

Minimally Invasive Spine Surgery

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Goals of this talk

- 1. Discuss what MIS spine surgery is**
- 2. History of MIS spine surgery**
- 3. Advantages/disadvantages**
- 4. Specific techniques**

Challenge

- Spine surgery, particularly spinal fusion surgery, requires extensive muscle dissection and potentially high blood loss
- There is no potential space in the spine as there is in the abdomen, making minimally invasive approaches more difficult

What does MIS surgery mean?

- Minimally invasive spine surgery is a series of techniques that can be used to access the spine in a less invasive fashion to perform procedures that are traditionally done in an open fashion
 - Laminectomy/Decompression
 - Fusion surgeries
 - Tumor resection

What MIS surgery is not

- It is less invasive, but how minimal can vary
- It is not suitable for every spine case
 - Depends who you ask
- It is not difficult, but...
 - There is a learning curve

Advantages of MIS Spine

- Reduced blood loss
- Reduced tissue disruption
- Reduced muscle atrophy
- Shorter operative times*

Limitations of MIS Spine

- **Learning curve**
- **Limited anatomical exposure**
- **Need for fluoroscopy or image guidance**
- **Limited bony exposure for grafting**
- **Not optimal for all pathology**

History of MIS Spine

- **1982: Magerl described a “closed” technique for the insertion of screws and assembly of an external fixation device for the treatment of spine fractures**
- **1994: Foley and Smith describe tubular retractor system for microdiscectomies**
- **1995: Mathews and Long described an internal connector underneath the skin**
- **1998: McAfee reported on minimally invasive lateral retroperitoneal approach**
- **2001: Foley described a technique (Sextant, Medtronic) for the passage of a subfacial rod between screws**

MIS vs Open; Things to consider

- **Surgical goals**
 - **Decompress nerves**
 - **Fuse vertebrae together**
 - **How will you get them to fuse?**
 - **Correct spinal alignment (deformity)**
- **Comorbidities**
- **Prior fusion/instrumentation**

MIS vs Open; tools of the trade

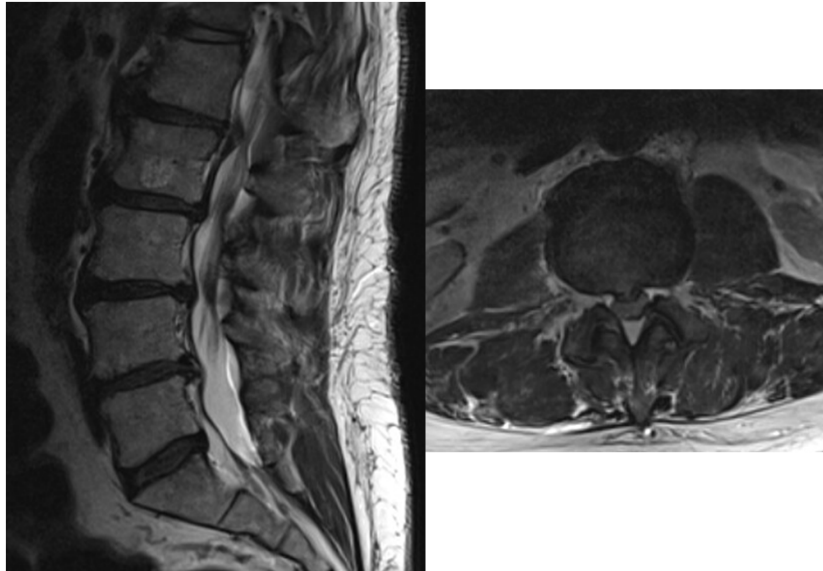
- | | |
|---|---|
| <ul style="list-style-type: none">• Open<ul style="list-style-type: none">• Osteotomies<ul style="list-style-type: none">• SPO, VCR, PSO• Interbody cages<ul style="list-style-type: none">• ALIF• TLIF• Facetectomy• Laminectomy• Pedicle screw fixation | <ul style="list-style-type: none">• Minimally invasive (MIS)<ul style="list-style-type: none">• Lateral interbodies<ul style="list-style-type: none">• XLIF, DLIF, LLIF, OLIF (oblique interbody fusion)• Anterior column release (ACR)• MIS TLIF• MIS facetectomy• MIS decompression (laminectomy)• Perc screws |
|---|---|

