Minimally Invasive Approaches for Spinal Tumors

Praveen V. Mummaneni, M.D.
Associate Professor
Dept. of Neurosurgery
Director: Minimally Invasive Spine Surgery
Co-Director: UCSF Spine Center
University of California, San Francisco

Thoracolumbar Tumors

- Intradural
  - Extramedullary
  - Intramedullary
- Extradural

Intraspinal Tumor Removal Options

- Open Approach
  - Midline spinal incision
  - Muscle Retraction
  - Wide exposure of tumor
- Minimally Invasive (Tubular) and Mini-open (Expandable tube)
  - Smaller incision
  - More limited tumor access?
  - Muscles dilated
  - Less tissue retraction
  - Shorter hospitalization?
  - Less blood loss?
  - Decreased dead space for accumulation of pseudomeningoceles?

Disclosure

Medtronic (Consultant, Grants)
DePuy (Consultant, Other Financial Support)
Location of the Minimally Invasive Incision

1. Large Intradural Spinal Tumors

Traditional Open Approach to Intradural Spinal Tumors

**Traditional Approach:**
- Midline incision (two levels rostral and caudal to pathology)
- Muscle Dissection, Laminectomy
- If near cervicothoracic or TL jxn – May add fusion to prevent kyphosis

**Traditional Approach:**
- Proven safety and Efficacy
  (McCormick Clin Neurosurg, 1994; Tobias Childs Nerv Syst 2008)
- Concern for: chronic pain and post-laminectomy kyphosis
  (Iguchi Spine 2000)
- Need for fusion?
Intradural Spinal Tumor: Min Inv Tech

- Limited tissue destruction
- Achieving same surgical goal, possibly reducing incidence of iatrogenic instability
- Reduced blood loss
- Improved speed of recovery

Bresnahan Spine 2009;
Costa J Neurosurg Spine 2007;
Khoo Neurosurg 2002;
Rahman Minim Invasive Neurosurg 2008;
Thome J Neurosurg Spine 2005

Intradural Spinal Tumor

Mini-Open trans-spinous approach for intradural tumors in the thoracolumbar spine

Midline incision
- Utilizing expandable retractors
- Preserve lateral lamina, facets and muscle attachments

Steps for MIS Trans-Spinous approach

Cadaveric Study:
Comparison of MIS vs Open Exposure of the T6-7 levels:
MIS affords 50-75% smaller incision

Lu, Dhall, Mummaneni: Submitted: Neurosurgeons
Cadaver Findings: Incision length is **50% less** in thin patients
and **75% less** in obese pts (BMI >30)

<table>
<thead>
<tr>
<th>Case No.</th>
<th>BMI</th>
<th>MIS Incision Length (cm)</th>
<th>Open Incision Length (cm)</th>
<th>Levels of Thoracic Lamina Accessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>4.2</td>
<td>8.0</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>4.2</td>
<td>10.0</td>
<td>3.0</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>4.5</td>
<td>11.0</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>4.5</td>
<td>12.0</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>36</td>
<td>4.5</td>
<td>14.0</td>
<td>3.0</td>
</tr>
<tr>
<td>6</td>
<td>43</td>
<td>4.5 cm</td>
<td>15.0 cm</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Case Illustration

- 40 y/o female with 3-months progressive paraparesis with urinary incontinence
- Neuro exam reveals 2/5 strength in bilateral lower extremity with hyper-reflexia and clonus

MRI: Intradural, Extramedullary Tumor at T4

MIS Trans-spinous T3-T5 tumor resection
Intradural Meningioma

Case Example: Intradural, Intramedullary Tumor Case

- 46 year-old woman with progressive paraparesis for 2 years
  - History of chest radiation for lymphoma

- Pt first had numbness in her legs followed by weakness

- Now with complete paraplegia and incontinence

1 yr F/U: ambulates independently and regained bladder control
Differential Diagnosis

• Multiple Sclerosis
  – Treated for presumed multiple sclerosis
  – MRI of brain is normal
• Radiation Myelitis
• Spinal Cord Tumor
  – Lymphoma?
  – Primary cord tumor?

• Biopsy needed to ascertain the diagnosis

Mini Inv Biopsy of Cord

Path Result: Glioblastoma of Cord

• Extends 8 Segments
  – Can not perform gross total removal
  – Pt treated with radiation and chemotherapy
Trans-Spinous MIS Intradural Tumor Experience

- Initial Report of 3 MIS intradural tumor cases
  - Lu, Dhall, Mummaneni: Submitted: Neurosurgery
- Current Experience: 15 Cases

Initial Experience: 3 MIS Intradural Tumor Cases

Patient Demographics

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age (yr)/sex</th>
<th>Duration of symptoms (mo)</th>
<th>Level</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>46/F</td>
<td>24</td>
<td>T5-T6</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>40/F</td>
<td>6</td>
<td>T3-T5</td>
<td>23.2</td>
</tr>
<tr>
<td>3</td>
<td>67/M</td>
<td>3</td>
<td>T6-T8</td>
<td>35.5</td>
</tr>
</tbody>
</table>

