My 16 Year Evolving Clinical Experience in Endoscopic Lumbar Surgery

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“Bienvenida del CSI”

Calif. Center for Minimally Invasive Spine Surgery
Overview:

1. MISS being disruptive technology with dilatation technology e.g. microdecompressive endoscopic lumbar discectomy

2. MISS with limited visualization requires GPS for navigation

3. DOR facilitates MISS by “technology convergence and control”

4. Patient centric IOM

5. Clever micro spinal instruments

6. Important of education, technology training, surgical anatomy, hands on training, meticulous imaging planning preoperatively
Introduction:

What is Minimally Invasive Spine Surgery (MISS)?

- **Surgery** is trending toward **minimally invasive surgery** worldwide including spine surgery.
- **Advancements in instrumentation, fiber optics, laser technology, fluoroscopic imaging, high resolution video imaging endoscopy**, along with the **accumulated** experience in **endoscopic laser spine surgery** made **MISS** possible.
- **MISS** requires **more precise, delicate and effective method** for spinal decompression.
- **MISS** does **not de-stabilize the vertebral segments**.
- Can **safely treat multiple level symptomatic spinal discs, spinal stenosis and high risk** spinal patients.
Introduction:

Herniated Lumbar Discs Causing Nerve Impingement - Radiculopathy

- If conservative treatment fails, and continue to have persistent significant symptoms affecting their daily activities and ability to work this can lead to the need for surgical decompression of the disc.

- In the past, the only method was open traumatic lumbar surgery with cutting of the muscle, bone and the disc, and even spinal fusion, which are associated with long periods of recovery, wound healing, blood loss, hospitalization, and others.
Surgical Indication for MISS
MISS Surgical Indications:

- Herniated discs/degenerative spine disease
- Post fusion Junctional Disc Herniation Syndrome (JDHS) or Adjacent Segment Disease (ASD)
- Vertebral compression fracture (Osteoporotic and post-traumatic)
MISS Surgical Indications:

For treatment of:

- Lumbar *spinal stenosis* and spondylolisthesis
- *Cervicogenic headache* and discogenic pain
- *Intraspinal lesions*
  - Synovial cyst and degenerative cyst
  - Intraspinal tumor, lipoma
  - Others
Challenges Facing Traditional - Current Open Spine Surgery/Fusion
Challenges Confronting Open Traditional Spine Surgery/Fusion, Spinal Arthroplasty and Disc Replacement

- **Obvious challenges:**
  - **Larger surgical incision** – longer healing time
  - **More traumatic** than MISS and more **blood loss**
  - Often is performed under **general anesthesia**
  - **Higher risk** and **complication** rate
  - **Long** and **painful recovery** time
  - **Higher long term complication rate** including post fusion junctional disc herniation syndrome (JDHS 19-49% after 4-5 years)
  - Alarming high rate of “**failed back syndrome**”
  - **Long term benefit** and outcome in question by numerous studies published
  - **Disc replacement technology/arthroplasty** is **yet to be proven** – only time will tell (another 8-15 years)
  - **More difficult** in **high risk patients** with morbid obesity, cardiac pulmonary disease, advanced diabetes, elderly
  - **Affecting spinal segmental motion**
Logical Evolution of Spine Surgery

Endoscopic Laser MISS
Logical Algorithm for Spine Care:

The modern concept - algorithm of spine care like walking up a staircase

For treatment of degenerative and herniated spinal discs, and spinal stenosis

- Pain Management Injectional Therapy and RF
- MISS and NFT
- Conservative Treatment
- Minimally Invasive (Laser) Spinal Surgery
- Spinal Arthroplasty Disc Replacement Artificial Disc
- Open Spinal Surgery Fusion

The last resort

Maybe
Advantages of MISS

Obvious advantages of Endoscopic MISS:

- An outpatient or "same day surgery", no hospitalization
- Less traumatic
- Small or tiny incision
- Costs less - approximately 40% less than a open spinal surgery/fusion
- Economic savings for the employee and employer are significant due to earlier return to work
- Done under local anesthesia except occasional brief general anesthesia
- Early post-op exercise one day after surgery
- Surgical triad approach and critical "fan-sweep maneuver" further facilitate the disc decompression and improves surgical result
- Multiple level spinal discectomy can be performed at one sitting with minimal risk
- Can be done for high risk anesthesia patients with morbid obesity, emphysema, and cardiac conditions under local anesthesia/IV sedation at much less risk
- Intra-operative neurophysiological/EMG monitoring, and direct visualized endoscopic significantly reduces the chance of inadvertent injury of neural structure
- Preserves spinal motion

Obviously “less is better – less is more” for MISS
MISS Surgical Procedure:

Preparing for MISS – Anesthesia
(requiring technological monitoring and precision)