Case 1

- 55 yo M with hx of Parkinson Disease
- Several months of worsening LBP
- Can walk ½ block
- Some radiation to BLE
- Feels like he is falling forward and to the R

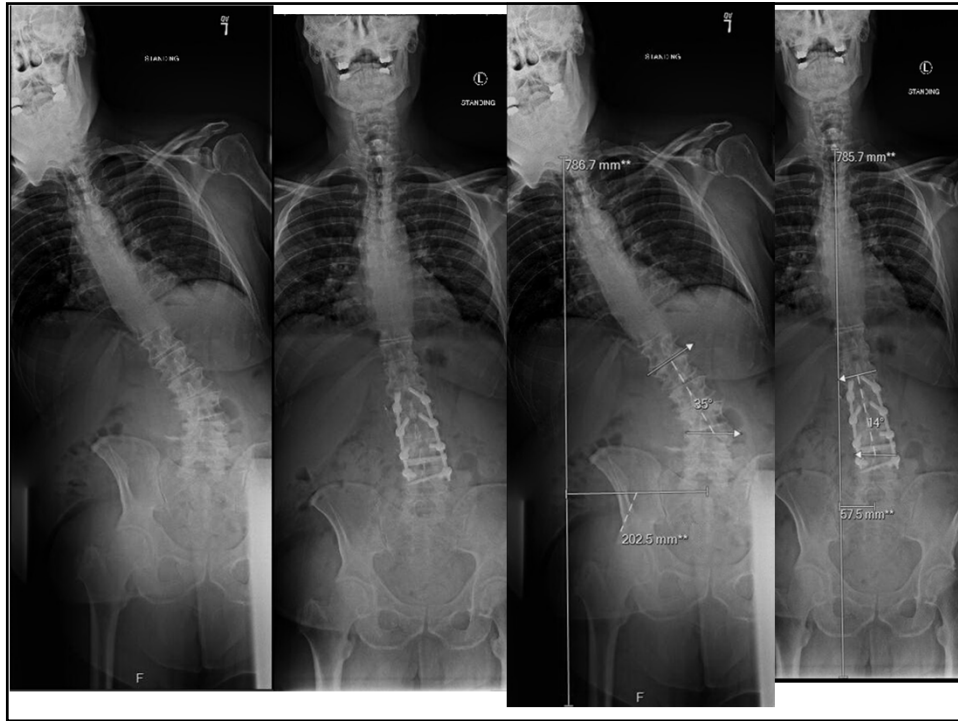


Case 1



Case 1

- MIS lateral interbody fusion
 - L1/2, L2/3, L3/4
 - MIS instrumentation
- Uncomplicated hospital course
- DC'ed to rehab POD 5
- 3 month f/u
- Back pain currently 1/10
- Feels slightly off to the R, but much happier



MIS surgery for spine trauma?

- Can be used for wide array of traumatic spine injuries
- Allows for pedicle screw fixation and some reduction of spine fractures
- Allows for limited decompression
- Not ideal for severe fracture-dislocations or burst fractures with severe canal compromise and neurologic deficits

