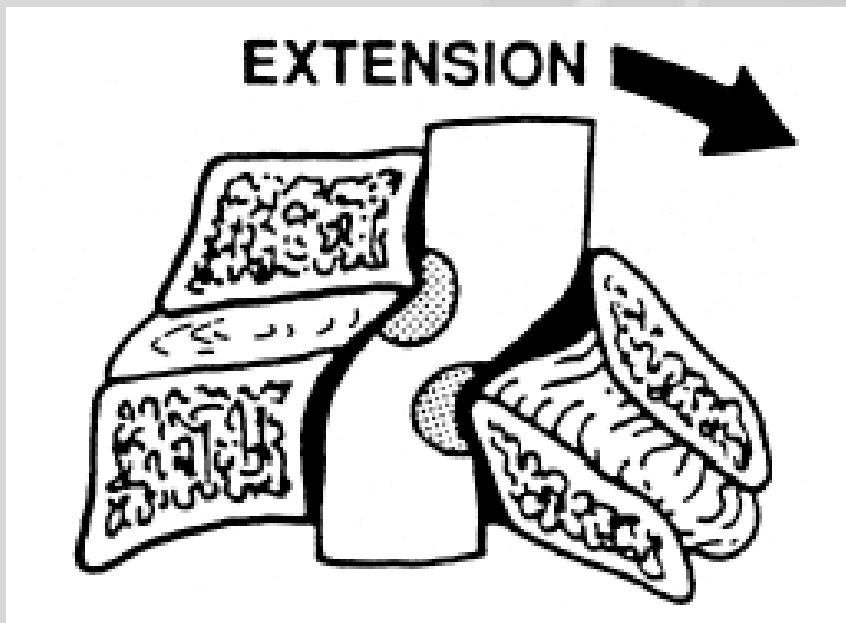


Ossified Posterior Longitudinal Ligament (OPLL)



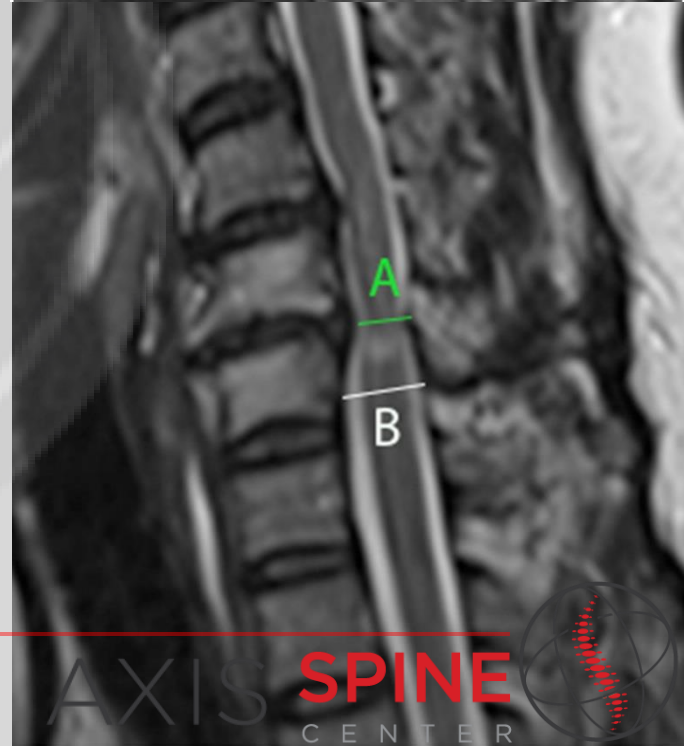
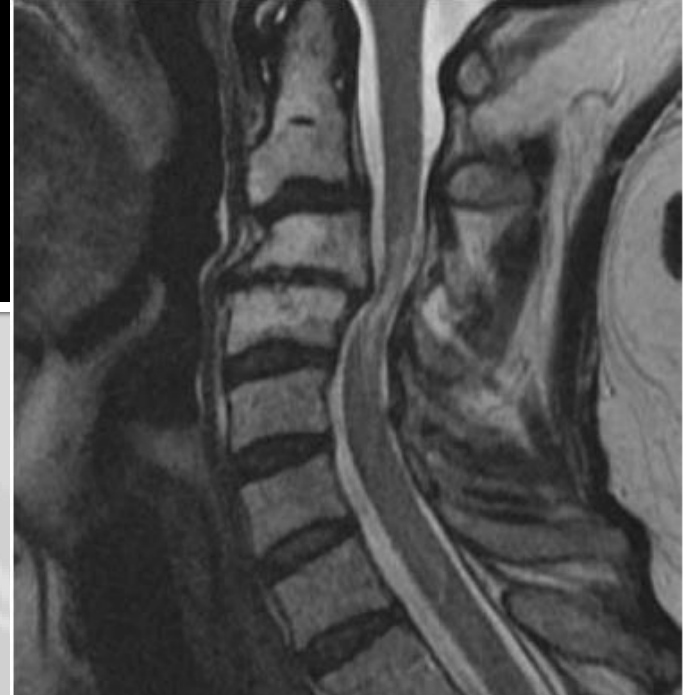
Dynamic Stenosis

