Posterolateral Endoscopic Thoracic Microdiscectomy (PTD) with GPS System

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I. Overview of This Presentation

- **Challenges of thoracic spinal surgical anatomy**
- Surgical technique with **dilatation technology non-fusion technique** of minimally invasive spinal surgery (MISS)
- Requiring **GPS and IOM** techniques to facilitate a safer PTD
- **Technological convergence and control in a DOR**
- **Potential risks, complications and their avoidance**
- To discuss endoscopic posterior lateral thoracic microdecompressive discectomy (PTD) with **laser thermodiskoplasty (LTD)**
- Introduction of a **triad** in **microdecompressive** surgical approach and LTD **denervation** of sinu-vertebral nerve with LTD **tissue shrinkage** to further improve the surgical outcome
II. Introduction:

- Due to tight and confined anatomical relationship at thoracic spine of the spinal cord and spinal canal, the traditional thoracic laminectomy and disc surgery has high rate of neurological complications.

- Spinal surgeons have long sought to find a better procedure to treat thoracic disc herniations effectively and less traumatically.

- The approaches have been more traumatic, complicated, and lengthy, including:
  - Posterior lateral approach
  - Lateral approach
  - Trans thoracic approach
  - Trans sternal approach
  - Thoracoscopic endoscopic approach/with collapse of lung
Introduction:

- Often **conservative treatment can bring relief:**
  - Bed rest
  - Exercise
  - Physiotherapy
  - Pain Medication
  - Spinal injectional treatment (i.e. epidural injection, facet injection, denervation, and nerve blocks)

- **Some continue to have intractable symptoms requiring surgical decompression**
III. Material and Methods:

- **433 patients** with **542 herniated thoracic discs** (40 extruded without significant cord compression or myelopathy) at T-1 through T-12 had endoscopic PTD with laser thermodiskoplasty
  - **Males:** 271
  - **Females:** 162
  - **Age:** average 44.7 (16-73)
- Each failed at least 12 weeks of conservative care
Material and Methods: Demographics of Herniated Thoracic Discs (542)

Level of disc herniation:
- T-1: 8%
- T-2: 4%
- T-3: 3%
- T-4: 1%
- T-5: 1%
- T-6: 8%
- T-7: 11%
- T-8: 11%
- T-9: 11%
- T-10: 11%
- T-11: 11%
- T-12: 11%

99 (18%)
82 (15%)
77 (14%)
77 (15%)
62 (11%)
60 (11%)
43 (8%)
21 (4%)
4 (1%)
3 (1%)
4 (1%)

IV. Endoscopic PTD Surgical procedure:

Surgical indications:

- **INTRACTABLE SYMPTOMS**
  thoracic spinal pain, numbness and parasthesia and radiating pain of chest wall due to **herniated thoracic disc** or other lesions (e.g. intra-spinal cyst, lipoma, osteophytes or tumor)

- **POSITIVE PHYSICAL FINDINGS:**
  spinal tenderness, muscle spasms, dysethesia or hypoesthesia

- Positive **MRI or CT** scan or CT myelogram findings

- **Failed** three months of **conservative therapy**

- Positive **provocative discogram** or pain provocation disc injection test

- **EMG** maybe helpful
IV. Endoscopic PTD Surgical procedure:

Pre-op Prep and Anesthesia

- **Local anesthesia** and monitored **IV conscious sedation**
- 2 grams Ancef and 8 mg dexamethasone IV pre-op
- **Surface EEG monitoring** (BIS)
- **IOM - EEG, EMG** to prevent undue neural trauma
IV. Endoscopic PTD Surgical procedure:

Surgical Instrument and Equipment – with minimally invasive microdecompression and dilatation technology

- Video digital endoscopic tower, thoracic endoscopes 0°, 6°, 30° and tri-chip digital camera, endoscopic spinal instruments, including stylette, dilator, working channels (ID-2.5, 3.5, 4.2mm), various type of forceps and ronguers, curette, drill, burr, trephine
Surgical Instrument and Equipment

Surgical Instrument and Equipment – with minimally invasive microdecompression and dilatation technology

- For bony decompression:
  - Round ball tip drill avoids neural and tissue trauma
Surgical Instruments/Equipment:

Endoscopic PTD Surgical Instruments

Flexible cutter grasper forceps
Endoscopic flexible dissector
Surgical Instruments/Equipment:

- **Discectome:**
  - OD 2.5mm, 3.5mm and 4.7mm
  - For rapid disc removal
Surgical Instruments/Equipment:

Other Mini Spinal Instruments

- Duck bill tubular retractor with dilator to enter the GPS for lumbar disc surgery to avoid dura and neuro vascular injury.