Flexion-distraction injury

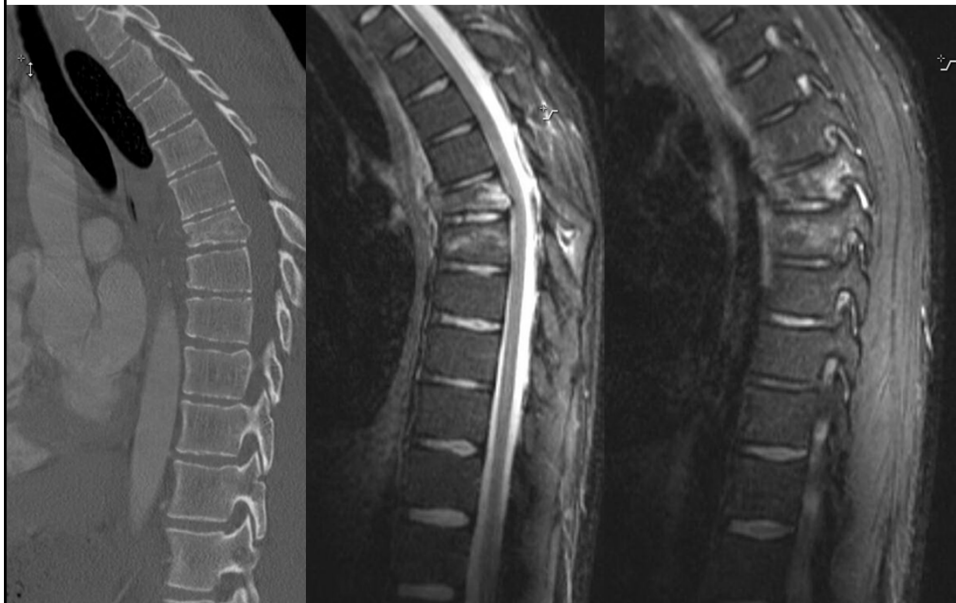
- **Three column injury**
- **1-16% of thoracolumbar fractures**
- **Distractive forces disrupt posterior and middle columns**
- **Often associated with anterior column fractures**
 - **Compression fractures**
- **Chance fracture**

MIS

Ideally suited for flexion distraction injuries because:

- 1. No need for spinal manipulation to reduce a dislocation**
- 2. Aim for restoration of posterior tension band**
- 3. Ease of reducing kyphotic deformity acutely**

Flexion-Distrraction Injury



Flexion-Distrraction Injury



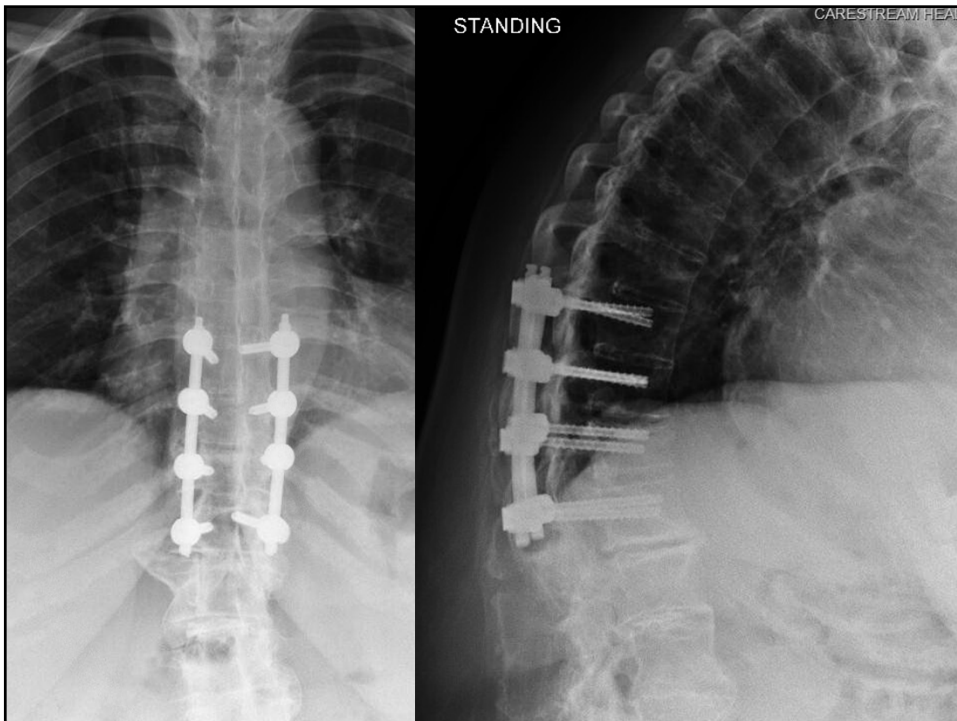
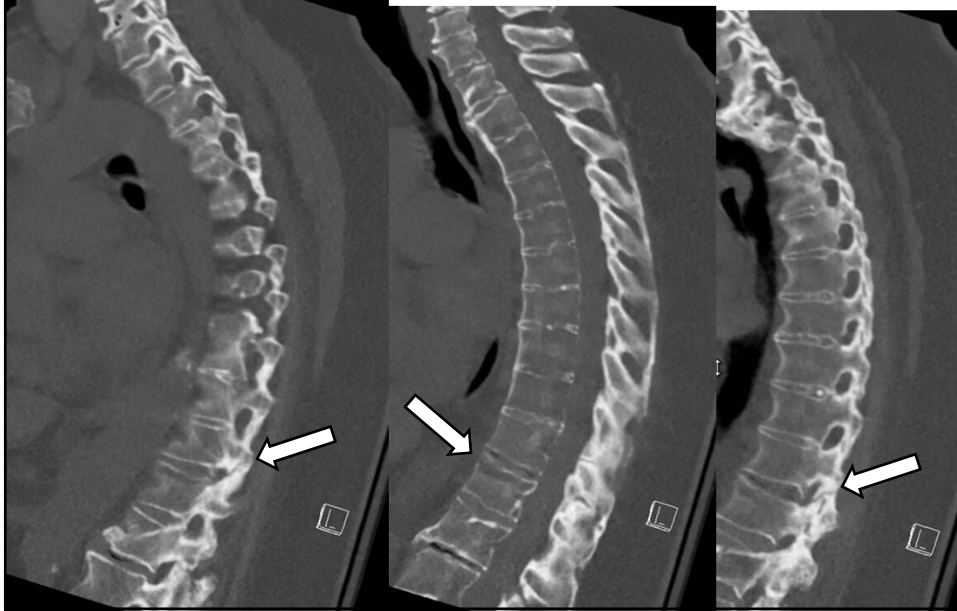
Methods for Screw Insertion