- Anesthesia: Local/IV conscious Sedation
- INTRA-OPERATIVE NEUROPHYSIOLOGICAL MONITORING (IOM), – EEG, EMG of vital signs (pulse rate, BP, RR), pulse oxymetry CO2 content, on intra-operative wave form display/monitor
- To insure safer and to facilitate MISS
Types of Endoscopic MISS
(Requiring precision, navigation and monitoring)
LUMBAR ENDOSCOPIC MISS TECHNIQUE:

Posterio-lateral and posterio–median surgical approaches

- Patient **positioning and localization**
  - Patient in **prone** position
  - Or in lateral **decubitus** position
  - Localization – **skin marking** for **portal of entry** and placement of needle
  - Under **fluoroscopic guidance**
Lumbar Endoscopic MISS Technique:

Localization of skin incision and portal of entry
Provocative discogram

- Under fluoroscopic guidance
- Provocative discography to confirm the damaged herniated disc
- Point of incision – by placing the “bull’s-eye” target device to determine the portal of entry and skin incision
Surgical Plane/Approach/Technique: With GPS

- Extreme obese patient had successful left posterolateral endoscopic lumbar discectomy with application of geometric line/plane and GPS system
Grid Position System (GPS) in Endoscopic Lumbar MISS

Fluoroscopic monitoring to provide safer and precise lumbar spine surgery by using GPS

- Lumbar spine has neuroforamen and intra-lamina foramen openings restricting MISS at a portal of entry
- Critical structures within the foramen – DRG, neural structure
- GPS provides a precise and safe path to reach the lesion and to avoid trauma to the nerve vessels, DRG, dura and even the spinal cord
- The grid – the GPS System – Zones (in A,B,C, D and 1,2,3) provides an accurate navigation map for MISS surgeons
Surgical Instrument and Equipment

Mini Endoscopic Spinal Surgical Instruments for MISS

Close up view

- **Duck bill tubular retractor** with dilator to enter the GPS for lumbar disc surgery to protect dural and neurovascular injury

- Under endoscopy and fluoroscopy, spinal instruments of trephine forceps, curette, rasp, knife, discectome, and laser can safely be utilized for MISS surgery and laser thermodiskoplasty
Surgical Instrument and Equipment

• For bony decompression:
  – Round ball tip drill avoids neural and tissue trauma
Surgical Instrument and Equipment

Application of Tissue Modulation Technology in Endoscopic Laser MISS

- Holmium YAG laser equipment for Laser Thermodiskoplasty (LTD)

Trimatedye
Holmium YAG laser generator

Right angle (side firing) laser probe

California Center for Minimally invasive Spine Surgery
GPS (Grid Position System) for Endoscopic Lumbar MISS

Fluoroscopic/imaging and endoscopy to provide safe and precise lumbar MISS and foraminoplasty
Lumbar Endoscopic MISS Technique:

Fluoroscopic/imaging and endoscopic monitoring to provide safe and precise application of endoscopic microdiscectomy and laser thermodiskoplasty.
Lumbar Endoscopic MISS Technique:

Additional advanced MISS surgical instruments

- Small spinal discectome for rapid disc removal
Lumbar Endoscopic MISS Technique:

Posterio-lateral approach vs. posterior–median approach

- Under fluoroscopy -
  With dilatation technology
- Introduction of dilator and then a tubular retractor/working cannula are passed over the stylette
- Foraminoplasty and decompressive discectomy performed with trephines, forceps, ronguers, discectome and Holmium laser

(Requiring precision, navigation and monitoring)
Lumbar Endoscopic MISS Technique:

Endolumbar paramedium approach
(SMART Endo System)

For larger extruded herniated lumbar discs (red arrows)

(Requiring precision, navigation and monitoring)
Illustration Case I Lumbar MISS

26 yo "Extreme Athlete", Motorcycle, Rally car X-games gold medalist
Severe posttraumatic L4-5 disc herniation
Excellent relief from outpatient endoscopic MISS
Return to rally car racing in two weeks
Illustration Case II Lumbar MISS:

Extremely large extruded/herniated lumbar disc

- 45 year old male firefighter for Anchorage Alaska Fire and Rescue
- Suffered from an extremely large L4-5 paracentral extruded disc, extending upward measuring 18 mm x 10 mm towards the left, neuro foramen and also towards the right
- Microdecompressive lumbar L4-5 laminectomy, exploration and meticulous removal of the sequestrated disc fragment with endoscope gave him immediate relief of his symptoms, returned to work in a few weeks
- Incidentally adjoining L4 – L5 vertebra showed prior post laser thermodiskoplasty - subchondral vertebral/bone marrow asymptomatic changes/artifact
Severe lumbar stenosis

• 73 yo with severe rapid progressive (in 6 mos.) neurogenic claudication, leaning on grocery cart syndrome
• Successfully treated with endoscopic microdecompressive discectomy and interspinous spacer Coflex-f with facet fusion
• One hour post op able to stand and walk unassisted and straight
Digital Technology in the DOR
Introduction:

- Endoscopic **MISS is a technologically dependent surgery**, requiring utilization of advanced endoscopic surgical instruments, imaging-video technology and tissue modulation technology, in a digital operating room (DOR)

- It requires **seamless connectivity and control** to perform the surgical procedures in a precisely orchestrated manner.

