Primary Bone Tumors:
Spine Surgery Live - Video Techniques
Mobile Spine

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Disclosures

DePuy  Consultant
Medtronic  Consultant
Stryker  Consultant
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Fish & Richardson  P.C.
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Outline

- Background of Grading and Staging
- Examples with Treatment Implications (Mobile Spine)

Modern Spine Tumor Surgery

Metastatic Spine Tumors

"OK, all those in favour of delegating decision-making, shrug your shoulders."

Primary Spine Tumors
Primary Tumors

- Primary tumors rely more on surgical treatment at initial surgery
- Diagnosis
- Histology
- Staging System
  - Oncological
  - Location
  - Surgical
- Treatment Planning
  - Adjuvant yes/no/pre/post
  - Surgery wide/marginal/intralesional (part/whole)
- Surgical Technique

Histology

- Chondrogenic
- Osteogenic
- Fibrogenic
- Fibrohistiocytic
- Osteoclastic GC-rich
- Vascular
- Neuro/Ectodermal
- Notochordal
- Undefined/Pseudotumoral
## Surgical staging system

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Grade</th>
<th>Tumor</th>
<th>Metastasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 G0 T0 M0</td>
<td>Benign latent</td>
<td>G0</td>
<td>T0</td>
<td>M0</td>
</tr>
<tr>
<td>2 G0 T0 M0</td>
<td>Benign active</td>
<td>G0</td>
<td>T0</td>
<td>M0</td>
</tr>
<tr>
<td>3 G0-1 T0-1 M0</td>
<td>Benign aggressive</td>
<td>G0</td>
<td>T0</td>
<td>M0</td>
</tr>
<tr>
<td>I A G1 T1 M0</td>
<td>Malignant, low grade, intracompartmental</td>
<td>G1</td>
<td>T1</td>
<td>M0</td>
</tr>
<tr>
<td>I B G1 T2 M0</td>
<td>Malignant, low grade, extracompartmental</td>
<td>G1</td>
<td>T2</td>
<td>M0</td>
</tr>
<tr>
<td>II A G2 T1 M0</td>
<td>Malignant, high grade, intracompartmental</td>
<td>G2</td>
<td>T1</td>
<td>M0</td>
</tr>
<tr>
<td>II B G2 T2 M0</td>
<td>Malignant, high grade, extracompartmental</td>
<td>G2</td>
<td>T2</td>
<td>M0</td>
</tr>
<tr>
<td>III G any T any M1</td>
<td>Malignant, any grade, any extent, distant metastasis</td>
<td>G any</td>
<td>T any</td>
<td>M1</td>
</tr>
</tbody>
</table>

Enneking et al, 1983

## Benign Tumor

1. G0 T0 M0 Latent
2. G0 T0 M0 Active
3. G0 T1/2 M0/1 Aggressive

1. Capsule, 2. Pseudocapsule
Hemangioma

Grade 1

Grade 2

Grade 3
Treatment of Enneking Stage 3 Aggressive Vertebral Hemangiomas With Intralosional Spondylectomy

Report of 10 Cases and Review of the Literature

Frank L. Acosta, Jr, MD,* Nader Sanai, MD,† Jordan Cloyd, BS,† Vedat Deviren, MD,‡ Dean Chou, MD,† and Christopher P. Ames, MD†

Osteochondroma

- Low grade
- Benign
- Symptomatic
- Marginal Excision

20 yo f
Benign Tumor-Osteoid Osteoma

**Treatment**

- NSAIDS
- RFA
- Intralional curettage
- Associated scoliosis

13 yo female

**ABC**

**Modern Tx**

- Serial Embolization
- Intralional embolization
- Intralional resection
  - Not able to embolize
  - Mechanical Instability
- Denosumab?
Posterior resection and reconstruction of C1 lateral mass for ABC
ABC vs GCT vs Telangiectatic OS

- Bx - GCT vs ABC

30 yo male back pain

Indications for En Bloc Resection

Table 5. Indications to en bloc surgery

<table>
<thead>
<tr>
<th>Stage 3 benign, aggressive tumors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I low-grade, malignant tumors</td>
</tr>
<tr>
<td>Stage II high-grade malignant tumors (indication must be considered after evaluating the role of chemotherapy and radiation therapy)</td>
</tr>
</tbody>
</table>

Staging and treatment of primary tumors of the spine

Stefano Boriani, MD, Stefano Bandiera, MD, Roberto Biagini, MD, and Piero Picci, MD

Curr Opinion Orthopedics 1999
The Role of “Tumor-Free Margins” in the Resection of Spinal Tumors: Who Should Be Treating Spine Tumors?

Stefano Boriani, MD,* and James N. Weinstein, DO, MSc†

GCT

<table>
<thead>
<tr>
<th>Treatment</th>
<th>n</th>
<th>Rec./Prog.</th>
<th>R1-Ops</th>
<th>Lung Mets.</th>
<th>CDF</th>
<th>NED</th>
<th>AWD</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intralional exc.</td>
<td>19</td>
<td>4 (2-50, ave. 15 mo)</td>
<td>0</td>
<td>2 (4 and 59 mo)</td>
<td>15 (24-295, ave. 107 mo)</td>
<td>19 (24-295, ave. 155 mo)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Intralional exc. + RT</td>
<td>18</td>
<td>6 (0-60, ave. 18 mo)</td>
<td>1 (18 mo)</td>
<td>2 (10 and 33 mo)</td>
<td>11 (75-328, ave. 182 mo)</td>
<td>16 (51-328, ave. 164 mo)</td>
<td>0 (56 mo)</td>
<td>2 (177 mo)</td>
</tr>
<tr>
<td>En bloc exc.</td>
<td>14</td>
<td>1 (0-31)</td>
<td>0</td>
<td>1 (27 mo)</td>
<td>12 (24-180, ave. 74 mo)</td>
<td>13 (24-180, ave. 73 mo)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>11</td>
<td>1</td>
<td>9</td>
<td>37</td>
<td>47</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Terminology

**En bloc resections without tumor-free margins**

**Intralional:**

The tumor periphery is violated and the tumor is not covered by healthy tissue.

