Combined posterior hemiosteotomies and stabilization with lateral thoracotomy for en bloc resection of thoracic paraspinal primary bone tumors: technical note

Mauricio J. Avila, MD,¹ Jesse Skoch, MD,¹ Vernard S. Fennell, MD,¹ Sheri K. Palejwala, MD,¹ Christina M. Walter, MS,¹ Samuel Kim, MD,² and Ali A. Baaj, MD¹

Divisions of ¹Neurosurgery and ²Cardiothoracic Surgery, University of Arizona, Tucson, Arizona

Primary bone tumors of the spine are rare entities with a poor prognosis if left untreated. En bloc excision is the preferred surgical approach to minimize the rate of recurrence. Paraspinal primary bone tumors are even less common. In this technical note the authors present an approach to the en bloc resection of primary bone tumors of the paraspinal thoracic region with posterior vertebral body hemiosteotomies and lateral thoracotomy. They also describe 2 illustrative cases.

<http://thejns.org/doi/abs/10.3171/2015.4.SPINE15107>

KEY WORDS en bloc resection; osteotomy; spinal neoplasms; chordoma; chondrosarcoma; thoracic neoplasms; oncology

P RIMARY bone tumors account for 5% of spine neoplasms.⁵ The most common of these rare tumors are chordoma, chondrosarcoma, osteosarcoma, and Ewing sarcoma.⁷ Patients with primary bone tumors usually present with nonspecific axial pain over a period of time, with radicular or myelopathic symptoms absent in most cases.^{6,7} Obtaining a histological diagnosis is essential, and CT-guided biopsy yields the best oncological results compared to those obtained with open biopsy.¹⁴

Given the high rate of local recurrence if only intralesional excision or incisional biopsy is performed,^{3,14} the best treatment for these lesions is en bloc resection.^{3,4,6,7,10,14} The best disease-free prognostic factor is negative margins at the surgical site.² However, en bloc resection is technically challenging¹⁰ and associated with significant potential complications.¹

Paraspinal primary bone tumors are unique since these lesions are adjacent to the vertebral column but sometimes without obvious involvement of the vertebral bodies. The best approach for these lesions is also en bloc with wide resection, but the extent of vertebral body resection is not known. Smitherman et al.¹¹ reported the case of a male with thoracic paraspinal giant cell tumor treated with navigation-guided parasagittal vertebrectomy and en bloc resection. In this technical note we describe a nonnavigated combined posterior and lateral approach for stabilization, resection, and delivery of primary bony tumors of the

thoracic paraspinal region. We also provide 2 illustrative cases.

Surgical Technique

After a thorough preoperative evaluation, particularly the imaging of adjacent vertebral bodies and spinal canal, the patient is prepared for a 2-stage procedure. Stage 1 involves a traditional posterior midline approach to the thoracic spine. Pedicle screws are placed above and below the levels of the lesion for stabilization. On the ipsilateral side, a high-speed drill is used to create sagittal cuts along the lateral aspect of the lamina and/or pedicles and into the vertebral bodies. Navigation is helpful; otherwise the pedicles are identified using anatomical landmarks, and a vertical imaginary line that connects multiple pedicles can be delineated. This constitutes the sagittal hemiosteotomy line (Fig. 1). Wire saws have the theoretical advantage of less tumor dissemination, but in our experience a high-speed drill (with a diamond drill bit) provides better control and less bony blood loss. Osteotomes can also be used. The exiting nerve roots are ligated, stable neuromonitoring signals are confirmed, and the nerve roots are sharply cut. The sagittal bony cuts are performed as deep as possible into the vertebral bodies so they can be “green-stick fractured” laterally during Stage 2. Depending on how much (if any) vertebral body is involved, the cut can be medial-

SUBMITTED January 27, 2015. ACCEPTED April 22, 2015.

INCLUDE WHEN CITING Published online October 9, 2015; DOI: 10.3171/2015.4.SPINE15107.

FIG. 1. Artist's depiction of the 2-stage technique in which the medial vertebral column cuts are made, followed by lateral en bloc resection of the tumor. Copyright Ali Baaj. Published with permission.

ized accordingly. Measuring the depth of each vertebral body preoperatively assists in the osteotomy depth intraoperatively. This, in effect, dissociates the affected lateral vertebral segments of the rib cage from the remainder of the vertebral column (Fig. 2). Stage 2 involves a traditional lateral thoracotomy approach. The ribs are cut with a lateral margin (at least 4 cm), and then dissection is performed dorsal to the ribs until the ipsilateral rod is visualized. At that point osteotomes are again placed in the defect made in Stage 1, and the lesion along with the lateral vertebral column and ribs is fractured out laterally away from the spinal canal, with delivery of the tumor en bloc (Fig. 3). As only about one-third of the vertebral body is hemicorpectomized, anterior stabilization is typically not needed. The chest wall is reconstructed using Gore-Tex and closed in a traditional fashion. The chest wall does not need to be reconstructed if less than 3 ribs are resected.

FIG. 2. Intraoperative photograph illustrating hemicorpectomies to create a negative margin and separate the lateral vertebral column from the chest wall. Note that a combination of a high-speed drill and osteotomes can be used.

Illustrative Cases

Case 1

History and Examination

A 48-year-old male presented with a history of right upper quadrant pain. He had no neurological deficits. Imaging revealed a right-sided paraspinal chest lesion at the level of T-8 (Fig. 4). Computed tomography-guided biopsy revealed chondrosarcoma. After a multidisciplinary oncological team including thoracic surgery, oncology, and neurosurgery planned the surgical treatment, a 2-stage en bloc resection of the lesion was proposed.

