Minimally Invasive Spine Surgery

Andrew Grossbach, MD
Assistant Clinical Professor
Department of Neurological Surgery
The Ohio State University Wexner Medical Center

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

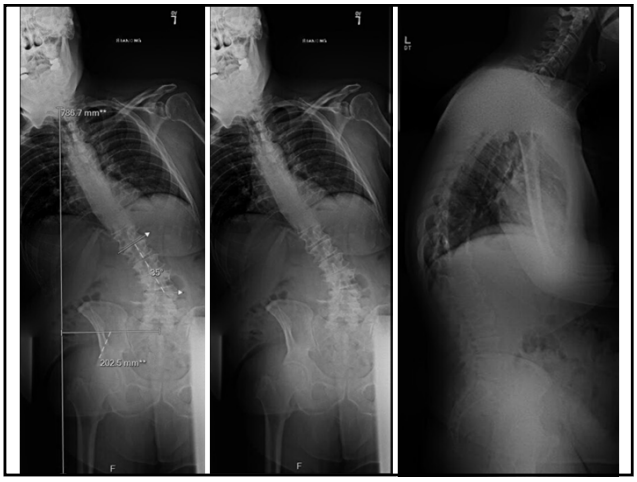
- Surgical goals
  - Decompress nerves
  - Fuse vertebrae together
    - How will you get them to fuse?
  - Correct spinal alignment (deformity)
- Comorbidities
- Prior fusion/instrumentation

MIS vs Open; tools of the trade

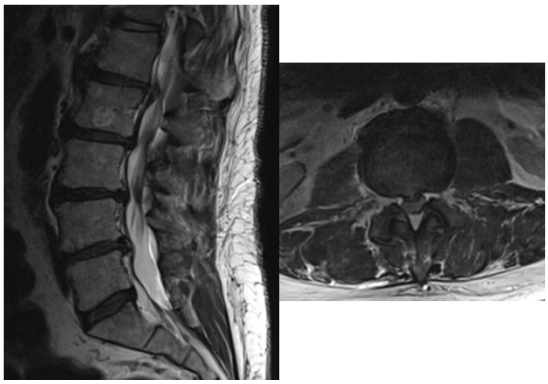
- Open
  - Osteotomies
    - SPO, VCR, PSO
  - Interbody cages
    - ALIF
    - TLIF
  - Facetectomy
  - Laminectomy
  - Pedicle screw fixation
- Minimally invasive (MIS)
  - Lateral interbodies
    - XLIF, DLIF, LLIF, OLIF (oblique interbody fusion)
  - Anterior column release (ACR)
  - MIS TLIF
  - 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