- **Percutaneous**
 - **Stab incisions in skin**
- **Trans-muscular/fascial**
 - **Midline skin incision**
 - **Stab incisions in muscular fascia**

Methods for Screw Insertion

- **Fluoroscopy**
 - **AP plane***
- **Navigation**
 - **When available**
 - **O-arm**
 - **Software expertise**

Extension Type Injury



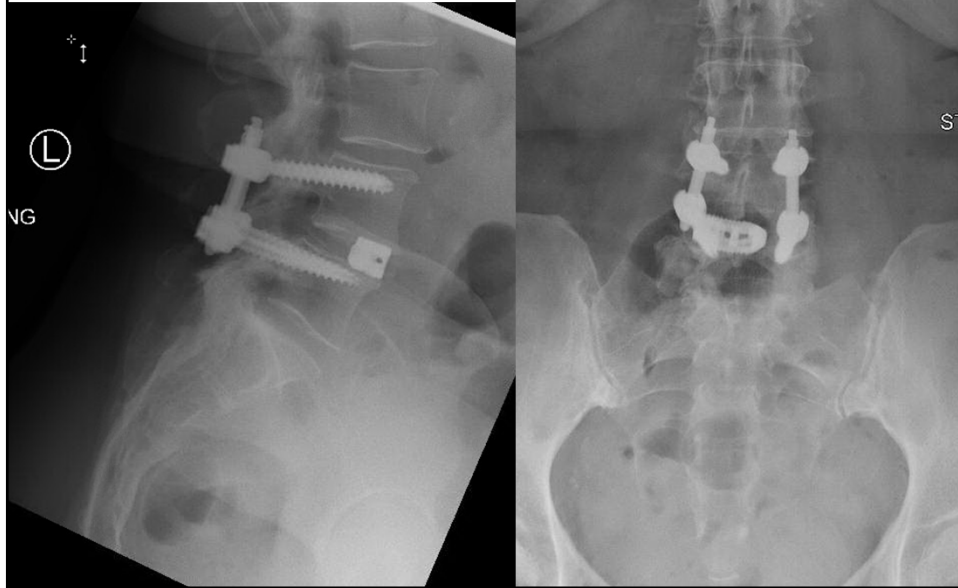
What can be done MIS?