**Marginal:**

The pathologist describes histologically a thin layer of healthy muscle, bone, or an endothelial membrane continuously covering the tumor mass.

**Wide:**

A fascial barrier represents a wide margin… 1 cm of muscle or cancellous bone sometimes is not enough and a 2 cm barrier may be required to consider the margin wide.
Osteoblastoma

**Benign**

- Type 3
- 20% recurrence intralesional
- En Bloc Excision
- Associated ABC
Operative Plan
Giant cell tumor

- Chondrogenic
- Osteogenic
- Fibrogenic
- Fibrohistiocytic
- Osteoclastic GC-rich
- Vascular
- Neuro/Ectodermal
- Notochordal
- Undefined/Pseudotumoral
Recurrent GCT L1-2

Options?
Giant cell Tumor (location)

- **Denosumab**
  - The efficacy assessment included 49 patients who had the opportunity to be on denosumab treatment for at least 6 months.
  - After 6 months, 47 patients (96%) were free of disease progression based on subjective assessment of disease status.
Malignant Tumor

Low grade
IA Intra-comp; thin capsule, tumor in pseudocapsule
IB Extra-comp (Zone A,D,E) chordoma, chondrosarcoma

High grade
IIA Intra-comp; tumor in PC, Osteosarcoma, ES
IIB Extra-comp (Zone A,D,E)

- How to access contralateral nerve root?
- Lateral retraction of specimen
Chordoma

- Chondrogenic
- Osteogenic
- Fibrogenic
- Fibrohistiocytic
- Osteoclastic GC-rich
- Vascular
- Neuro/Ectodermal
- Notochordal
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En Bloc Resection Technique

1. Single stage, posterior
   - High to mid thoracic, sacrectomy
2. 2 stage, posterior/anterior
   - Cervical, Lower thoracic, lumbar, ? Vessel or large extracompartmental disease
First Step-pass wire saw
Single stage, posterior
High to mid thoracic
Standard 2 stage P/A Chordoma
Chordoma 5 level
Spinal Cord Perfusion after Segmental Ligation

**Table 2. Neurological Outcomes One Week After Ligation**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Group 1 (3 Pairs)</th>
<th>Group 2 (4 Pairs)</th>
<th>Group 3 (5 Pairs)</th>
<th>Group 4 (7 Pairs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Grade 0 indicates complete paraplegia with no hind extremity motion; Grade 1, minor joint movements; Grade 2, major joint movements; Grade 3, animal can stand; Grade 4, animal can walk; Grade 5, animal can climb a 20° inclined plane.

NEW for Chordoma—Combined Hybrid Surgery

Preop SRS 2500cGy/5, max tumor 3450cGy
3 Stage P/L/R

- IVC Filter
- PSF/I T2-T11, posterior osteotomy and nerve sacrifice
- Left Thoracotomy, aortic dissection, 3.25 level
- Right Thoracotomy, esophageal dissection, delivery
Chordoma (Location)
Case 4 Spondylectomy Technique
En Bloc marginal - contaminated at vertebral a.

Bilateral Transverse Cervical Exposure
Outcomes following attempted en bloc resection of cervical chordomas in the C-1 and C-2 region versus the subaxial region.

**Figure 3:** Peri-operative and post-operative surgical complications stratified according to tumor location.

**Figure 2:** Surgical margins stratified according to tumor location.

**Chondrosarcoma**

- Chondrogenic
- Osteogenic
- Fibrogenic
- Fibrohistiocytic
- Osteoclastic GC-rich
- Vascular
- Neuro/Ectodermal
- Notochordal
- Undefined/Pseudotumoral
2 Stage A/P Thoracic 270
Spondylectomy Chondrosarcoma

2 Stage Thoracic Spondylectomy Chondrosarcoma
L2-3 chondrosarcoma

A/P

- 32 yo male
**Osteosarcoma**

- Preoperative adjuvant therapy
  - Response to therapy predictive of outcome
  - Refinement of surgical margins
    - Chondrogenic
    - Osteogenic
    - Fibrogenic
    - Fibrohistiocytic
    - Osteoclastic GC-rich
    - Vascular
    - Neuro/Ectodermal
    - Notochordal
    - Undefined/Pseudotumoral

**Ewings Sarcoma**

- Preoperative Adjuvant Therapy
  - Chondrogenic
  - Osteogenic
  - Fibrogenic
  - Fibrohistiocytic
  - Osteoclastic GC-rich
  - Vascular
  - Neuro/Ectodermal
  - Notochordal
  - Undefined/Pseudotumoral
P32 Brachytherapy

- Leiomyosarcoma
- Adjuvant therapy
- P32 to margin
- Dural margin
- Shape radiation targets for SRS
P32

- Beta emitting radioisotope (1-2 Gy/minute)
- Embedded in thin plastic polymer
- Half-life 14 days
  - Conforms to the dura
  - Handled without shielding
  - Custom fit at surgery to the target
- FDA approved
Soft Tissue Sarcoma

Primary vs Metastatic
Bone grafting demand

Recurrent CS 5 years later…
Thanks to the Primary Tumor Team!

- Vedat Deviren Orthopedics
- Igor Barani Rad Onc
- Pierre Theodore Thoracic
- Ivan El Sayed ENT
- Mika Varma Colorectal
- Bill Hoffman Plastics
- Charles Eichler Vascular
- Rebecca Mustille PT