Operation

The first stage of the surgery, as described above, was performed to create a negative margin in the vertebral column. It consisted of T7–10 pedicle screw stabilization with hemicorpectomies of T-8 and T-9 on the right side. The next day, the patient underwent Stage 2 of the procedure for delivery of the tumor (Figs. 5 and 6).

Postoperative Course

The patient was extubated on postoperative Day 1 and had no complications in the immediate postoperative course. He had no postoperative deficits, and final pathology confirmed low-grade chondrosarcoma but with a positive histological margin medially. He underwent postoperative adjuvant radiation. Follow-up imaging at 3 months after surgery did not reveal obvious recurrence. At 6 months postsurgery, the patient continued to be free of neurological deficits and was doing well.

Case 2

History and Examination

A 60-year-old male presented with a 1-year history of stabbing back pain. Imaging demonstrated a large left-

FIG. 3. **Left:** Intraoperative photograph demonstrating Stage 2: lateral thoracotomy has been performed. The osteotome is placed in the posterolateral defect, and the chest wall region together with the tumor is outfractured laterally (arrows). **Right:** Intraoperative photograph of the lateral chest well and vertebral column after the tumor is resected showing the surgical bed, including hemicorpectomized vertebral bodies (arrows).

sided paraspinal mass spanning the levels of T7–9 (Fig. 7). The patient initially underwent attempted resection at an outside facility, but intraoperative biopsy demonstrated chordoma and the surgery was halted. He was transferred to our institution for definitive management.

Operation

The surgical approach was staged. Posteriorly, the spine was stabilized from T-6 to T-10 with pedicle screws, and

FIG. 4. Case 1. **Left:** Axial T2-weighted MR image shows lobulated lesion in the right paraspinal region. **Right:** Midsagittal T1-weighted postcontrast MR image shows spared vertebral bodies.

FIG. 5. Case 1. Intraoperative photograph depicting resected tumor with adjacent chest wall and lateral vertebral body components.

FIG. 6. Case 1. Postoperative axial CT image demonstrating hemi-corpectomy and paraspinal surgical bed after tumor resection.

hemiosteotomies were made to create a margin. Forty-eight hours later, Stage 2 was performed through a thoracotomy with the completion of chest wall, tumor, and lateral vertebral column resection (Figs. 8 and 9). Final pathology confirmed chondroid chordoma, with gross negative margins but a focal microscopic medial positive margin.

Postoperative Course

At 3 months' follow-up, the patient was doing well with no evidence of residual tumor or recurrence on MRI (Fig. 10). He was referred for outpatient adjuvant therapy.

Discussion

En bloc resection of primary spine tumors is the mainstay of treatment. Paraspinal or chest wall primary tumors

FIG. 7. Case 2. Preoperative axial T2-weighted MR image demonstrating a large left-sided paravertebral lesion.

FIG. 8. Case 2. Intraoperative photograph depicting resected tumor mass.

are rare, but their management principles are not different. Among the 52 cases reported by Boriani et al.,³ only 7 were located in the thoracic spine. In general, chest wall tumors are uncommon;^{8,9} chondrosarcoma, osteosarcoma, and Ewing sarcoma (in children) are the most common primary bone tumors in this location.^{9,12} The paraspinal location in the thoracic spine for primary bone tumors is uncommon as well, with the majority located in the midline.¹³

FIG. 9. Case 2. Immediate postoperative axial CT image demonstrating extent of hemi-corpectomy after Stage 1.

FIG. 10. Case 2. Three-month postoperative axial T2-weighted MR image demonstrating no obvious recurrence of tumor.

The important questions are 1) how much of the vertebral body needs resection—and hence stabilization, and 2) how does one create a margin medially in the vertebral column. In the proposed approach a medial margin is created with parasagittal osteotomies. This involves multiple rhizotomies and dissociation of the lateral vertebral body elements from the chest wall. A second stage operation laterally then completes delivery of the tumor. In this instance, posterior stabilization should suffice and anterior cage reconstruction is not necessary. However, it should be noted that en bloc resection with true negative margins (that is, wide marginal resection) is often difficult in spinal column tumor surgery given the local constraints of the surrounding neurovascular structures. As demonstrated in our cases, even without obvious radiographic vertebral body involvement, final pathology demonstrated focal microscopic positive medial margins. This margin could be at the level of the foramen or vertebral body. Many authors report “negative margins” after en bloc resection, but rarely is there clarification or distinction between gross negative and microscopic negative margins. From a practical surgical perspective, every effort should be made to perform a safe en bloc resection with gross negative margins, as was done in our 2 cases. It is also unknown whether a complete spondylectomy, even in the absence of radiographic tumor invasion, would lead to better long-term results with parasagittal tumors.

As in many cases of en bloc resection, limitations of hospital infrastructure and expertise are important. As suggested by the Spine Oncology Study Group and others,^{1,6,13,14} these patients should be biopsied and treated by the same surgical team in a specialized center. Even then, a thorough evaluation and management plan by multidisciplinary teams are mandatory.

Conclusions

A combined approach of posterior hemiosteotomies and stabilization followed by lateral thoracotomy and tu-

mor delivery is a feasible option for en bloc resection of primary parasagittal bony tumors of the thoracic region.

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Disclosure

Dr. Baaj was a consultant for DePuy and receives royalties from Thieme Medical Publishers.

Author Contributions

Conception and design: Baaj. Acquisition of data: Baaj, Avila, Kim. Analysis and interpretation of data: Baaj, Avila. Drafting the article: Baaj, Avila, Skoch. Critically revising the article: all authors. Reviewed submitted version of manuscript: Baaj. Approved the final version of the manuscript on behalf of all authors: Baaj. Study supervision: Baaj.

Correspondence

Ali A. Baaj, Department of Neurological Surgery, Weill Cornell Medical College, 525 E. 68th St., New York, NY 10065. email: alb9140@med.cornell.edu.