- Translation or angulation between vertebrae → narrow canal space
- Get FLEX-EX imaging



MRI

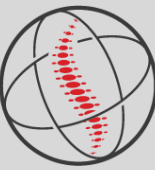
- Study of choice to evaluate cord
- Evaluate CSF effacement
- Spinal cord changes
 - Bright T2 (myelomalacia)
 - Bright T1 (poor prognosis)
- Compression ratio < 0.4
 - Poor prognosis
- Evaluate soft tissue, discs, ligaments, and bone (to an extent)



MRI: Incidental Findings

- **Boden et al. 1990**
 - Evaluated MRIs in asymptomatic patients
 - 20% of asymptomatic patients had abnormal findings
 - Disc degeneration/narrowing at one or more level
 - **25% of subjects less than 40**
 - **60% in those older than 40**

EMORY SPINE CENTER



CT

- Gold standard for bony anatomy
- Evaluate OPLL
- Myelography
 - Evaluate soft tissue vs. bony compression
 - Useful for pacemaker, previous surgery (w/ or w/o hardware), evaluate fusion status
 - Risk of spinal headache



Treatment

■ Non-operative

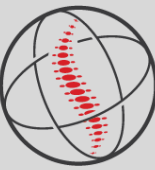
- Observation, NSAIDs, ESIs, therapy, immobilization and lifestyle modifications
 - Mild disease with **NO** functional impairment
 - Poor surgical candidates
- CLOSE FOLLOW-UP

■ Operative

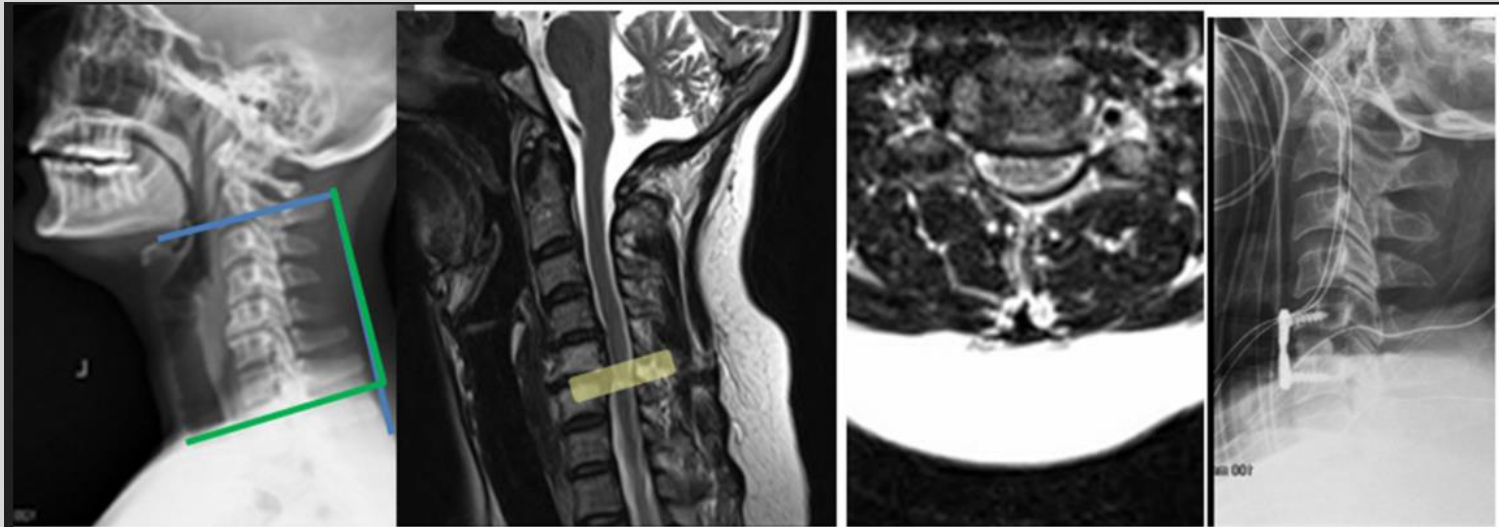
- Significant functional impairment
- Outcomes contingent upon pre-operative impairment
- Procedure selection depends on:
 - Cervical alignment, number of stenotic levels, location of compression, comorbidities

Treatment

Simplified Treatment Algorithm for CSM		
	1 or 2 levels of compression	3+ levels of compression
> 10 rigid Kyphosis	③ Anterior alone (ACDF/corpectomy /hybrid)	⑤ Combined AnteroPosterior •Anterior to correct kyphosis/decompress •Posterior to Decompress
< 10 rigid kyphosis		④ Posterior alone Laminoplasty vs Laminectomy + Fusion



