ANTERIOR & POSTERIOR APPROACHES TO THE THORACIC SPINE

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Thoracic Spine

- **Anatomy**
  Complex osteoligamentous connections with rib cage
  - Rib to Disc/Body connections
  - Costrotransverse ligaments
    - Superior
    - Posterior
    - Inferior
Thoracic Spine

- Anatomy
  - Head of the Rib
  - Transverse Process
  - Pedicle
  - Neural foramen
  - Rib Articulation with Vertebral Body and Disc
  - Intercostal Neurovascular Bundle
Operative Thoracic Spine Anatomical Nuances

1. Vertebral Bodies
   - Dorsal, ventral and lateral diameters increase from T2-T12.

2. Physiologic Kyphosis
   - Greater height of dorsal vertebral wall as opposed to ventral vertebral wall

3. Pedicle Dimensions
   - Transverse pedicle diameters decrease from 9 mm at T1 to 5 mm at T5 and then increase to T12.
   - Sagittal Width increases from T1-T11
   - Pedicle Angle decreases from T1-T12
     - 251 degrees at T1, 0 degrees at T12
Operative Thoracic Spine Anatomical Nuances

- Facet Orientation
  - Coronal Plane
  provides resistance to anterior translation forces

- Laminae
  Increase in width and thickness from T1-T12 (prevent hyperextension)

- ALL
  Provides additional stability, increases in tensile strength from T1-T12.
Surgical Approaches

Ventral
- Ventral cervicothoracic
- Transthoracic

Dorsolateral
- Lateral Parascapular Extrapleural Approach (T1-T4)
- Costotransversectomy
- Lateral Extracavitary

Dorsal
- Laminectomy
- Transpedicular Decompression
SUMMARY OF ANGLE OF ATTACK OF VARIOUS THORACIC APPROACHES

Figure 89.20 Alternative approaches to thoracic and lumbar spine. 
(A) Dorsal laminectomy; (B) transpedicular approach; (C) costotransversectomy; (D) lateral extracavitary approach; (E) ventral intracavitary approach.
Ventral

Cauchoix and Nanson (1957)

first to use neck approach/sternotomy for upper thoracic pathology

Ventral Thoracic Spine

- Direct ventral cervical approach extended caudally by using a rostral sternal osteotomy or median sternotomy
- Successful exposure down to T3
- Left side is preferred site
- Radicular arteries should not be encountered
Median Sternotomy

Key points

Skin incision parallel from ventral border of sternocleidomastoid to midline of sternum

Retract carotid sheath laterally/trachea-esophagus medially, i.e. ACDF

Once thymus/superior thyroid artery are encountered, a medial sternotomy is performed with a saw

Stay within confines of mediastinal space

DO NOT place undue stretch on recurrent laryngeal
Ventral Cervicothoracic

- **Contraindications**
  - Dorsal or dorsolateral neural compression
  - Medical complications

**Advantages**
- Excellent ventral exposure of the dura
- May use Ventral Instrumentation

**Disadvantages**
- Limited to T1-T3
- Risk of recurrent laryngeal nerve –esophageal injury
Transthoracic Approaches

Hodgson and Stock
- 1957-first to use thoracotomy
- Mortality and Morbidity- 2.9%

- **T2-T6 Pathology**
  - Best exposed via right side
  - Left side less accessible because of aortic arch
  - Use double lumen ETT tube to deflate one lung

- **T6-T11 Pathology**
  - Best approached via left side (aorta easier to move there than vena cava)
Transthoracic Approaches

Trapezius:
- Spinous process to Scapula

Rhomboid
Arises from spinous process of C6-T5

Latisimus Dorsi
Arising from T6-T12
Transthoracic Approach

Five key anatomical points:
- Head of rib articulates with body and disc space adjacent to body above
- Pedicle lies ventral to the base of transverse process and medial to head of rib
- Boundaries of neural foramen
- Disc space: intervening space between intercostals and beneath rib head
- Sympathetic trunk: runs parallel to thoracic spine, over rib heads
Transthoracic Approach

Selected intercostal space (horizontal level) corresponds to thoracic vertebrae 2 levels down.