- Minimally invasive decompression/laminectomy
 - Lumbar stenosis
 - Neurogenic claudication
- Minimally invasive microdiscectomy
 - Herniated disc
 - Radiculopathy
- Minimally invasive fusion
 - TLIF, XLIF/DLIF
 - Spinal instability
 - Spondylolisthesis
 - Radiculopathy and/or back pain
- Percutaneous instrumentation
 - Spinal fractures
- Spinal deformity correction
 - In certain cases

Low Grade Spondylolisthesis



Low Grade Spondylolisthesis

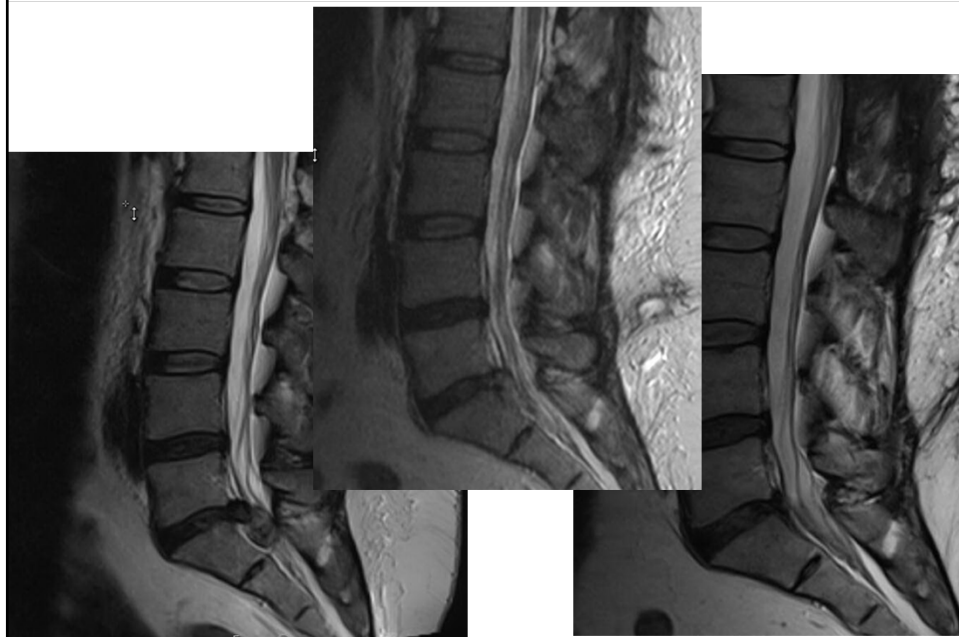


Pars defect (Spondylolysis) with instability





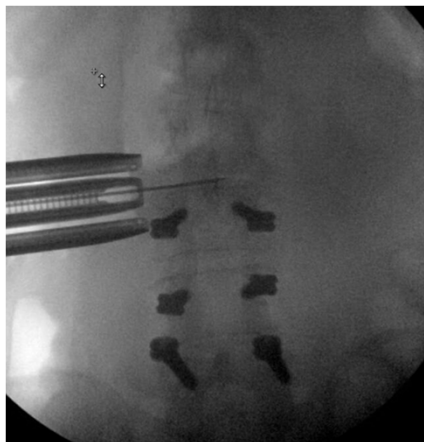
Lumbar Disk Herniation



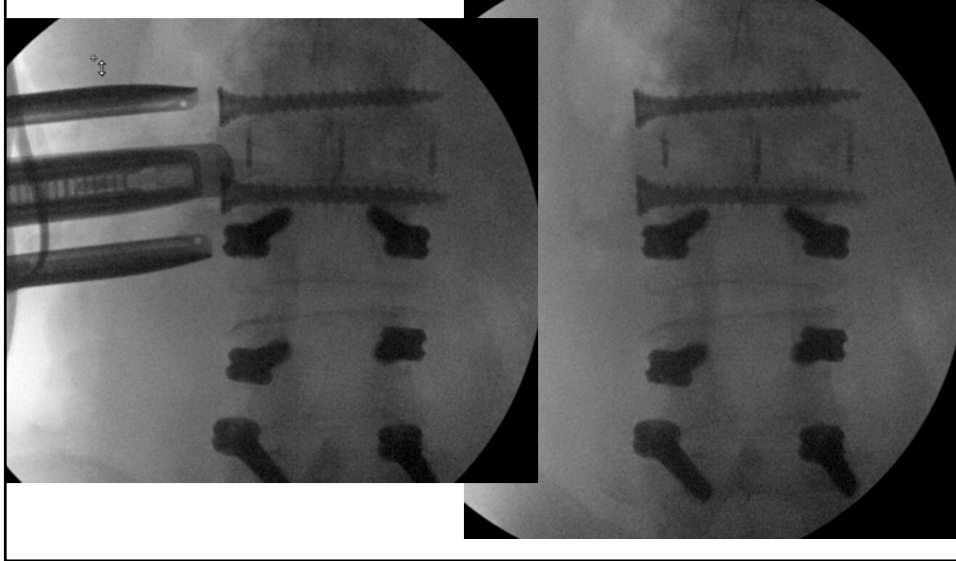
Adjacent Level Disease – Lateral Interbody Fusion