Treatment



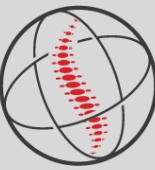
	1 or 2 levels of compression	3+ levels of compression
> 10 Kyphosis (Anterior Only)	Anterior alone ACDF/corpectomy/hybrid	Anterior & Posterior
< 10 kyphosis/ Lordotic (Anterior or Posterior)		Laminoplasty Laminectomy & Fusion



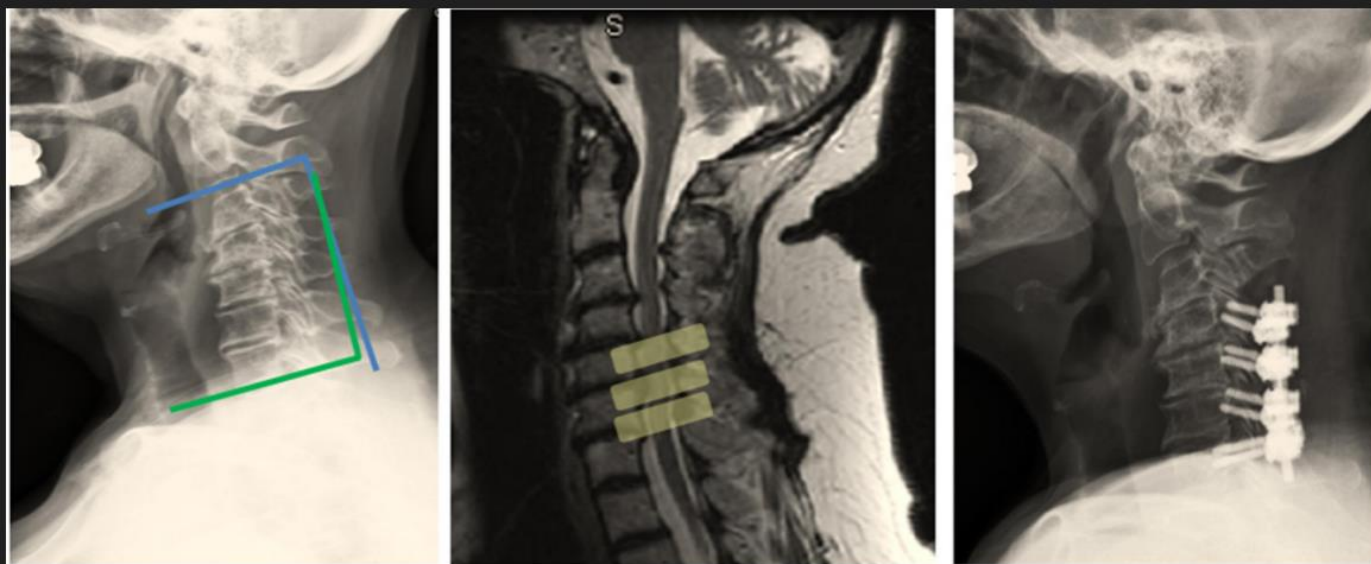
Treatment



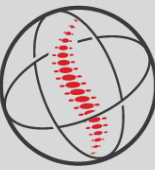
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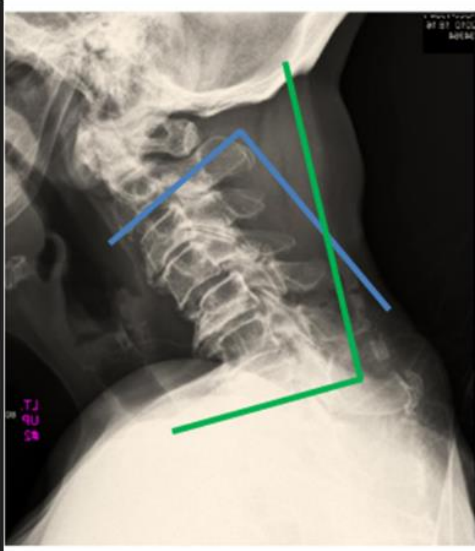
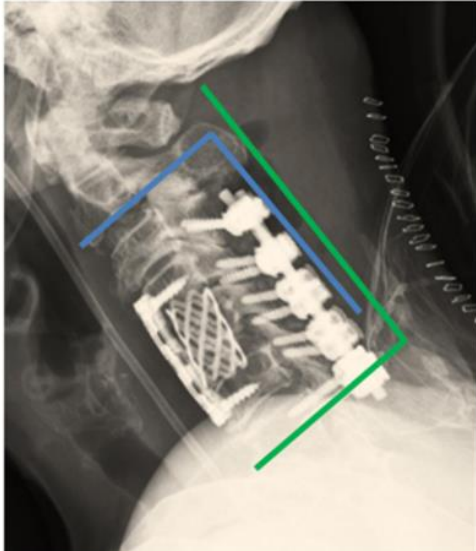
Treatment