- Under endoscopy and fluoroscopy, trephine forceps, curette, rasp, knife, discectome, and laser are utilized for Endoscopic PTD.
Surgical Instruments/Equipment:

Tissue Modulation Technology
Laser, Radio Frequency and Cryogenic Technology

Holmium YAG laser generator
Radiofrequency generator
Endoscopic Surgical Anatomy – The need for GPS

• Thoracic spine has only two neuro foramen openings, which are enclosed by lamina, pedicles and rib head

• PTD in general is restricted and confined at its portal of entry

• Critical structures within the foramen – neural structures and costal vertebral artery/vein
GPS (Grid Position System) for Endoscopic PTD

The Thoracic Spinal GRID – Basis for GPS

- In order to reach the thoracic discs or lesion precisely and to avoid trauma to the nerve vessels, dura, plural cavity, lung, and even the spinal cord
- Need to have a precise path to reach the lesion via GPS
- The location can be precisely located – in the grid – GPS System with 21 different zones (in A,B,C,D and 1st, 2nd, 3rd stories)

The Grid – GPS for thoracic microdiscectomy - 3 stories and 4 zones – 1,2,3 & A,B,C,D
GPS (Grid Position System) for Endoscopic PTD

Various location of thoracic disc lesions in the grid
Understanding of the grid facilitates endoscopic thoracic MISS

Portal of Entry into the GPS for endoscopic PTD

Herniated thoracic disc can migrate toward different part of spinal canal and foramen
GPS (Grid Position System) for Endoscopic PTD

Endoscopic PTD along the red arrow for avoidance of trauma to the nerve, spinal cord medially, plural cavity, laterally the lung and the costal artery via the “safety zone” pathway.

Approach for Endoscopic PTD under fluoroscopic guidance between the pedicle and rib head line into the safety zone for discectomy.
Surgical Procedure/Technique:

Patient positioning, localization and portal of entry
Surgical Procedure/Technique

Endoscopic PTD

- After removal of the needle, a dilator with a working cannula are passed over the stylette
- Under fluoroscopy endo-microdiscectomy is performed precisely with mini spinal instruments
Surgical Procedure/Technique:

Endoscopic PTD

- Under fluoroscopy and endoscopy microdiscectomy is performed with mini spinal instruments
- Aggressive trephines, drill, burr and laser application are used for removal of osteophytes and discs for decompression
Surgical Procedure/Technique:

Endoscopic PTD

Video Recording

- Microdiscectomy and LTD for disc shrinkage and tightening

Microdiscectomy with micro forceps

Side firing laser probe for LTD

Disc fragment removal
Surgical Procedure/Technique:

Endoscopic PTD

Herniated thoracic disc

Disc removal under the intercostal nerve

Disc fragments Removed
Surgical Procedure/Technique:

Endoscopic PTD

- Surgical technique using Holmium YAG laser (LTD)
- With fan sweep maneuver for disc shrinkage, sinu vertebral denervation

“Fan sweep maneuver” (25 degree from side to side) of instrument increased disc removal, shrinkage and tightening

Laser used to shrink and tighten the disc besides “purse string” of the disc defect
• **Trend** of spinal surgery is **minimally invasive spine surgery (MISS)**

• MISS aims at being less traumatic, with less morbidity and improved surgical outcome

• The **obvious challenge** of MISS is **limited visualization and exposure** of the relevant anatomy and potentially placing the neural structures at **increased risk** of trauma

• **INTRAOPERATIVE NEUROPHYSIOLOGICAL MONITORING (IOM)** of neural structure, direct visualization with fluoroscopy and endoscopy **creates safer endoscopic MISS procedures**

• **Spontaneous EMG monitoring,** at times SSEP and MEP can provide the surgeon with useful feedback **to avoid neural trauma**

• Intra-operative **surface EEG and IOM optimize the anesthesia** for MISS
Endoscopic PTD MISS with SurgMatix®

- Performed in a DOR equipped with SurgMatix® which provides “digital technology convergence and intuitive OR control system”
- To orchestrate DOR with patient:
  - being transparent to all staff
  - patient centric
  - to facilitate MISS and enhance surgical safety
DOR Technological Integration and Control System - SurgMatix

- *SurgMatix®* Is a “digital surgical technology convergence and OR control system”, involving monitoring and recording of all wave form and imaging data, including sEMG, Pre-Operative, Intra-Operative and Post-Operative phases of MISS

- Real time sEMG IOM integrates with all patient related medical/surgical information creates a “patient centric“ and “patient transparent” DOR in order to facilitate a safer MISS
SurgMatix intraoperative monitoring screen displays real time waveform, imaging, vital signs, sEMG, BIS, IOM information to facilitate MISS surgery.
Case Illustration I
Endoscopic PTD for F-22 Fighter Pilot