Initial Experience: 3 MIS Intradural Tumor Cases

Pre- and Postoperative Neurological Findings

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Preop Sensory Symptoms</th>
<th>Preop Motor Deficit</th>
<th>Postop Sensory</th>
<th>Postop Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T4 sensory level</td>
<td>Paraplegia</td>
<td>T4 sensory level</td>
<td>Paraplegia</td>
</tr>
<tr>
<td>2</td>
<td>Thoracic and leg pain</td>
<td>2/5</td>
<td>Resolving pain</td>
<td>4/5</td>
</tr>
<tr>
<td>3</td>
<td>T6 sensory level</td>
<td>3/5</td>
<td>None</td>
<td>4+/5</td>
</tr>
</tbody>
</table>

Operative Statistics

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Pathology</th>
<th>Lami Levels</th>
<th>EBL (cc)</th>
<th>OR Time (min)</th>
<th>Length of incision (cm)</th>
<th>Length of hospital stay (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GBM*</td>
<td>T5-T6</td>
<td>100</td>
<td>180</td>
<td>4.0</td>
<td>96</td>
</tr>
<tr>
<td>2</td>
<td>Meningioma</td>
<td>T3-T5</td>
<td>150</td>
<td>240</td>
<td>4.2</td>
<td>168</td>
</tr>
<tr>
<td>3</td>
<td>Meningioma</td>
<td>T6-T8</td>
<td>150</td>
<td>110</td>
<td>5.0</td>
<td>146</td>
</tr>
</tbody>
</table>

*GBM = glioblastoma multiforme
Pre- and post-operative Modified Prolo Score

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Follow-up period (mo)</th>
<th>Preop Modified Prolo</th>
<th>Postop Modified Prolo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>P1F2E2M1</td>
<td>P3F4E4M1</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>P1F1E2M2</td>
<td>P4F4E4M3</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>P2F2E3M1</td>
<td>P4F4E5M4</td>
</tr>
</tbody>
</table>

For Lesions Ventral to the Cord, May Add Transpedicular Approach

2. Paramedian Intradural Tumors

Min Inv. Hemilaminectomy

- Paramedian Incision
- Dilate paraspinal muscles
- Place retractor to expose hemilamina
Paramedian Intradural Spinal Tumors

MIS Technique

- **Hemilaminectomy**
- Leave Spinous Process and Interspinous Ligaments Intact
- Avoid Iatrogenic Instability

Minimally Invasive TL Jxn Hemi-Laminectomy: Avoids Fusion

Case Illustration: Hemilaminectomy for Intradural, Extramedullary Tumor

- 20 yo woman with back pain, bilateral leg radicular pain
- Unable to sit for 1 minute
- Urinary urgency
3. Mini-Open Foraminal Tumor Resection

Nerve Sheath Tumors account for one-third of all primary spinal neoplasms (Nittner, Acta Neurol Psych, 1968).

Mini-Open Resection of Nerve Sheath Tumor
(Lu, Dhall, Mummaneni, JNS Spine 2009)

- Traditional surgical approach is laminectomy, unilateral facetectomy (if tumor extends beyond intervertebral foramen), and fusion
  - Jinnai Neursurg 2005;
  - Ozawa J Neursurg Spine 2007
- Disadvantage of traditional approach is possible destabilization, large incision, muscle dissection, pain.

Mini-Open Removal of Foraminal Tumors
Results

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Levels</th>
<th>Instrumental</th>
<th>Rep</th>
<th>FDL (mm)</th>
<th>Off Time (min)</th>
<th>LCS (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L3-2</td>
<td>no</td>
<td>400</td>
<td>270</td>
<td>76</td>
<td>87</td>
</tr>
<tr>
<td>2</td>
<td>L4-3</td>
<td>yes</td>
<td>310</td>
<td>106</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>L5-S1</td>
<td>yes</td>
<td>310</td>
<td>106</td>
<td>72</td>
<td></td>
</tr>
</tbody>
</table>

* O = Operating score.

Case Illustration

• 48 y/o obese male
  – h/o L3-S1 circumferential fixation with one year of knee pain and right knee flexion weakness
  
  • MRI - mass in left L3-4 foramen

Case Illustration

• Mini-open paramedian approach
  – Pseudarthrosis found at L3-4 level.
  – Tumor resection performed.
  – L3-4 instrumentation and fusion performed.

• Follow-up at 1 year demonstrated complete recovery of motor strength. Improving knee pain.

• MRI showed GTR and no recurrence.

---

TABLE 1. Preoperative and postoperative modified Pelvic Scale scores*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Follow-Up (min)</th>
<th>Preop Score</th>
<th>Postop Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>P1 F1 E2 M1</td>
<td>F1 E4 M1</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>P1 F1 E2 M1</td>
<td>F1 E4 M1</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>P1 F1 E2 M1</td>
<td>F1 E4 M1</td>
</tr>
</tbody>
</table>

* The modified Pelvic Scale score is comprised of the following sub-scores: pain (P), functional status (F), ambulatory status (E), and incapacitation (M).
4. Epidural Mets Case

- 60 yo male
  - Obese
  - Prostate cancer hx
  - Became paraparetic with urine retention 6 hrs ago
  - Too big to fit into MRI
    - 330 pounds/150 kg

Lami for epidural tumor

Complications Can Strike When You Least Expect It…

- Use Flouro
- Trust the images over your “gut feel”
- Don’t erase the benefits of MIS with increased complication rates…
Conclusions

• Mini Open Approaches Combine Open Landmarks with Smaller Incisions

• Minimally invasive techniques may:
  – decrease hospitalization
  – Decrease blood loss
  – There is a learning curve
  – Elderly patients have medical comorbidities and osteoporosis that must be taken into account
  – Fusion rate in Deformity cases is unknown