*Figure 78.2* Lateral position for thoracoabdominal or thoracotomy approach with exposed iliac crest harvest site. (Note flexion of table at surgical site.)
Localization Pearls

Count ribs with fluoroscopy

Count ribs via intrathoracic visualization as second rib will be first rib visible within the thoracic apex

Confirm desired level with prior posterior instrumentation
Transthoracic Approach

Selected intercostal space (horizontal level) corresponds to thoracic vertebrae 2 levels down
Transthoracic Approach

- 1. Division of Muscles
- 2. Exposure of Scapula
- 3. Identify first rib/Strip periosteum of rib
- 4. Rib is cut 3-4 cm from rib head, and above interspace is opened
- 5. Open parietal pleura (pleural flap)
Parietal Pleura Flap
Transthoracic Approach

6. Ligate Intercostals (at midbody) over lateral aspect of body between aortic branch point and neural foramen
7. Subperiosteal dissection of body with possible release of ALL
8. Segments above and below fusion sites (end plate and disc space above and below) should also have periosteal dissection & their vessels ligated
9. Remove rib head
10. Exposure of pedicles/dorsolateral edge of body (with Penfield 4)
11. Close pleura
12. Placement of Chest Tubes
Transthoracic Approach

CORPECTOMY created with burrs, curettes, osteotomes and rongeurs

PLACEMENT OF INTERBODY CAGE S/P CORPECTOMY
Transthoracic Approach

PLATE PLACED WITH BONE STRUT

DUAL-ROD SYSTEM
Summary

Advantages

Excellent Anterior Exposure (multiple levels)
Little Compromise of Stability (due to supporting effect of rib cage)
Low Risk of Mechanical Cord Injury

Disadvantages
Requires Thoracic Surgeon
Risk of Vascular Cord Injury (sacrifice of intercostals)
Anesthesia dolorosa, Intercostal Neuralgia
Definitive diagnosis may not be possible

Possible complications
-Pulmonary (pleural effusion, atelectasis, pneumonia, empyema, hypoventilation)

-CSF pleural fistula
Incision Patterns

Figure 89.18 Different skin incisions for dorsolateral exposures of the thoracic and lumbar spine. (A) Dorsal midline incision; (B) semilunar incision; (C) hockey-stick incision; (D) straight paramedian incision; (E) T-shaped incision.
Lateral Extracavitary

- Introduced by Capener and modified by Larson et al. offers the advantage of single stage, single incision, ventral and dorsal exposure of the spine.

- This allows for single stage decompression, fusion, and fixation of the spine in many patients who otherwise may require two separate procedures.

- In addition, the procedure allows for the "revisiting" of the ventral graft site after dorsal fixation.
Lateral Extracavitary

Figure 89.19  The three-quarter prone position used for the lateral extracavitary approach.
Lateral Extracavitary

Sup. Scapular Angle  
T-3

Inf. Scapular Angle  
T-7
1. Identify Trapezius/Create Musculocutaneous Flap reflected toward medial border of scapula
2. Identify Costotransverse Articulation
3. Remove 2-3 ribs from costotransverse/costovertebral articulations
4. Remove rib of thoracic lesion and rib below
5. Strip intercostals/neurovascular bundle subperiosteally
5. Dorsal rib cut as far laterally and followed medially
7. Ligate Intercostals/Displace Sympathetic Chain ventrolaterally
8. Vertebral body/pedicle/foramina identified
Complications

- Undesired pleural tears
- Ligation of a radiculomedullary artery causing spinal cord infarction
- Controversy: Is spinal angiography necessary prior to this approach for lesions at T8-L1?
Costotransversectomy

1. Provides dorsolateral exposure
2. Does not violate pleural cavity
3. Prone positioning
4. Midline or T shaped incision arranged
5. After subperiosteal dissection->plane of dissection extended to tips of transverse process and proximal ribs
6. 3-4 cm medial aspect of ribs is cut and disarticulated from costotransverse articulations
Costotransversectomy

- 7. Identify neurovascular bundle under rib bed, follow proximally to neural foramen
- 8. Pedicle identified
- 9. Remove transverse process and pedicle
- 10. Lateral aspect of thecal sac identified
Dorsal Approaches
Positioning

*Figure 89.17* Prone position used for most thoracic, lumbar, and sacral dorsal approaches.
Transpedicular Approach

1. Prone Position
2. Midline Incision
3. Paraspinal/Soft Tissues retracted to 1 side
4. Facet Joint/Pedicile Removed using a High Speed Burr
5. Dorsal aspect of body adjacent to portion of body near rostral intervertebral disc space may be reached through pedicle
6. Partial tumor/disc removal
Transpedicular

- **Indications**
  - Accessible far lateral ventral neural compression
  - Dorsal instrumentation can be performed simultaneously
  - Less surgery

- **Contraindications**
  - Medial pathology requiring manipulation of spinal cord for exposure
    - Marked deformity/extensive vert. body fractures

- **Disadvantages**
  - Risk of deformity without ventral strut grafting
  - Incomplete decompression
  - Less visibility of the midline of the spinal canal
Laminectomy

- Position
  - Prone

- Upper Thoracic
  - Mayfield
  - Arms on the side

- Middle/Lower Thoracic
  - No mayfield needed
  - Arms may be fixed above head (do not abduct arms more than 90 degrees)
Laminectomy

- **Indications**
  - Dorsal laminar fractures/epidural hemorrhage

- **Contraindications**
  - Ventral Neural Compression
Laminectomy

- **Advantages**
  - Less surgery
  - Dural tears easier to repair posteriorly
  - Dorsal instrumentation performed simulatenously