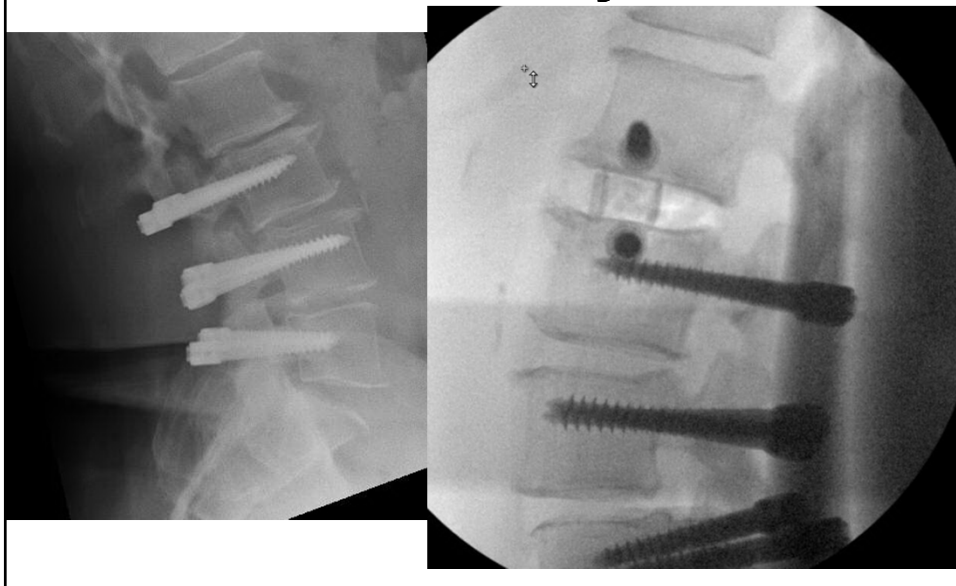
Adjacent Level Disease – Lateral Interbody Fusion



Adjacent Level Disease – Lateral Interbody Fusion



Adjacent Level Disease – Lateral Interbody Fusion



Conclusions

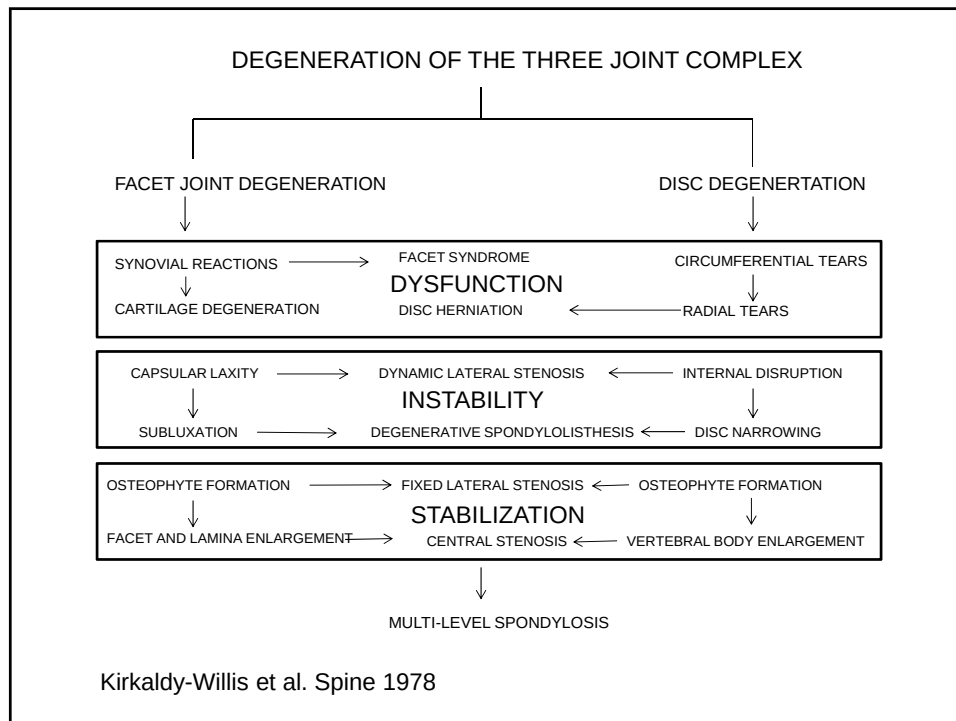
- **Minimally invasive spine surgery has several advantages including**
 - **Reduced blood loss**
 - **Less tissue disruption**
 - **Less post-operative pain**
 - **Reduced hospital stays**
- **Not all spine pathology is amenable to MIS spine techniques**
- **If goals of surgery can be achieved, MIS techniques are a great option!**