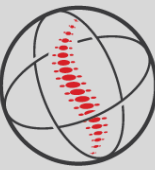


	1 or 2 levels of compression	3+ levels of compression
> 10 Kyphosis (Anterior Only)	Anterior alone CDF/corpectomy/hybrid	Anterior & Posterior
< 10 kyphosis/ Lordotic (Anterior or Posterior)		Laminoplasty Laminectomy & Fusion



Treatment

		
	1 or 2 levels of compression	3+ levels of compression
> 10 Kyphosis (Anterior Only)	Anterior alone CDF/corpectomy/hybrid	Anterior & Posterior
< 10 kyphosis/ Lordotic (Anterior or Posterior)		Laminoplasty Laminectomy & Fusion



Anterior Cervical Decompression and Fusion (ACDF)

- **Mainstay of treatment for 1-3 level disease**
- **Fixed cervical kyphosis of $> 10^\circ$**
 - Lordosis restored by anterior procedure
- **Pathology is anterior (discs or disc-osteophyte complexes)**
- **Corpectomy can be added if pathology is behind vertebral body**
 - Multilevel corpectomies are mechanically inferior
- **Pros**
 - Lower infection rate, less post-operative pain, less blood loss, faster
- **Cons**
 - Requires fusion → loss of motion, non-union (especially with multi-level), can be dangerous with OPLL



Anterior Cervical Decompression and Fusion (ACDF)



Anterior Cervical Decompression and Arthroplasty (ACDA)

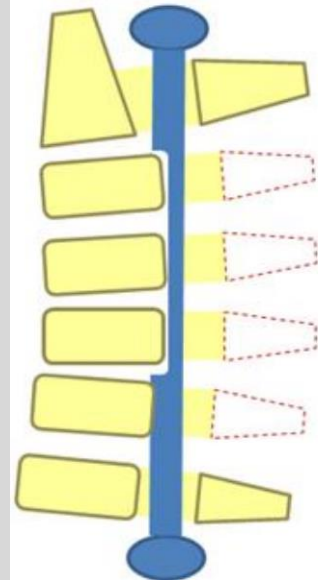
- **Alternative to ACDF**
- **Maintains motion**
- **Reduced rate of adjacent segment degeneration**
 - Studies +/-
- **Contraindications**
 - Kyphosis
 - Advanced age
 - Spondylolisthesis
 - Extensive bony central stenosis



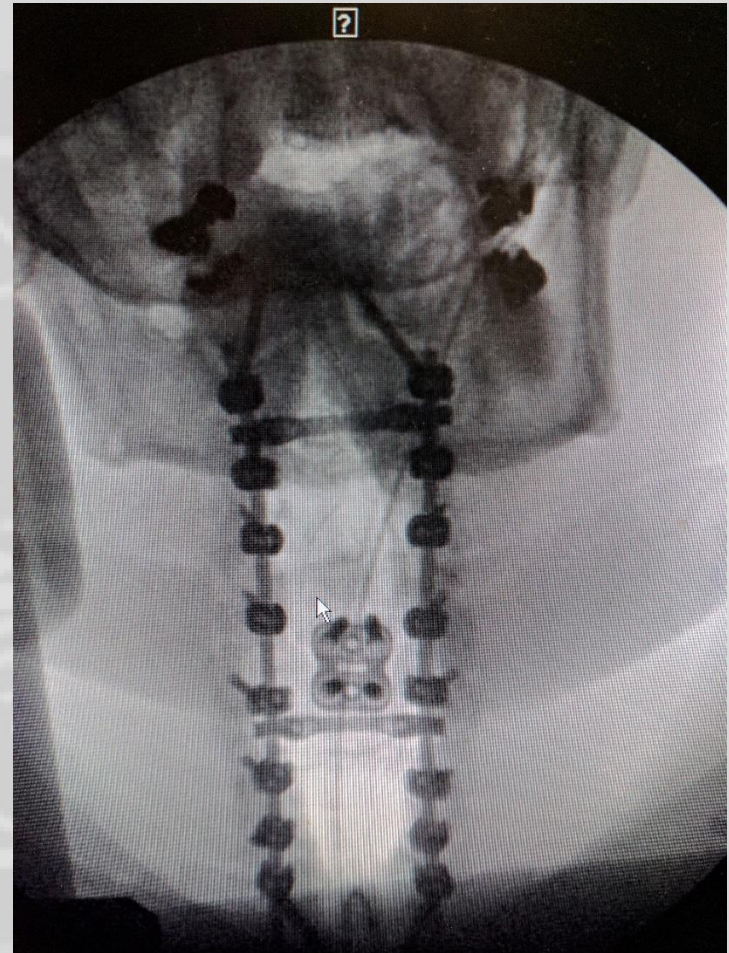
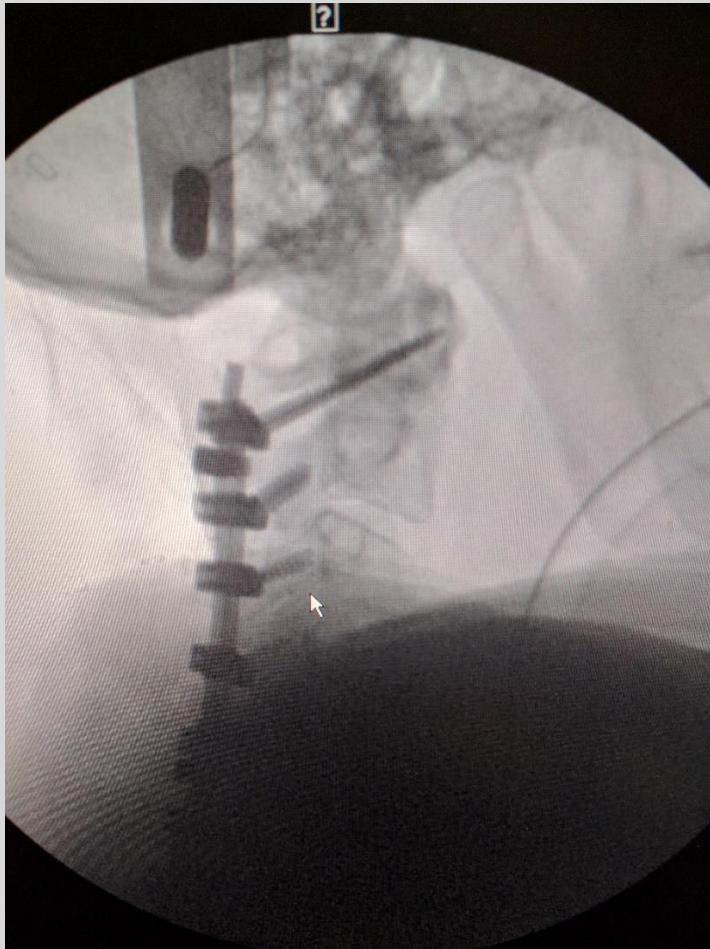
Posterior Laminectomy and Instrumented Fusion

