## 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
<table>
<thead>
<tr>
<th>What MIS surgery is not</th>
<th>Advantages of MIS Spine</th>
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</thead>
<tbody>
<tr>
<td>• It is less invasive, but how minimal can vary</td>
<td>• Reduced blood loss</td>
</tr>
<tr>
<td>• It is not suitable for every spine case</td>
<td>• Reduced tissue disruption</td>
</tr>
<tr>
<td>• Depends who you ask</td>
<td>• Reduced muscle atrophy</td>
</tr>
<tr>
<td>• It is not difficult, but...</td>
<td>• Shorter operative times*</td>
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<tr>
<td>• There is a learning curve</td>
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<table>
<thead>
<tr>
<th>Limitations of MIS Spine</th>
<th>History of MIS Spine</th>
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<tbody>
<tr>
<td>• Learning curve</td>
<td>• 1982: Magerl described a “closed” technique for the insertion of screws and assembly of an external fixation device for the treatment of spine fractures</td>
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<tr>
<td>• Limited anatomical exposure</td>
<td>• 1994: Foley and Smith describe tubular retractor system for microdiscectomies</td>
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<td>• Need for fluoroscopy or image guidance</td>
<td>• 1995: Mathews and Long described an internal connector underneath the skin</td>
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<td>• Limited bony exposure for grafting</td>
<td>• 1998: McAfee reported on minimally invasive lateral retroperitoneal approach</td>
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<tr>
<td>• Not optimal for all pathology</td>
<td>• 2001: Foley described a technique (Sextant, Medtronic) for the passage of a subfacial rod between screws</td>
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</table>
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

- 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
### 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

![Extension Type Injury Image](image-url)
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

Pars defect (Spondylolysis) with instability
Low Grade Spondylolisthesis

Lumbar Disk Herniation

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!
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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>No Difficulty walking</td>
</tr>
<tr>
<td>2</td>
<td>Mild gait symptoms able to work</td>
</tr>
<tr>
<td>3</td>
<td>Gait symptoms preventing employment</td>
</tr>
<tr>
<td>4</td>
<td>Able to walk only with assistance</td>
</tr>
<tr>
<td>5</td>
<td>Chairbound or bedridden</td>
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</table>
### Modified Japanese Orthopaedic Association

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Score</th>
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<tbody>
<tr>
<td>Lower limb motor dysfunction</td>
<td></td>
</tr>
<tr>
<td>• Unable to walk</td>
<td>0</td>
</tr>
<tr>
<td>• Able to walk on flat floor with walker</td>
<td>1</td>
</tr>
<tr>
<td>• Able to walk up/down stairs</td>
<td>2</td>
</tr>
<tr>
<td>• Lack of stability and smooth gait</td>
<td>3</td>
</tr>
<tr>
<td>• No dysfunction</td>
<td>4</td>
</tr>
<tr>
<td>Lower limb sensory deficit</td>
<td></td>
</tr>
<tr>
<td>• Severe sensory loss or pain</td>
<td>0</td>
</tr>
<tr>
<td>• Mild sensory deficit</td>
<td>1</td>
</tr>
<tr>
<td>• No deficit</td>
<td>2</td>
</tr>
<tr>
<td>Trunk sensory deficit</td>
<td></td>
</tr>
<tr>
<td>• Severe sensory loss or pain</td>
<td>0</td>
</tr>
<tr>
<td>• Mild sensory deficit</td>
<td>1</td>
</tr>
<tr>
<td>• No deficit</td>
<td>2</td>
</tr>
<tr>
<td>Sphincter dysfunction</td>
<td></td>
</tr>
<tr>
<td>• Unable to void</td>
<td>0</td>
</tr>
<tr>
<td>• Difficulty with micturition</td>
<td>1</td>
</tr>
</tbody>
</table>

### 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


### 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

- 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

- 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