- Therefore a new integrated **technological convergence and control system (SECS)** SurgMatix® was created by myself and Professor HK Huang, USC MC to facilitate MISS

- This system **facilitates MISS with “organized control instead of organized chaos”** in an endoscopic DOR suite and **enables a safer, precise and more effective surgery**
Current Digital **Endoscopic DOR** suite facility
Courtesy of: Dr. John Chiu, California Spine Institute
DOR - Surgical ePR Control System (SECS) was invented TO FACILITATE MISS, (by Professor HK Huang and Dr. John C. Chiu)

With Image acquisition, Display, Manipulation and Document Historical and Live Data on two Opposite Large Screens
SurgMatix® SECS IN MISS DOR

• **SurgMatix®** SECS was created by an innovative team for **seamless connectivity** and **teamwork in** a MISS DOR

• It provides **not only digital connectivity but also integration of all OR systems including**, sophisticated surgical instruments, equipment, complex high tech systems for **“digital technological convergence”**, and efficient **DOR control system**

• In order **to facilitate** and to perform a **safer and better MISS**
Goals of SurgMatix® SECS integration system to facilitate and control MISS

- Provides a **complete picture** of the patient’s medical history and status by consolidating data from multiple IT and OR systems – **patient transparent**
- **Improves patient safety** by converging pre-op, intra-op and post-op data and OR control – **patient centric**
- Offers a complete **“real-time” picture of the patient’s medical status**, including vital signs, waveform and biosensor data
- Promotes **workflow efficiency** in the DOR, reducing personnel and other **costs, leading to a significant economic saving** in an **“organized control instead of an organized chaos”** environment
- **Enhances quality of patient care** by providing information available to all OR staff and facilitating communication in the DOR
- **Facilitates post-surgical care and trend analysis** through increased data collection during surgery
Post Operative Care and Surgical Outcome
Post Operative Care:

- **Ambulatory within one hour** and discharged subsequently
- May **shower** the following day
- May use a **cervical collar** in a vehicle or on a flight as needed (for cervical **AECD**)
- **Ice pack** is helpful
- Mild **analgesics** and muscle relaxant are required at times
- **Progressive spine exercise** second post operative day on
- Postoperatively on average, **resumed usual activity** in a few days and in 2-5 weeks resumed full active lives, providing no heavy work
Results:

- Average follow-up 47 months (7-68 months)
- Overall result: 3710 (90%) patients with good to excellent results, fair results 165 (4%) patients (single level)
- Various evaluations of response to treatment: modified Mac Nab criteria, Oswestry disability score/index (ODI), visual analogue pain scale (VAS), patient satisfaction scoring, pain diagram and/or patient target achievement score (PTA) for assessment were utilized
- Average satisfaction score – 3875 (94%)
- 165 (4%) patients had mild residual pain and paraesthesia, although overall their pain lessened
- Complication rate: less than 1%
- Average return to work: 10-14 days
Results (symptomatic improvements)

Lumbar disc patients (2858)

- Pre-Op vs Post-Op

- Numbness
- Spine Pain
- Muscle Spasm
- Muscle Weakness
- Analgesics

Pre-Op vs Post-Op

Lumbar disc patients (2858)
RESEARCH, DEVELOPMENT, EDUCATION AND TRAINING IN MISS
R&D for MISS:

Robotic aided endoscopic spine surgery and image guided technology on the horizon

• Microphone headset
• Voice activated

• **Advanced 3D Image guided system** is being developed and will be applied to enhance and navigationally to guide the surgical robot

• **Surgical robotics** can improve endo-MISS with better surgical precision and minimal trauma
Education/Training for Endoscopic MISs:

- Thorough knowledge of the surgical anatomy and the surgical procedure
- Specific endoscopic MISs training
- Hands-on experience in a laboratory including cadaveric
- Meticulous pre-operative surgical planning
- Working closely with an experienced endoscopic spine surgeon through the steep surgical learning curve
- Fluoroscopy as “The 3rd Eye” or “Eye of Wisdom” for confirmation of location of instruments; endoscopy alone is not enough
- Use of digital imaging system PACS, enhanced 3D visualization, and use of SurgMatix® in DOR

- Training is critical in order to perform endoscopic MISs effectively, safely and avoid potential complications
Conclusion:

- The convergence, utilization and control of science and technology is a must for furthering MIST and MISS.
- Endoscopic MISS has advanced as a result of the past spinal surgical experience, advancement of bio-technology and new MISS instruments.
- MISS performed in a patient centric, seamless DOR is an effective, safe, less traumatic and easier spine surgery.
- MISS is a smart way to perform spine surgery.
Hope you enjoyed this presentation!

“Gracias por su amable atención!”

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