- **Multilevel (3+) compression with fixed kyphosis $< 10^\circ$**
- **Pros**
 - Able to address more levels without a disproportionate increased in non-union rate, fusion can improve neck pain from degen. facets
- **Cons**
 - Significantly more painful, longer recovery, cannot address kyphotic deformity without osteotomy

Laminectomy Fails to address Anterior Compression

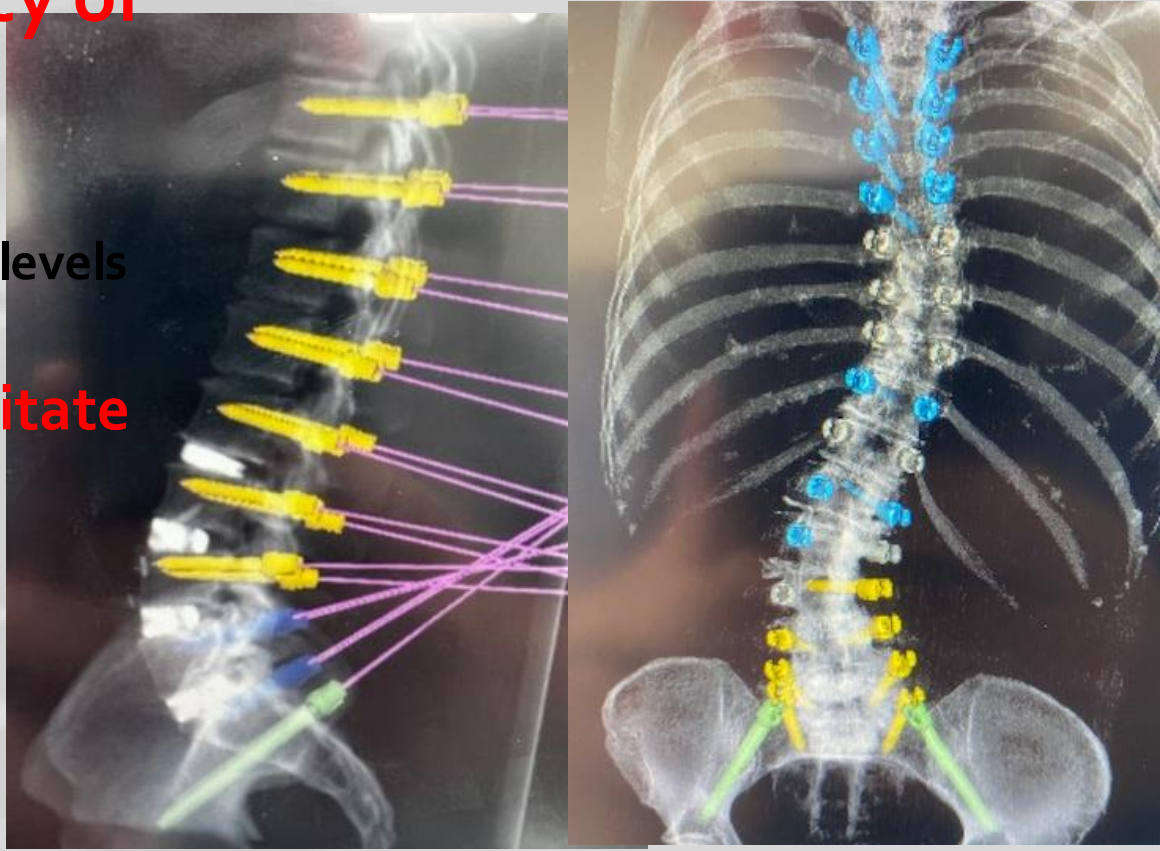


Posterior Laminectomy and Instrumented Fusion

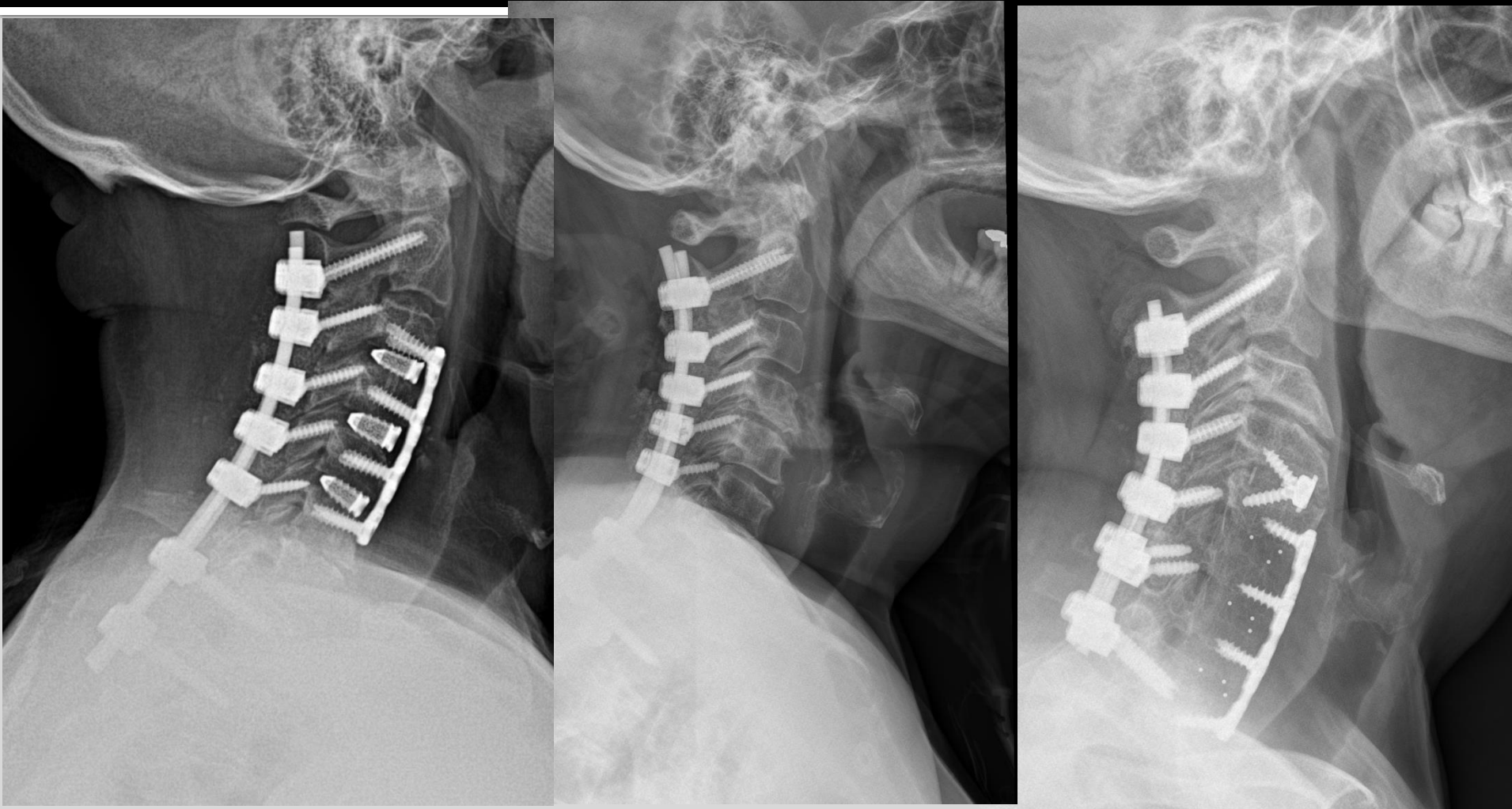


Posterior Laminectomy and Instrumented Fusion w/ ROBOTS

- **Increased accuracy of instrumentation**
 - Longer, large screws
 - Instrument diminutive levels
- **Screws placed to facilitate alignment correction**
- **Increased speed of instrumentation**

