Modern Approaches to Spinal Tumor Surgery

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Organization-Talk
- Transpedicular approach for ventral intradural tumors
- Transpedicular Corpectomy
- En Bloc Resection
- En Bloc Spondylectomy
- En Bloc Complete Sacrectomy
- Combined Sacrectomy/Pelvic Resection

Definition
- Minimize or eliminate neural element retraction
- Accomplish this by maximizing exposure through resection of bone
- Intimate knowledge of local anatomy and tumor anatomy allows selection of optimum approach corridor

Skull Base Surgery for the Spine

Application to Spine
- Previous approach to ventral and ventral lateral intradural tumors
  - Laminectomy and Facetectomy
  - Cut nerve roots –C1-C4, T2 and below
  - Dentate ligament section and cord rotation/retraction
  - Neuromonitoring SSEP/MEP/EMG to alert to potential problems while problem is still reversible

Direct Anterior Approach
- Access corridor is deep and narrow for cervical approach—i.e. corpectomy
- Problematic for multilevel cases—sacrificing significant anterior column bone to access lesion
- Come right down on the tumor—don’t visualize normal anatomy first
- Difficult dural reconstruction
- Probably best used only for single level, purely ventral lesions –lateral component may be challenging to reach
Limitations of Traditional Posterior Approach

- Poor visualization of tumor
- Constant cord retraction in order to work
- Blood loss from internal tumor debulking
- No working room
- MEP changes may be sudden and irreversible

Neuromonitoring Changes

- Cord already compromised and now must be retracted and rotated
- Blood loss and hypotension during resection
- Nerve root EMG activity of unclear significance

New Technique

- Lateral Paramedian Transpedicular Approach for Intradural Tumors

Cervical Spine Presents Unique Challenges

Where is the lesion??

Necessity of Pediculectomy

- Increased working room
- Improved nerve root mobilization
Vertebral Artery Mobilization/Dorsal Corpectomy (working room)

Partial Corpectomy Technique

Dural H Flap

Downward dural traction “delivers” tumor en bloc away from cord

Table Rotation Improves View
Case 1

- 18 y.o. female about to begin college with mild LE weakness, right hand weakness

Case 2

- 38 y.o. mother of 2 with progressive LE weakness

Case 2 – after bone and pedicle resection prior to table rotation

After table rotation and tumor resection

Case 1 Reconstruction
Visualization and Working Space

Case 3 Large but Lateralized

Reconstruction Technique
- Significant vertebral column resection results in instability
- Loss of posterior fusion surface
- Loss of fixation points in lateral mass and pedicles
- Need to engage anterior column for lordosis restoration

Translational Work-Techniques

Reconstruction
- Artificial pedicle screws
  - Requires only vertebral body
  - Cortical
  - Control of anterior column for reduction
  - Placed under direct vision, no danger to vertebral artery
- May also be used for fractured lateral mass bailout for routine pathology
Artificial Pedicle Screws

Construct Shortening

Lordosis Restoration with APS

Fusion Surface
Transpedicular Corpectomy for Metastatic Disease

Tokuhashi Scoring system (who we operate on)

Tokuhashi Scoring System for Metastatic Spine Tumor Prognosis Spine 2005

1. Who to operate on
2. How much surgery to do

Tokuhashi score and survival validation

<table>
<thead>
<tr>
<th>Total Score</th>
<th>Survival Period</th>
<th>Survival Period</th>
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<tbody>
<tr>
<td></td>
<td>&lt; 6 mo</td>
<td>6 mo to 1 yr</td>
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<tr>
<td>0-8 (n = 158)</td>
<td>133 (85.3%)</td>
<td>16</td>
</tr>
<tr>
<td>9-11 (n = 67)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>12-15 (n = 23)</td>
<td>2</td>
<td>21</td>
</tr>
</tbody>
</table>

*The 95.4% refers to the combination of the 21 and 20 survivors in this row.