Cervical Spondylotic Myelopathy

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Background

- **Cervical spondylotic myelopathy (CSM)** is the most common cause of spinal cord related disability in adults.
- **Degeneration of the discs, cervical facets, and ligamentous structures** are a common result of aging.
- **Symptomatic myelopathy occurs when the degenerative process results in compression of the spinal cord, spinal malalignment, or instability that subjects the cord to repeated dynamic injury.**



Presentation

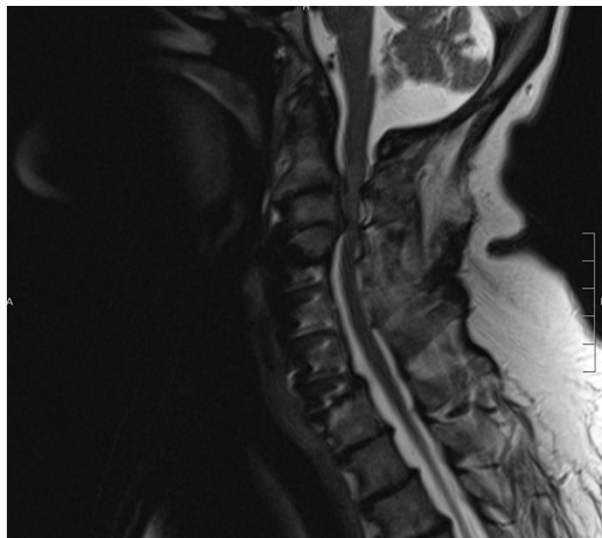
- CSM patients most commonly present between age 50-70 y.o.
- Typically insidious onset
 - May have inciting factor (i.e. fall or trauma)
- Gait disturbance
- Loss of fine motor control in hands
- Upper or lower extremity numbness
- Urinary or bowel urgency or incontinence
- Upper or Lower extremity weakness

Exam Findings

- Increased reflexes in the upper and lower extremities
- UE/LE sensory loss (spinothalamic and dorsal columns)
- UE/LE weakness
 - Usually greater than one myotome
- Hoffman's sign
- Clonus
 - LE > UE
- Babinski
- Gait instability
 - Tandem walk

Imaging

- **MRI: disc-osteophyte complexes, spinal cord compression, T2 signal in spinal cord, ligamentous hypertrophy**
- **CT: osteophytes, ankylosis of uncovertebral joints and/or facet joints, OPLL, calcified discs**
- **X-ray: cervical lordosis, listhesis, instability, oblique views can be useful to see foraminal stenosis.**





Nurick Scale

Grade 1	No Difficulty walking
Grade 2	Mild gait symptoms able to work
Grade 3	Gait symptoms preventing employment
Grade 4	Able to walk only with assistance
Grade 5	Chairbound or bedridden

Modified Japanese Orthopaedic Association

Lower limb motor dysfunction	Score
• Unable to walk	0
• Able to walk on flat floor with walker	1
• Able to walk up/down stairs	2
• Lack of stability and smooth gait	3
• No dysfunction	4
Lower limb sensory deficit	
• Severe sensory loss or pain	0
• Mild sensory deficit	1
• No deficit	2
Trunk sensory deficit	
• Severe sensory loss or pain	0
• Mild sensory deficit	1
• No deficit	2
Spincter dysfunction	
• Unable to void	0
• Difficulty with micturition	1