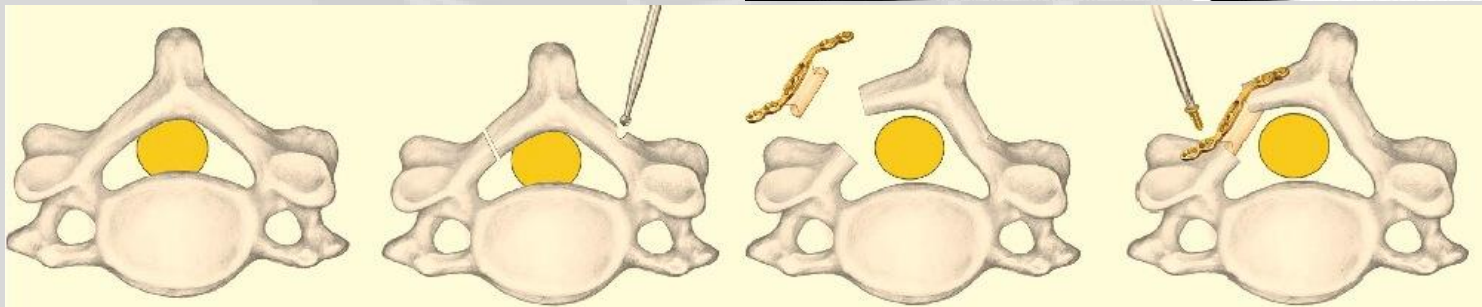
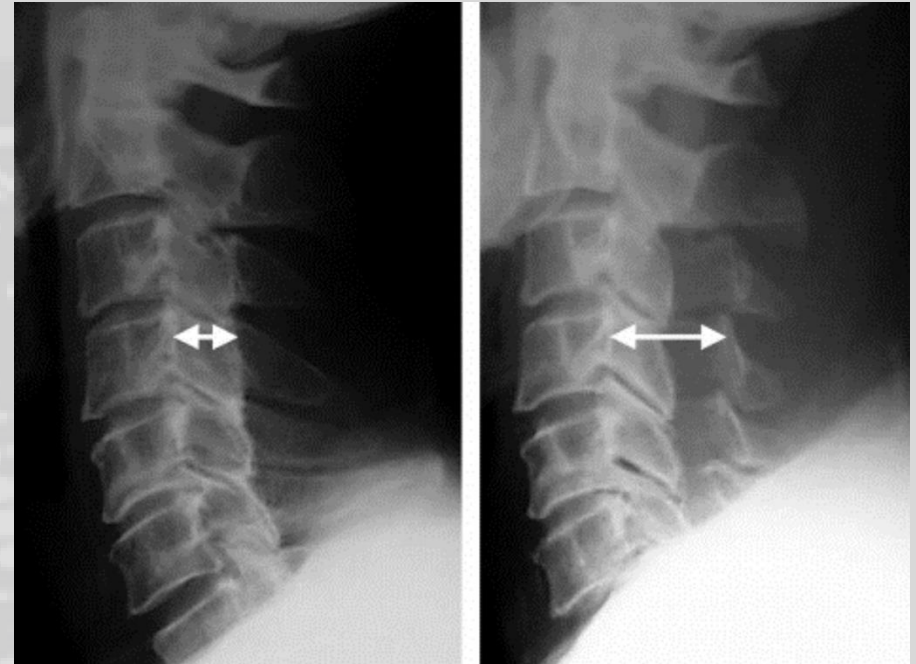


Posterior Laminectomy and Instrumented Fusion w/ ROBOTS



Cervical Laminoplasty

- Multilevel (3+) compression with fixed kyphosis $< 10^\circ$
- Volume of canal is expanded by creating a "hinged-door" laminectomy



Cervical Laminoplasty

- **Posterior decompression but maintains motion**
 - Usually performed from C₃ - 7
- **Contraindicated with severe axial neck pain**
- **Pros**
 - Able to address multiple levels without fusion and without destabilization
 - Non-union not concern (option for smokers, chronic steroids, etc)
 - Lower complication rate than multilevel anterior
 - Especially in OPLL
- **Cons**
 - Post-operative neck pain, still some loss of motion

