Epidemiologic, functional, and oncologic outcome analysis of spinal sarcomas treated surgically at a single institution over 10 years

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Received 26 February 2014; revised 17 June 2014; accepted 9 July 2014

Abstract

BACKGROUND CONTEXT: Spinal sarcomas are aggressive tumors that originate from the cells of mesenchymal origin, specifically fat, cartilage, bone, and muscle. They are high-grade lesions, and treatment of spinal sarcomas can involve chemotherapy, radiation therapy, and surgery. In the appendicular skeleton, sarcomas are often treated with amputation, however, in the spinal column, surgical resection poses a unique set of challenges.

PURPOSE: To better understand the optimal treatment regimens and the impact of en bloc or intralesional resection on patient outcome.

STUDY DESIGN: A cohort of 25 sarcoma patients treated at a single medical institution between 2002 and 2012 was reviewed.

PATIENT SAMPLE AND OUTCOME MEASURES: Patients were classified by tumor type for subgroup analysis, including chondrosarcoma, osteosarcoma, and other malignant spinal sarcomas. Demographic data for review included patient age, tumor type, tumor location, surgery type, exposure to chemotherapy, and radiation therapy.

METHODS: Survival statistics and Kaplan-Meier curves were calculated using GraphPad Prism 5.0. The threshold for statistical significance was set at p < .05. Unpaired, two-tailed, equal variance t tests were performed for statistical analyses in Microsoft Excel 2010.

RESULTS: Twenty-five patients with spinal sarcomas were treated over the 10-year period. Diagnosis included chondrosarcoma (n = 9), osteosarcoma (n = 4), and other sarcomas (n = 12). Mean age at the time of diagnosis was 42 years. Pain was present at the time of diagnosis in 92% patients. Median survival after surgery was 59.5 months for chondrosarcoma, undefined for other sarcomas, and 16.8 months for osteosarcoma. Median survival after en bloc resection was undefined. Median survival after intralesional resection was 17.8 months. The difference in median survival between en bloc and intralesional resection was statistically significant (p = .049).

CONCLUSIONS: The authors report the largest cohort of patients with spinal sarcoma. Median survival in this cohort was the longest for patients with sarcomas of varying pathologies. Median survival was longer for chondrosarcoma. En bloc resection demonstrated a survival advantage over...
Introduction

Spinal sarcomas are a rare group of spinal malignancies that are associated with high rates of morbidity and mortality. Epidemiologic studies of spinal sarcomas, such as from the Surveillance Epidemiology and End Results database cancer statistics review from 1975 to 2009, demonstrate that sarcomas represent less than 5% of all osseous neoplasms and less than 0.2% of all new cancers [1,2]. Sarcomas can occur in a variety of osseous regions throughout the body. However, sarcomas of the spine and surrounding structures often elicit debilitating consequences because of severe focal pain and neurologic morbidity.

Chondrosarcoma represents 25% of sarcomatous tumors and increases in likelihood in patients older than 50 years [3–6]. Chondrosarcomas are part of a family of malignant tumors, where the cells differentiate uncontrollably into cartilaginous tissue. It is further classified as central, peripheral, or periosteal, with mesenchymal and clear cell variants [7]. Osteosarcoma tends to be more common, representing 35% of all sarcomas and 3% to 15% of all primary spine tumors. There exist a variety of subtypes including conventional osteosarcomas, telangiectatic, small-cell and giant-cell, epithelioids, and osteoblastoma-like osteosarcomas [8,9].

While previous studies have been confined by the limited patient data or the size of their patient population, this database of spinal sarcomas comprises 25 spinal sarcoma patients who underwent surgical resection at a single institution from 2002 to 2012. We investigated the impact of en bloc resection on patient outcome through analyzing a single institution’s surgical management of spinal sarcomas over the last decade. Although the Surveillance Epidemiology and End Results database provided invaluable epidemiologic data of 1,378 sarcoma patients, it did not stratify the outcomes based on surgical approach from each surgical institution separately. Thus, by looking only at the patients from a single institution during a single decade, this study allows for a controlled standard of care that we hope may then be used by neurosurgical and orthopedic spinal surgeons to determine functional and oncologic survival data for a variety of surgical techniques and treatments.

Methods

Study population

Demographic, treatment, and outcome data were collected retrospectively from the electronic medical record following protocols dictated by the institutional review board (IRB application NA_00066200). Twenty-five consecutive patients with histology-confirmed spinal sarcomas treated at a single institution from 2002 to 2012 were reviewed. Patient medical records including clinic notes, primary radiographs, computed tomography (CT) scans, and magnetic resonance imaging (MRI) were reviewed. Pathology reports were also reviewed.

Study criteria

All patients included in this study presented with histologically confirmed sarcoma of the spine. Covariates identified were epidemiologic data such as age, gender, length of hospitalization, location of sarcoma, number of spinal levels involved, surgical approach, tumor volume, pathology of sarcoma, extent of resection, pain at diagnosis, Frankel score, presence of myelopathy and cauda equina, adjutent treatment, local recurrence, and overall survival. The diagnosis of other sarcomas included epithelioid sarcoma (n=3), pleomorphic undifferentiated sarcoma (n=2), spindle cell sarcoma (n=2), alveolar soft part sarcoma (n=1), unusual low grade sarcoma (n=1), postradiation sarcoma (n=1), fibromyxoid sarcoma (n=1), and Ewing sarcoma (n=1).

