Minimally Invasive & Endoscopic Spine Surgery

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Why Minimally Invasive Spine Surgery?

• A basic tenet of surgery is to effectively treat pathology with minimal disturbance of normal anatomy: leaving “the smallest footprint.”

• Illumination  
  Small incisions

• Magnification

• Instrumentation  
  Less tissue 
  disruptions
Why Minimally Invasive Spine Surgery?

• A basic tenet of surgery is to effectively treat pathology with minimal disturbance of normal anatomy: leaving “the smallest footprint.”
  -Minimizes tissue trauma, post-operative pain & hospital stay
  -Better cosmesis
MISS-Advantages:
• Reduced post-operative pain
• Tiny scars
• Shorter recovery time
• Shorter hospital stay
• Surgery → Tissue damage

• Tissue Damage → Pain/Function

• MIS → Less Pain/Better Function
• Kawaguchi et al (Spine;1998): Effect of retraction on back muscles in rats

• Three comparison groups:
  2-hour continuous retraction,
  5-minute retraction release after 1 hour of retraction
  5-minute release at every 40 minutes of retraction.
• Kawaguchi et al (Spine; 1998)
• Histochemical examination at 48hrs, 1 week, 6 weeks
• Serum CPK MM measurement at 48 hrs
• Results: Muscle degeneration max. in group 1
  CPK MM highest in group 1
  Regenerated muscle fibres of smallest diameter in group 1
Taylor H et al (Spine; 2002): Impact of self retaining retractors on paraspinal muscles

Twenty patients; Intramuscular pressure measurement 5, 30, 60 min into the surgery

Muscle biopsies before and after retraction studied using ATP birefringence.

Results:

Significant increase in IMP during retraction
Reduced function following retraction (decreased ATP)

- Twenty patients; continuous monitoring of IMP & IPP
- VAS, ODI, SF-36 Health survey
- Results:
  - Rapid/sustained rise in IMP with retraction; IPP$\rightarrow$0
  - VAS, ODI, SF-36 at 6 months worse with retraction $>60$min; no relation to retractor type, IMP/IPP, surgeon, wound length
• MISS circumvents iatrogenic surgical morbidity decreasing tissue injury and blood loss, and thereby reduce length of hospitalization, perioperative pain, analgesic usage, and recovery times.

• In many decompressive operations into outpatient procedures. Thus capturing the interest of surgeons and patients alike.
Types of Spinal Minimally Invasive Procedures

- Minimally invasive procedures and technologies can be broadly characterized as:
- Traditional open procedures through small incisions (open microdiscectomy),
- Endoscopy (thoracic/lumbar discectomy, deformity management, and trauma management),
- Tubular retractor–muscle dilation (MED, METRx, XLIF, Sextant, Mantis, and Longitude),
- Fine needle procedures (chemonucleolysis, nucleotome procedures, vertebroplasty, and kyphoplasty), and
- Miscellaneous technologies (laser-assisted percutaneous discectomy, X-STOP, and AxiaLIF).
Keys to MISS

• Smaller incisions

• Muscle splitting instead of muscle cutting
  Spine Surgery

• Fluoroscopic and image-guided navigation
MISS-Lumbar Spine Disease

- MI Discectomy
- Anterior Lumbar Interbody Fusion (ALIF)
- Posterior Lumbar Interbody Fusion (PLIF)
- Transforaminal Lumbar Interbody Fusion
- eXtreme Lateral Interbody Fusion
- AxialIF for Degenerative L4-S1 Disc Disease
- Kyphoplasty/Vertebroplasty
Evolution of MISS-Lumbar Disc Disease

• 1857: Virchow- Traumatic Lumbar disc disease
• 1955: Mallis- Intraoperative binocular
• 1963: Smith- Chemonucleolysis
• 1967: Yasargil- Microdiscectomy
• 1975: Hijikata- Percutaneous discectomy
• 1978: Williams- Open lumbar microdiscectomy
• 1984: Ascher- Nd-YAG Laser
• 1987: Maroon- APLD
Evolution of MISS-Lumbar Disc Disease