Cervical Laminoplasty

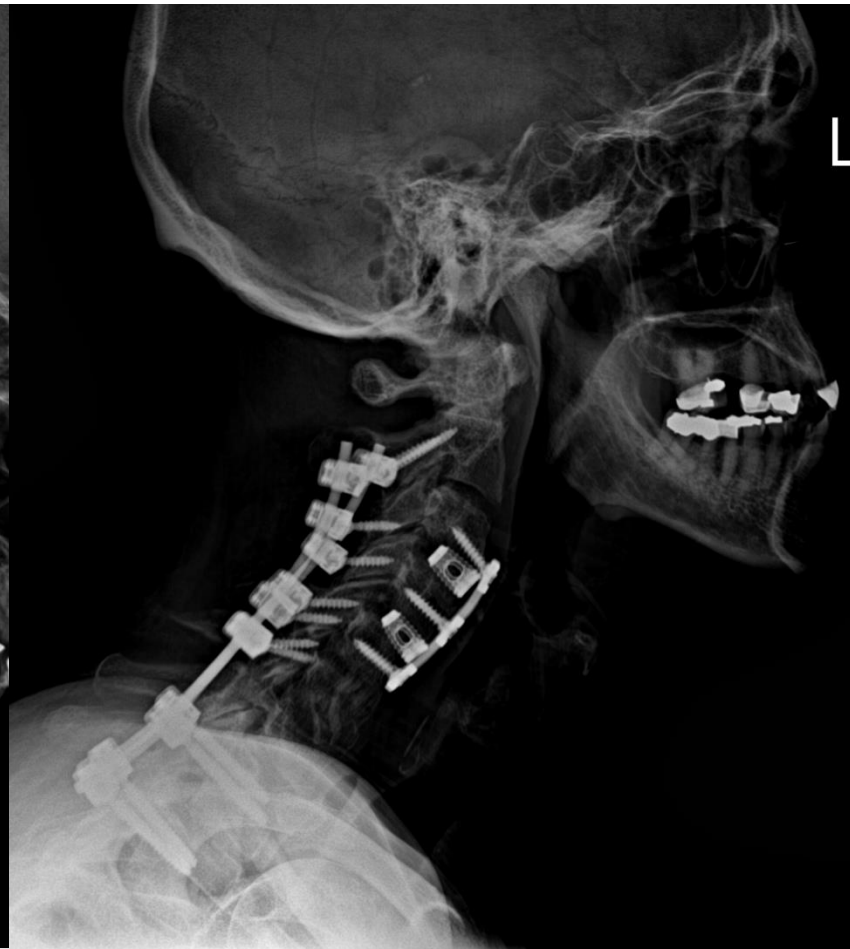


Cervical Laminectomy

- Previously very common, but now rarely indicated due to well known risk of post-laminectomy kyphosis
 - 11-47% incidence



Cervical Laminectomy



Cervical Laminectomy



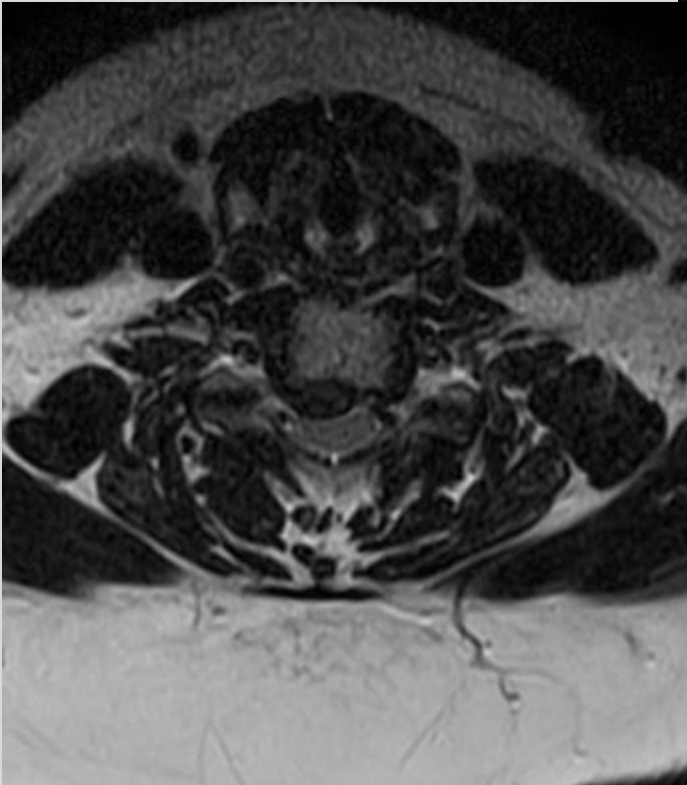
Case Example

- 51yoF referred by local chiropractor for severe, symmetric, bilateral distal foot numbness and burning paresthesias
- Normal gait
- On detailed questioning, mild difficulties with use of buttons (not progressive)
- No back or neck pain
- Extensive diagnostic w/u: Lumbar MRI/CT/XR, EMG/NCS, ESIs
- Slowed gait, but not clearly ataxic. Normal/diminished reflexes, normal Babinski, Hoffman, IBR, clonus

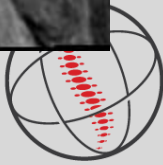
Summary



Summary



Summary



Summary

- **Patients with cervical myelopathy can frequently present without pathognomonic symptoms**
 - Presenting complaints are often subtle
 - Pain is often a primary complaint and attracts attention from patient and provider
 - Symptoms can be downplayed, minimized, or attributed to other issues
- **Gait instability cannot be simply attributed to normal aging**
- **Providers need high index of suspicion**
 - Early identification and treatment is paramount to treatment and prognosis
- **25-36% of symptomatic lumbar stenosis patients will have CSM**
 - Failed treatment of lumbar disease (op or non-op) doesn't always mean permanent nerve damage → funicular pain

Thank You