- **Disadvantages**
  - Cord compression typically anterior
  - May be destabilizing with ventral pathology
## Incidence Mortality/Morbidity by Approach in Thoracic Discs

<table>
<thead>
<tr>
<th>Approach</th>
<th>No of patients</th>
<th>Total Mortality</th>
<th>Postop Neurological Deterioration</th>
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<tbody>
<tr>
<td>laminectomy</td>
<td>63</td>
<td>8 (13)</td>
<td>22 (35)</td>
</tr>
<tr>
<td>transpedicular</td>
<td>41</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>transfacet pedicle sparing</td>
<td>23</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Costotransversectomy</td>
<td>55</td>
<td>0</td>
<td>3 (5.5)</td>
</tr>
<tr>
<td>lateral extracavitary</td>
<td>72</td>
<td>1 (1.4)</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>transthoracic</td>
<td>140</td>
<td>0</td>
<td>1 (0.7)</td>
</tr>
</tbody>
</table>

Thoracic Disc Outcomes due to Approach

- Laminectomy Studies
  - Morbidity: 18-75%, mortality >50%
  - (Mixter and Barr, 1934): 3 patients:
    - 2 paraplegic, 1 death
  - Hawk (1936): 4 patients:
    - 2 paralyzed, 2 died

The surgery related complications of paresis and paralysis have become rare since laminectomy has been abandoned.
Why is Laminectomy for Thoracic discs so dreadful?

- Manipulation required for removal of the disc ventral to the spinal cord may produce mechanical injury and also potentially interfere with the spinal cord blood supply.

- There is also evidence that even minor kyphotic deformities produced by laminectomy can cause tethering of the spinal cord over incompletely removed disc or osteophyte and lead to neurological deficit.
Why is choosing the correct approach so vital?

- **Thoracic disc herniation**
- **Dickman et.al.(1999)**
  - 8/15 cases had reoperation for thoracic discs
  - 86% centrally located discs
  - Majority of approaches performed via dorsolateral approaches (transpedicular, costotransversectomy, lateral extracavitary)
  - Only successful approach: transthoracic

Why is choosing the correct approach so vital?

- **Intradural discs**
  - Approached favored: lateral extracavitary approach
    - Less risk of developing CSF pleural fistulas
    - Dickman et. al.
      - May use transthoracic as long as lumbar drain placed

Thoracic Spine Surgery 2009

- Procedures just described:
  - Significant pain/morbidity
  - Compromised ventilation

Thorascoscopy/VATS

- Indications
  1) Disc herniation
  2) Abscess Removal
  3) Scoliosis
  4) Vertebral Body Instrumentation
Port points

VATS/Thorascoscopy for Metastatic Prostate CA @T10

Corpectomy with Osteotome

Placement of Expandable Cage

Pathological Burst Fx T10 from Prostate CA

Thorascoscopy Guided Cage placement with T8-T10 MACS TL Anterolateral Aesculap plate/polyaxial screws

Thoracoscopy for Thoracic Disc Video

- JP Johnson Video on Thoracoscopy from Cedars Sinai is shown
• VATS/Thorascoscopy Complications (1)
  • Incidence rate of transient intercostal neuralgia and pulmonary complications such as postoperative atelectasis, pneumothorax, pleural effusion, & hemothorax: 14-29%
  • Not all thoracic levels are equally accessible (narrowing of the thoracic diameter as inlet approached)
  • Learning curve is steep

Minimally Invasive LEC?

T6 Burst Fracture treated with T6 Corpectomy and T5-T7 Posterior Fusion through a Minimally Invasive Left LEC Approach

Minimally Invasive LEC?

Cadaver study out of Stanford from Kim DH (2008)
Unpublished data:

- Posterolateral aspects of the vertebral bodies are accessed extrapleurally and intraprocedural fluoroscopy and postoperative CT were used to assess the degree of decompression.

- An average of 93% of the ventral canal and 80% of the corresponding vertebral body were removed.

- In no case was the pleura or the intrathoracic contents violated.

- In all cases, adequate exposure was achieved to allow interbody grafting.

Minimally Invasive LEC?

Potential to address the anterior column without surgically entering the chest and would enable combining percutaneous pedicle screw fixation into a single-stage procedure

Conclusions

- **Thoracic Spine**
  - Diverse approaches to access a complicated anatomical circuit
  - Important to have careful attention to neurovascular structures (radicular arteries, intercostal artery ligations, sympathetic trunk etc) prior to bone/disc removal (corpectomy, pedicle removal, etc)
  - Ideal to combine one approach (ideally a minimally invasive LEC) to minimize post operative pain, reduce risk of pleural tears that can occur with thoracotomy or thoracostomy, and be able to place graft/instrumentation at both A/P sites
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