• 1991: Faubert & Caspart-Tubular retractor for discectomy
• 1997: Foley & Smith-MED
• 2000: Saal & Saal- Intradiscal electrothermy
• 2003: METRx System-Adaptation of microscope to tubular retractors
Endoscopy

• Posterior cervical lamino-foraminotomy and discectomy.
• Thoracic discectomy, lumbar laminectomy for stenosis
• Farlateral lumbar discectomy, and interbody lumbar
• Fusion
Retractor Systems

- METRx
- MIRA
- AccuVision Minimally Invasive spine System
- NAPA Minimally Invasive Retractor System
- Serengeti Retractor System
- Luxor Minimally Invasive Retractor System
Microlumbar discectomy

- Entry point is through the interlaminar window
- Microscope provides better visualization
Microlumbar discectomy

Indications:
- Single level disc herniation
- Adjacent bisegmental herniation
- Desiccated disc with bony root entrapment/lateral canal stenosis

Contraindications:
- Spinal canal stenosis
- > 2 level disc
- Bony bridging of interlaminar space
Microendoscopic discectomy

- First developed in 1997
- Muscle splitting approach with serial tubular dilators
- Tubular retractor and special endoscope used to perform discectomy
Microendoscopic discectomy
MED-Advantages

- It reduces tissue trauma, less traumatic than standard microdiscectomy
- Integral visualization and illumination of the operative field through the endoscope
- Allows direct visualization of the nerve root and disc disease, and
- Enables bony decompression.
MED-Limitations

- There is a learning curve to using the system efficiently and safely
- Complications like dural tear, if occur can be difficult to repair
- Delicate instruments with risk of instrument failure
MED vs Open Lumbar discectomy

- Righesso O et al (Neurosurgery; 2007)
- Randomized controlled trial
- 40 patients with sciatica/lumbar disc disease; 24 months follow-up
- Statistically significant variables amongst many studied:
  - Length of incision- Greater in OD
  - Length of hospital stay- Greater in OD
  - Operative time- Greater in MED
MISS-Degenerative Disease of Spine

• Advances in imaging, instrumentation, bone graft substitutes have allowed development of MISS.

• Much of the developmental trends in MISS and in spine surgery in general have been driven by the challenge of achieving arthrodesis in the lumbar spine.
MISS-Degenerative Disease of Spine

• The chronology of open techniques for accessing the disc space
  1933: Burns-ALIF
  1952: Cloward-PLIF
  1966:Fernstrom ADR
  1982: Harms & Rolinger-TLIF
• 1991: Obenchain- Anterior laparoscopic disc removal
• 2002:Khoo- First MIS–PLIF procedure
• 2006,:Holly and Schwender MISTLIFs using tubular retractors.
• 2008:Park & Foley- Percutaneous reduction screws (CD Horizon Sextant, Medtronic, Inc.) along with PEEK interbody spacers to perform MISTLIF procedure in patients with Grades I and II isthmic spondylolisthesis.
Minimally Invasive Percutaneous Posterior Lumbar Interbody Fusion
Sextant System

**Sextant** - An instrument used to measure the altitude of an object above horizon. The scale has a length of 1/6 of a full circle.

**Principle:** Any two points in proximity can be considered part of a circle.
Anterior Lumbar Interbody Fusion

• Iatrogenic trauma- the main contributor to complications and morbidity associated with open anterior approach to the lumbar spine and lumbosacral junction

• The application of microsurgical principles and philosophy could overcome these technique-associated disadvantages.
Anterior Lumbar Interbody Fusion

• Retroperitoneal microsurgical approach (L2-3,L3-4,L4-5)
Anterior Lumbar Interbody Fusion

- Midline microsurgical approach to L5-S1
Anterior Lumbar Interbody Fusion

  - 20% reduction in operative time
  - 50% reduction in blood loss
  - No significant difference in clinical outcome & complication rates
eXtreme Lateral Interbody Fusion-XLIF

- Retroperitoneal approach
- Lateral flank incision
- Microscope/Endoscope
eXtreme Lateral Interbody Fusion-XLIF