Natural History

- In 1956, Clark and Robinson followed 120 patients with CSM
 - 75% showed episodic progression
 - 20% showed slow steady progression
 - 5% showed rapid onset with relative stability after

Rao. J Bone Joint Surg. 2002

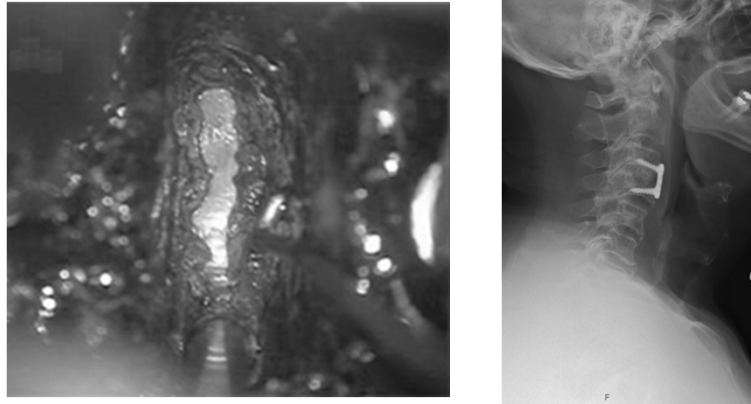
Surgical Approaches

- Anterior vs posterior
- 2013 systematic review
 - Lawrence et al.
 - 2+ levels
 - JOA scores similar
 - Anterior: less infections, trend towards less axial neck pain
 - Posterior: less dysphagia
 - Limited number of studies
 - ACDF vs laminoplasty; ACDF vs laminectomy/fusion; corpectomy vs laminoplasty; etc

Surgical Approaches

- 2011 retrospective review
 - Ghogawala et al.
 - Anterior surgery associated with greater improvement of HR-QOL
 - Posterior decompression and fusion associated with higher costs and longer hospital stays

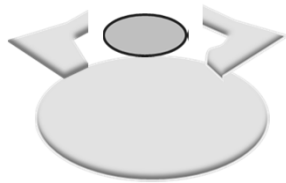
Anterior approach



Complications

- **Early Complications**
 - Recurrent laryngeal nerve injury 0.3-3.7%
 - Dysphagia reported ranges from 1.8-35%
 - Hematoma 0.2-0.9%
 - Durotomy
 - Wound infections 0.1-2%
- **Late Complications**
 - Pseudoarthrosis
 - More common in smokers
 - Non-union rates increase with levels treated
 - Many non-unions are asymptomatic
 - Adjacent segment disease

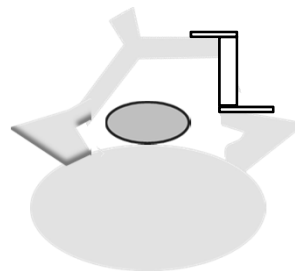
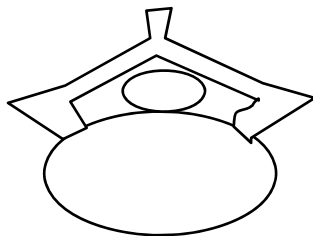
Posterior Approach



Laminectomy and Fusion

- Results in similar neurological improvement as anterior surgery
- Less risk of dysphagia
- Better for addressing multi-level stenosis

Posterior Approach



Laminoplasty

- Reserved for patients with minimal neck pain, and normal cervical alignment.
- Preserves normal range of motion

Clinical Trials

- **Cervical Spondylotic Myelopathy Surgical Trial**
 - Prospective, randomized with nonrandomized arm
 - Ventral vs dorsal surgery for CSM
 - 11 sites

- **Anterior Vs Posterior Procedures for Cervical Spondylotic Myelopathy: Prospective Randomized Clinical Trial (CSM)**
 - ACDF vs laminoplasty
 - University of Hong Kong

- **CSM-Protect Trial – 300 enrolled (now closed)**
 - Double-blind design evaluating potential efficacy of 6 weeks peri-operative Riluzole

Conclusion

- **Cervical spondylotic myelopathy is a common problem in the aging population**

- **Non-operative management has limited role for progressive disease (especially when moderate to severe or progressive symptoms)**

- **Surgical approach should be tailored to the patient**
 - Site of compression, sagittal balance, instability

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