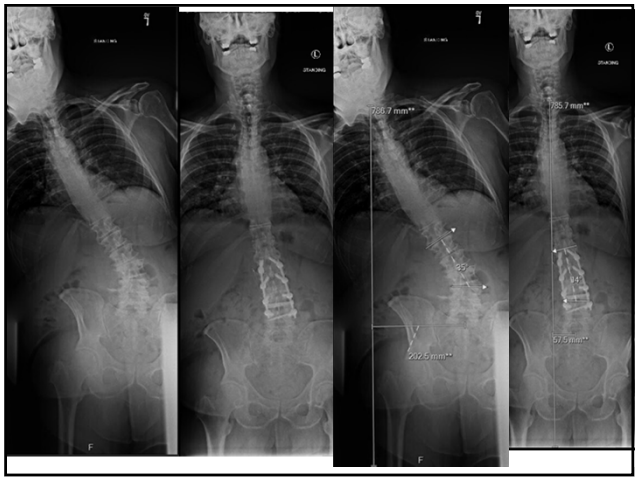


Case 1



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-Distraction Injury

Flexion-Distraction Injury

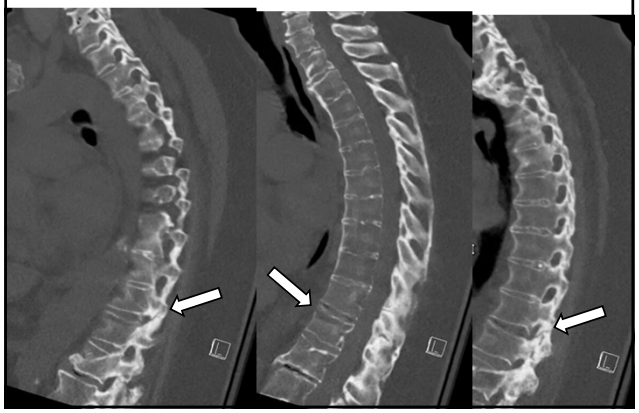
Methods for Screw Insertion

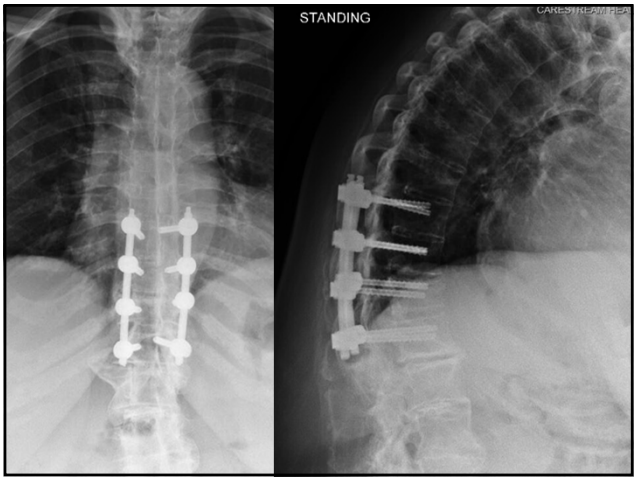
- Percutaneous
  - Stab incisions in skin
- Trans-muscular/fascial
  - Midline skin incision
  - Stab incisions in muscular fascia

Methods for Screw Insertion

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

Extension Type Injury



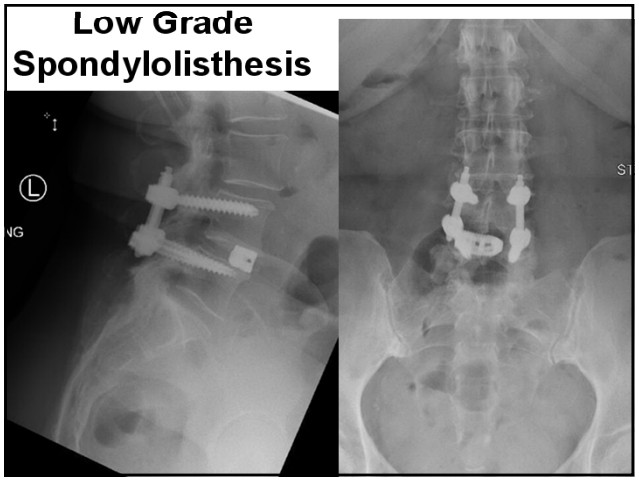


What can be done MIS?

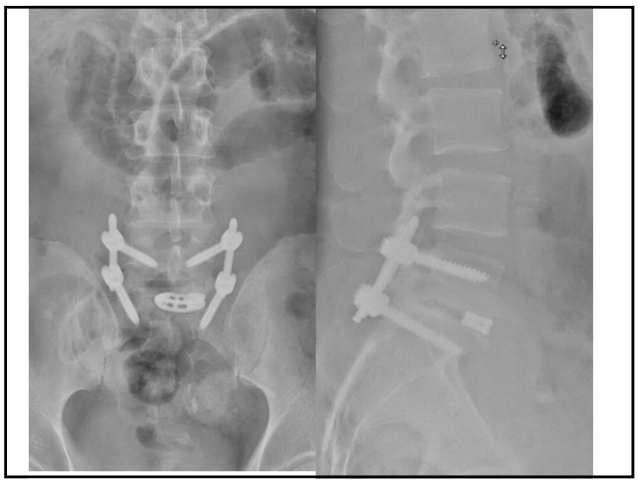
- Minimally invasive decompression/laminectomy
  - Lumbar stenosis
  - Neurogenic claudication
- Minimally invasive microdiscectomy
  - Herniated disc
  - Radiculopathy
- Minimally invasive fusion
  - TLIF, XLIF/DLIF
  - Spinal instability
  - Spondylolisthesis
  - Radiculopathy and/or back pain
- Percutaneous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