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Transpedicular corpectomy

- Eliminates need to open sternum or thoracic cavity
- Allows complete vertebrectomy over 1, 2, 3 or more levels
- Simultaneous anterior and posterior column reconstruction
- Can be used in cervical, thoracic and lumbar spine
- Expandable cages very beneficial here

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Posterior Approaches

- Transpedicular Corpectomy
  - C7-L5
  - C2-C6 with unilateral vertebral sacrifice
  - One approach reconstructs anterior and posterior columns
  - The most extensile
  - No difficulty with instrumentation placement around great vessels

Technique
Hemi-clamshell/Trapdoor

Trapdoor/Hemiclamshell Limits

T1 corpectomy-low anterior Cervical/manubrectomy

T2-3 Sternal Split

HemiClamshell/Trapdoor

Transpedicular Corpectomy

T4 High Lateral Thoracotomy

T2

T4

T6
**Outcome**
- Strength dramatically improved
- Now ambulating
- DC’d to rehab POD #5

**TPC Case Example 2**
- 63 yo male, LE weakness, renal CA
- TPC @ L3? L2? L1?
- T1?
En Bloc Resection

Mayo 2005 Chordoma

<table>
<thead>
<tr>
<th>Margins</th>
<th>Recurrence</th>
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<tr>
<td>Adequate</td>
<td>20</td>
</tr>
<tr>
<td>Inadequate</td>
<td>9</td>
</tr>
<tr>
<td>Inadequate</td>
<td>22</td>
</tr>
</tbody>
</table>

*The relationship was significant (p = 0.0001). A margin was considered adequate if it was wide according to intraoperative and histological assessments. All other margins (less than wide—e.g., contaminated, marginal, and intraventricular) were considered to be inadequate.

Translational Work-Technique

Borani Classification
H and P

- 44 yo female with r le weakness
  Q/TA/EHL 4/5
- Referring DX: benign nerve sheath tumor, neurofibroma

Plan

- Needle bx
  - Leiomyosarcoma – medium grade

TX

- En bloc posterior resection with L5 hemicorpectomy via sagittal osteotomy
- Sacrifice of R L4, L5 roots
- Anterior-Ex Lap, bx nodes, completion corpectomy for reconstruction, IORT
En Bloc Spondylectomy

- Complete removal of vertebral segment in 2 pieces
- Minimize violation of tumor to prevent seeding
- Application of surgical oncological principals to spinal oncology
- Chordoma, Osteosarcoma, Chondrosarcoma, ? Isolated metastatic disease

En Bloc Spondylectomy

Enneking Staging

H and P

- 45 y.o male presents with a 6 month history of T/L junction pain
- Neuro exam is normal
Spondylectomy Technique

1. Single stage, posterior
   - High to mid thoracic
2. 2 stage, posterior/anterior
   - Lower thoracic, lumbar

Single stage, posterior
High to mid thoracic

First Step - pass wire saw

Divide Segmentals First!
Single stage, posterior
High to mid thoracic

Back to our case
2 stages since T12
Larger body
Any ? Of anterior vessel attachments
Posterior instrumentation already in place-no ability to distract and compress
En Bloc Resection for Isolated Metastatic Disease

- Tomita JSD 2004 12 pts
- 17% Local recurrence rate overall
- 50% recurrence rate if paraspinal extension
- Involvement of pedicle did not affect recurrence rate

Translational Work

Transoral
Transoral c trach
Transoral
Transmandibular
Transoral
Transmaxillary
Transoral
Circumglossal

Approaches
- Transmandibular
- Transglossal
- Transmandibular Retropharyngeal
- Circumglossal

Cervical Spine En Bloc Tumor Resection
H and P
- 50 yo male
- Severe neck pain
- U/LE weakness 3-4/5
- PMH (-)
- Underwent a C1-C4 PSF/PSI for a “C2 lesion” at other facility
- BX at UCSF-Chordoma

En Bloc Resection Transoral
- Posterior vertebral mobilization bilateral C1-C3
- OCC-Thoracic fusion
- Transmandibular transglossal
- Anterior vertebral mobilization
- En Bloc marginal resection C2 body
- ASI C1-C3
Cervical Case Example 2

Needle Bx Chordoma
En Bloc Sacrectomy-Technique

Evolution

- Anterior Stage-no osteotomy-just Discectomy L5-S1, nerve mobilization, sacrifice and protection, silastic sheet
- Posterior-no transiliac bar, anchoring of femur into pelvis with AO screws, BMP-2

H and P

- 63 yo male with sacral pain and left leg pain
- Neuro exam
  - Bilateral S1 4/5
  - Decreased perineal sensation

Sacral Chordoma
Original Resection Technique
Reconstruction

Gokaslan Technique

ISSLS Prize 2005

Advances in challenging reconstructions

Concomitant followed by the placement of laminar spreader with multilevel cages and recombinant human bone morphogenetic protein-2 for vertebral osteosynthesis

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Department of neurosurgery at the University of Florida, The University of Florida
Posterior Guided Osteotomy

UCSF Neurospine

Thanks for your attention