- 27yr old F-22 fighter pilot suffered severe T7 herniated disc as result of tremendous G-Force at 12
- Successfully treated with endo-MISS precisely via GPS
Case Illustration II  
Endoscopic PTD for University Student

- 24 yr old University Student with congenital 13 ribs suffered severe post traumatic T10 & T12 herniated disc symptoms
- Successfully treated with endoscopic PTD via GPS

Subsidence of T10 and T11 disc herniation after endoscopic thoracic discectomy
Post Operative Care:

- Check neurologically prior to leaving operating room
- An upright **chest X-ray** in the recovery room rules out pneumothorax
- **Immediate ambulation** after recovery
- **Discharged** in one hour
- May shower the following day
- **Mild analgesics** and muscle relaxant as needed an **ice pack** is helpful
- Progressive spine **exercise** second post operative day on
- Allowed to **return to work** in one to two weeks, providing heavy labor not required
Post Operative Care:

Rehabilitation compliments MISS and Motion Preservation

- Before and after Endoscopic PTD:
  - A physical medicine and rehabilitation unit with computerized assistance
  - Motorized pool and hydrotherapy equipped with video camera for monitoring and assessment
Surgical Outcome:

- Average follow-up **47.3 months** (5-72 mos)
- Overall result: 394(91%) patients with **good to excellent results**, fair results 22(5.1%) patients
- **Response to treatment** evaluated by using: MacNab, modified Mac Nab criteria, ODI, VAS, patient satisfaction scoring, pain diagram and/or patient target achievement score (PTA)
- **Average satisfaction score** – 407 (93.9%) patients
- 22 (5.1%) patients had **mild residual pain** and parasthesia, although overall their pain lessened
- **Complication rate**: Transient dysesthesia (less than 1%)
- Average return to work: 10 days

Pre-op

Post-op
Surgical Outcome:
Post Endoscopic PTD— (412 cases)

Symptomatic Improvements

- Severe Spine Pain
  - Pre-Op: 5
  - Post-Op: 21
  - Total: 410

- Mild Spine Pain
  - Pre-Op: 23
  - Post-Op: 23
  - Total: 433

- Required Analgesics
  - Pre-Op: 50
  - Post-Op: 20
  - Total: 338

- Muscle Spasm
  - Pre-Op: 21
  - Post-Op: 21
  - Total: 347

- Persistent Numbness
  - Pre-Op: 21
  - Post-Op: 21
  - Total: 347
Discussion:

Potential Complications and their Avoidance:

- Operating wrong level:
  - A major complication of all spine surgery
  - Avoided by using digital C-arm fluoroscopy for accurate anatomic localization
  - Provocative discogram verifies level

3 cases of rare 13 vertebral body ribs can be a problem in counting
Discussion:

Potential Complications and their Avoidance:

• **Pneumothorax**: another potential complication for endoscopic PTD
  - Introduction of the micro instruments through the GPS guided "safety zone" as described previously prevents complication
  - **Chest x-ray** is obtained immediately after completing the operation to rule out pneumothorax

Posteriorlateral Endoscopic Thoracic Discectomy
Endoscopic Instruments and Intercostal Nerve
Discussion:

• **Endoscopic PTD MISS** procedure, *does not interfere with the bones or joints of the spine*, nor require manipulation of the nerves or spinal cord, with obvious advantages

• Insertion of the micro-instruments with **GPS**, through the *safety zone* with a **small cannula** is less-traumatic, avoiding injury to the nerve, postoperative scarring and pneumothorax

• It is an **outpatient procedure** with negligible morbidity, a speedier recovery, and earlier return to work

• Best of all **PTD via GPS preserves spinal motion**
Discussion:

- To perform a successful **endoscopic PTD, by using GPS**
- It guides the surgical path along a narrow **“safety zone”** for endoscopic PTD
- And avoids causing trauma to **the lung, the rib head, the pedicles, the inter-costal nerve and artery, and the spinal cord**
- A probe placed too **close to the midline** may cause neurologic injury; if **too anterior**, there may be injury to the major vessels, or the sympathetic chain, and if **too laterally**, a possible pneumothorax
Conclusion:

- With understanding of **tight thoracic spinal surgical anatomy**, endoscopic microdecompressive thoracic discectomy (**PTD**) can be successfully performed
- By using GPS, IOM, dilatation technology, micro decompression and laser application in a seamless DOR
- The **convergence of technology and control system** facilitates a **safe, effective PTD**
- It is a **smart way** to perform thoracic spine surgery
Hope you enjoyed this presentation!

“Gracias por su amable atención!”

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References

1. Chiu J, Post fusion junctional disc herniation syndrome treated with endoscopic spine surgery. The Internet Journal of Minimally Invasive Spinal Technology. 2009 Volume 3 Number 4


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