Low Grade Spondylolisthesis

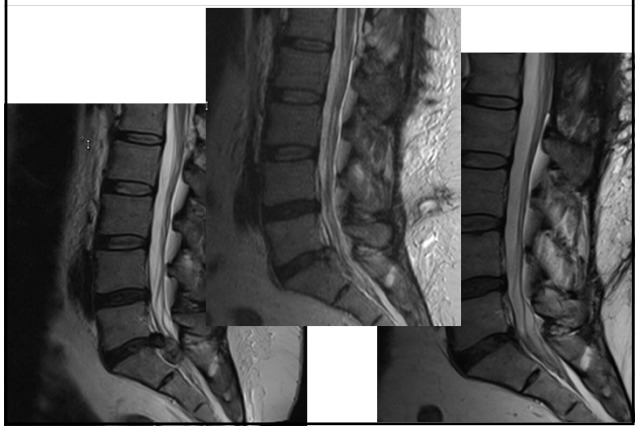
Low Grade Spondylolisthesis



Pars defect (Spondylolysis) with instability



Lumbar Disk Herniation



Adjacent Level Disease – Lateral Interbody Fusion

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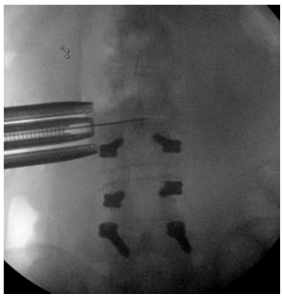
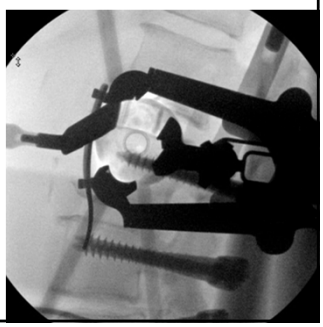
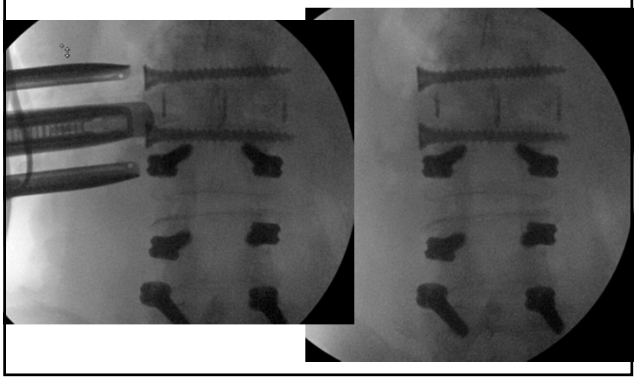
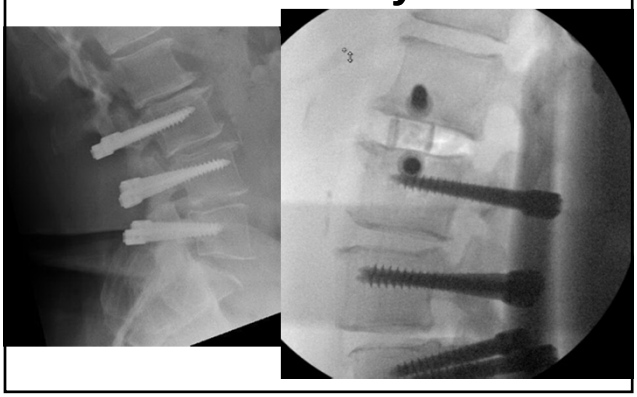




Adjacent Level Disease – Lateral Interbody Fusion



Adjacent Level Disease – Lateral Interbody Fusion



Conclusions

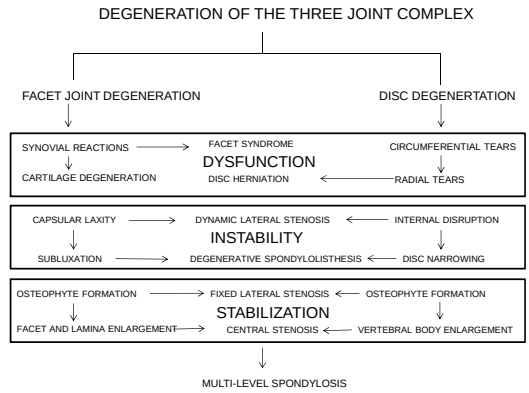
- Minimally invasive spine surgery has several advantages including
  - Reduced blood loss
  - Less tissue disruption
  - Less post-operative pain
  - Reduced hospital stays
- Not all spine pathology is amenable to MIS spine techniques
- If goals of surgery can be achieved, MIS techniques are a great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