- Patient starts walking within few hours
- Discharged after 24 hours
- Rapid return to normal activity, within weeks rather than months
eXtreme Lateral Interbody Fusion-XLIF

- XLIF can be performed for a variety of conditions:
  - Degenerative disc disease,
  - Recurrent disc herniation,
  - Spondylolisthesis,
  - Pseudoarthrosis, osteomyelitis/discitis, and post-laminectomy syndrome.
  - Anterior and lateral tumors of the thoracolumbar spine
  - Debilitating spinal deformity (scoliosis).
Patient selection is important –

Severe canal stenosis secondary to facet hypertrophy &
Dorsal compressive disease require posterior approach
AxiaLIF

- Developed by Cragg, 2004
- Safe, reproducible, pre-sacral approach
- Minimally invasive access
AxiaLIF

- Soft-tissue sparing
- Annulus remains intact
- Restoration of disc height
- Immediate rigid segmental fixation and stability of L4-S1
- Virgin corridor for a previously operated segment
- Enables fusion of L5-S1 without removing implants from rostral previously implanted segment
AxiaLIF-Complications

• Hemorrhage
• Bowel Perforation
• Infection
• Hardware failure
Vertebroplasty/Kyphoplasty

• Percutaneous vertebroplasty – Deramond et al (1987)
• An image-guided, minimally invasive, non-surgical therapy used to strengthen a broken vertebra
• Indications:
  - Pain caused by osteoporotic compression fractures.
  - Pain caused by fractures due to vascular malformations.
  - Pain caused by fractures due to tumors, which have invaded the vertebral body
Vertebroplasty /Kyphoplasty

- Contraindications:
  - Recent systemic/spinal infection
  - Uncorrected bleeding diathesis
  - Insufficient cardiopulmonary health
  - Fracture related canal compromise with myelopathy / radiculopathy
Fractured vertebra

Quick setting bone cement injected into fractured vertebra

1. Fractured Vertebra
2. Insert Instrument
3. Inflate Balloon Tamp
4. Fill with a "support cast"
Vertebroplasty-Complications

• Incidence :< 10%
  Increased pain,
  Radiculopathy,
  Cord compression,
  Infection,
  Rib fracture,
  Adjacent level vertebral body collapse,
  Venous embolism
  Cement migration(radiculopathy-4%;cord compression-0.5%)
Vertebroplasty-Complications

• Cement migration can be prevented by partial filling of VB(<30% by vol of VB)

• Liebschner et al (Spine; 2001) - Only 15% volume fraction is needed to restore stiffness to predamaged levels.
Video Assisted Thoracoscopic Surgery

• Indications:
  - Disc herniation
  - Sympathectomy
  - Vertebral biopsy
  - Vertebrectomy
  - Bone graft/instrumentation
  - Anterior release for spinal deformity correction
VATS-Surgical approach

• Side selection:
  Lateralization of pathology
  Eccentric placement of aorta

• Anesthesia:
  Single lung ventilation/bronchial blockers
VATS-Surgical approach

- Position: Lateral decubitus
- Port placement:
  Reverse L pattern
  10mm(3-18mm); 3-4 portals
  First port-Anterior axillary line 6th/7th ICS.
  One port caudal & another rostral central to the area of interest
VATS-Thoracic Discectomy

• VATS vs Open Thoracotomy
VATS-Thoracic Discectomy

• Thoracoscopy Vs Costotransversectomy (CT)&Open thoracotomony for thoracic discectomy

*Rosenthal & Dickman (1999):*

Fresh neurological deficits- None in thoracoscopy & thoracotomy group; 7% in CT group

Intercostal neuralgia- Thoracoscopy-16%; CT-20%; Thoracotomy -50%
VATS-Thoracic Discectomy

- One hour reduction in operative time
- 50% reduction in blood loss, narcotic use & hospital length of stay
- Neurological improvement- 27/36(myelopathy); 19/19(radiculopathy)
- Neurological stabilization in all
MISS-Disadvantages

- Steep learning curve
- Hand-eye coordination
- Lack of tactile feedback