Primary Malignant Tumors of the Spine

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KEYWORDS

• Malignant tumors spine • Chordoma • Chondrosarcoma • Osteosarcoma • Ewing's sarcoma

The last two decades have witnessed dramatic changes in the approach to tumors of the spine for several reasons.[1–4] Improvement in surgical approaches to the entire vertebral column have made it technically feasible to resect tumors involving the spine at all levels, and the development of third- and fourth-generation instrumentation systems has allowed surgeons to reconstruct entire vertebral segments after surgery. Improvement in the radiologic diagnosis of spine tumors because of the widespread availability of MRI and CT has greatly enhanced the ability of surgeons to visualize tumors in their entirety, plan the proper approach, and assess results of therapy. The introduction of positron emission tomography (PET)-CT scan has further altered treatment paradigms in cancer management. In a recent analysis of the National Oncologic PET registry, change in treatment/management was the major impact of 35% of patients evaluated. It is current standard of care to stage all patients with bone and soft-part sarcoma using PET scans to monitor treatment response and conduct surveillance to detect recurrence.[5] Exciting advances in molecular biology and therapy also offer the promise for treatment not thought feasible before.[6–8] Despite these advances, treatment of spinal tumors is still largely not standardized, and most clinical studies are retrospective reviews of nonuniform treatment modalities spanning several decades.

The field of spinal oncology might be credited properly to the pioneering work of Bertil Stener[9,10] in Goteborg, Sweden. In a series of articles, he described the surgical techniques of en bloc resection of chordomas of the sacrum and chondrosarcomas involving the spine. In an effort to bring uniformity to the field of spine oncology, Boriani and colleagues[11] proposed a staging system for spine tumors based on a system originally developed by Enneking for bone and soft-part sarcomas involving the extremities.

Surgical procedures are classified by the tissue planes and manner of removal.[12–14] ''Curettage'' and ''intralesional'' are terms that describe the piecemeal removal of the tumor. Surgeons often characterize a procedure as radical when the tumor capsule was violated by curettage, and we believe that the use of such terms should be avoided. ''En bloc'' indicates an attempt to remove the whole tumor in one piece, together with a layer of healthy tissue. The specimen is then submitted for careful histologic studies to further define the procedure as intralesional, marginal, or wide. The term ''intralesional'' is appropriate if the surgeon has cut within the tumor mass; ''marginal'' is appropriate if the surgeon has dissected along the pseudo-capsule, the layer of reactive tissue around the tumor; and ''wide'' is appropriate if the plane of surgical dissection is outside the pseudo-capsule, thus removing the tumor with a continuous shell of healthy tissue. This wide en

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Orthop Clin N Am 40 (2009) 21–36
doi:10.1016/j.ocl.2008.10.004
0030-5898/08/$ – see front matter © 2008 Elsevier Inc. All rights reserved.

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bloc procedure can be called excision or resection. These terms are too widely used and interchanged for them to be separated. To avoid confusion and compare results, it is essential to distinguish the longer, more difficult, and risky removal of the whole tumor in one piece (en bloc) from a simple intralesional procedure, although this sometimes means the piecemeal removal of the whole vertebra. Intralesional resection of malignant tumors may provide functional palliation and pain relief, but it results in a high incidence of local recurrence.

In this article, we review the current state-of-the-art in primary malignant tumors of the spine. Although various histologic conditions may be encountered in the spine, malignant tumors can broadly be categorized into low-grade and high-grade tumors. Low-grade tumors include chordoma and chondrosarcoma; high-grade tumors include osteosarcoma and other sarcomas, Ewing's sarcoma, and lymphomas. A special category is plasmacytoma, which frequently arises within the spine but later disseminates into multiple myeloma. From an anatomic perspective, low-grade malignant tumors are subdivided into stage 1A (the tumor remains inside the vertebra) and stage 1B (tumor invades paravertebral compartments). No true capsule is associated with these lesions, but a thick pseudo-capsule of reactive tissue often is penetrated by small, microscopic islands of tumor. In these cases a resection performed along the pseudo-capsule often leaves residual foci of active tumor; megavoltage radiation or proton beam therapy often is used as an adjunct to reduce the risk of recurrence. The treatment of choice—if feasible—is a wide en bloc excision.

High-grade malignancies are defined as stages IIA and IIB. The neoplastic growth is so rapid that the host has no time to form a continuous reactive tissue layer. There is continuous seeding with neoplastic nodules (satellites). These tumors also can have neoplastic nodules at some distance from the main tumor mass (skip metastases). These malignancies generally are seen on plain radiographs as radiolucent and destructive and in many cases are associated with a pathologic fracture; CT scanning and MRI give the most detailed views of the transverse and longitudinal extent of these tumors and may confirm the absence of a reactive tissue margin. Invasion of the epidural space is rapid in stage B, particularly in small-cell tumors (Ewing's sarcoma, lymphomas), and is characterized by infiltrating tumor spread beyond the cortical border of the vertebra with no gross destruction. The margin of the en bloc excision must be wide at the very least, because it is not possible to achieve a radical margin in the spine. Adjuvant courses of radiation and chemotherapy (according to the tumor type) must be considered for local control and to prevent distant spread. Stages IIIA and IIIB describe the same lesions as IIA and IIB, but with distant metastasis.

SURGICAL STAGING

Surgical staging is appropriate only after the diagnosis has been established and oncologic staging has been determined. In the transverse plane, the vertebra is divided into 12 radiating zones (numbered 1–12 in a clockwise order) and into five layers (A–E, from the paravertebral extraosseous region to the dural involvement). The longitudinal extent of the tumor is deduced by recording the spine segments involved (**Fig. 1**). CT scanning, MRI, and sometimes angiography of the tumor are the imaging techniques needed to describe the transverse and longitudinal expansion of these tumors. It is the authors' view that this system allows a more rational approach to the surgical planning, provided that all efforts are made to perform surgery along the required margins.

PLANNING OF SURGICAL PROCEDURES

There are three major methods for performing en bloc excisions in the thoracolumbar spine: vertebrectomy, sagittal resection, and resection of the posterior arch. The term ''vertebrectomy,'' which is used to describe removal of the entire tumor in one piece together with portions of the posterior elements, is also termed ''spondylectomy.''

Vertebrectomy (spondylectomy) involves marginal/wide en bloc excision of the vertebral body (**Fig. 2**). En bloc tumor excision of the vertebral body can be performed with appropriate margins if the tumor is confined to zones 4 to 8 or 5 to 9, which means that it is centrally located and that at least one pedicle is free from tumor. The procedure can be performed in two stages or in one stage. The posterior approach (with patient in the prone position) involves excision of the posterior elements, which enables the annulus fibrosus and the posterior longitudinal ligament to be sectioned. It also allows careful hemostasis of the epidural venous plexus to be achieved and posterior stabilization to be performed. The anterior approach (transpleural thoracotomy, retroperitoneal abdominal, or thoracoabdominal approach) allows the ligature of segmental vessels (at the lesional level, above and below), proximal and distal discectomies (or the section by chisel through the

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