Cervical Spondylotic Myelopathy

Stephanus Viljoen, MD
Department of Neurological Surgery
Assistant Professor - Clinical
The Ohio State University Wexner Medical Center

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.**



Kirkaldy-Willis et al. Spine 1978

Presentation

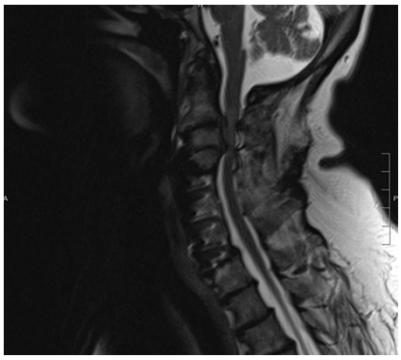
- **CSM patients most commonly present between age 50-70 y.o.**
- **Typically insidious onset**
  - **May have inciting factor (i.e. fall or trauma)**
- **Gait disturbance**
- **Loss of fine motor control in hands**
- **Upper or lower extremity numbness**
- **Urinary or bowel urgency or incontinence**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

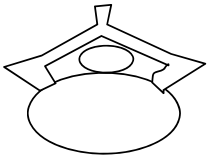
Complications

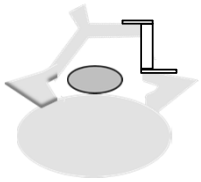
- Early Complications
  - Recurrent laryngeal nerve injury 0.3-3.7%
  - Dysphagia reported ranges from 1.8-35%
  - Hematoma 0.2-0.9%
  - Durotomy
  - Wound infections 0.1-2%
- Late Complications
  - Pseudoarthrosis
    - More common in smokers
    - Non-union rates increase with levels treated
    -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

References

- JA Tracy and JT Bartlson. Cervical Spondylotic Myelopathy. *The Neurologist*. 2010.
- Rao. Neck Pain, Cervical Radiculopathy, and Cervical Myelopathy: Pathophysiology, Natural History, and Clinical Evaluation. *J Bone and Joint Surg*. 2002.
- Iyer et al. Cervical spondylotic myelopathy. *Clinical Spine Surg*. 2016
- Abode-Iyhama KO, Stoner K, Grossbach AJ et al. Effects of brain derived neurotrophic factor Val66Met polymorphism in patients with cervical spondylotic myelopathy. *J Clin Neurosci*. 2016
- Ghogawala Z, Martin B, Benzel E et al. Comparative Effectiveness of Ventral vs Dorsal Surgery for Cervical Spondylotic Myelopathy. *Neurosurgery*. 2011.

- Baba H , Furusawa N , Imura S , et al. Late radiographic findings after anterior cervical fusion for spondylotic myeloradiculopathy .Spine (Phila Pa 1976) 1993 ; 18 : 2167 – 73 .
- Xu R , Bydon M, Macki M, et al. Adjacent Segment Disease After Anterior Cervical Discectomy and Fusion. Spine (Phila Pa 1976) 2014; 39 , 120 – 126.
- Hilibrand AS , Robbins M . Adjacent segment degeneration and adjacent segment disease: the consequences of spinal fusion? SpinevJ 2004 ; 4 : 190S – 4S .
- Eck JC , Humphreys SC , Lim TH, et al. Biomechanical study on the effect of cervical spine fusion on adjacent-level intradiscal pressure and segmental motion Spine (Phila Pa 1976) 2002 ; 27 : 2431 – 4 .
- Prasarn ML , Baria D , Milne E , et al. Adjacent-level biomechanics after single versus multilevel cervical spine fusion . J Neurosurg Spine 2012 ; 16 : 172 – 7 .
- J. Walraevens et al., "Qualitative and quantitative assessment of degeneration of cervical intervertebral discs and facet joints," Eur Spine J (2009) 18:358–369