Surgical approach was recorded from operative notes. Pain at diagnosis was self-reported by patients at any preoperative clinic visit within 3 months of surgery. The number of spinal levels involved and the presence or absence of a pathologic fracture were determined from the radiology reports of preoperative CT and MRI scans.

Vital statistics were recorded from the Social Security Death Master File accessed online. All vital statistics reflect the status of patients as of July 31, 2012. Survival data for non-US citizens were recorded as unknown. Recurrence data are recorded for all patients at the last clinical follow-up. Recurrence was determined from the postoperative neurosurgery clinic notes, reporting the neurosurgeon’s interpretation of radiographic recurrence at the time of last follow-up.

Tumor size and volume were recorded from the primary review of preoperative MRI or CT scans. Volume was calculated via the formula for the volume of an ellipsoid (4π/3r1r2r3). Radii were taken as one-half the cranial-caudal, anteroposterior, and lateral measurements of the tumor. Measured values were corroborated with radiology reports.

After surgery, patients were seen at 1 month, then at 3, 6, 9, and 12 months. Patients were followed every 6 months in the second year, then yearly, or as clinical progression dictated their plan of care. Magnetic resonance imaging with and without contrast was used to evaluate tumor recurrence at the time of clinical follow-up. Early, defined as occurring within 30 days postoperatively, and late complications,
defined as occurring after 30 days postoperatively, were recorded.

**Statistical analysis**

Survival statistics and Kaplan-Meier curves were calculated using GraphPad Prism 5.0 (GraphPad; La Jolla, CA, USA). The threshold for statistical significance was set at \( p < 0.05 \). Unpaired, two-tailed, equal variance \( t \) tests were performed for statistical analyses in Microsoft Excel 2010 (Microsoft, Redmond, WA, USA). The 95% confidence intervals were determined using the Confidence Interval Calculator for Proportions (Online, McCallum-Layton; 2010).

**Results**

**Patient population**

Twenty-five patients with spinal sarcomas were treated over a 10-year period. Mean age at the time of diagnosis was 42 years (range 17–75 years) and the disease was found predominantly in women (56%). The mean age at presentation differed by the type of tumor. Chondrosarcoma (46.7±10.4 years) and osteosarcoma (48.8±23.5 years) presented at an older mean age than other sarcomas (36.2±18.0 years). Median length of stay after surgery was 16 days (range 4–52 days). Median follow-up time was 11.8 months (range 0.1–71.6 months).

**Clinical presentation**

Pain was present at the time of diagnosis of most patients (92%). Pathologic fractures were typically not present at the time of diagnosis (12%). Myelopathy was present in most patients (68%), more so in cases involving chondrosarcoma (67%) and osteosarcoma (100%) than other sarcomas (58%). Cauda equina was absent in most patients (16%). Ten patients (40%) had undergone a previous spinal tumor resection. Preoperative Frankel scores of the sarcoma patients were C (28%), D (36%), and E (36%).

**Surgical approach**

Chondrosarcoma and osteosarcoma were found predominantly in the cervical, thoracic, or lumbar spine, whereas other sarcomas are more common in the sacral spine. The median number of vertebral levels involved was three (range 1–7). A posterior approach was used most commonly (56%), followed by surgeries involving both anterior and posterior approaches (40%). The most common procedure was a laminectomy or hemilaminectomy, which was performed in 15 cases (60%). The most common type of reconstruction used was an allograft (48%), followed by the use of a titanium cage (32%). Often, chondrosarcoma patients underwent no form of reconstruction (60%).

**Adjuvant treatment**

Adjuvant treatment was used in 15 cases (60%). Six patients received preoperative chemotherapy (24%), 4 received postoperative chemotherapy (16%), 7 underwent preoperative radiation (28%), and 10 underwent postoperative radiation (40%). Local recurrence occurred in six cases (24%).

**Complications**

Complications noted earlier than 30 days postoperatively (early complications) and later than 30 days (late complications) were stratified by either en bloc or intraleisional resection. In the en bloc resection group, five patients (33.3%) required reoperation secondary to wound dehiscence and three patients (20%) developed deep venous thrombosis in less than 30 days postoperatively. After 30 days postoperatively, four patients (26.7%) required reoperation for three cases of wound dehiscence and one case of instrumentation failure that resulted in the loss of correction of deformity. The other two cases of instrument failure did not have any loss of deformity correction and no operative intervention was pursued. In the intraleisional resection group, two patients (20%) required reoperation secondary...
to wound dehiscence and postoperative hematoma, and one patient (10%) developed deep venous thrombosis in less than 30 days postoperatively. After 30 days postoperatively, there was one complication of esophageal erosion requiring revision surgery to remove the cervical plate in the intrale- sional group. (Table)

### Patient survival

Median survival after surgery for chondrosarcoma was 59.5 months (range 0.2–70.6 months), undefined for other sarcomas (range 0.2–26.5 months), and 16.8 months for osteosarcoma (range 0.5–28.5 months) (Fig. 1). The difference in survival was not statistically significant on Mantel-Cox testing (p = .27). Median survival after en bloc resection was undefined. Median survival after intralesional resection was 17.8 months (Fig. 2). Survival after en bloc resection was significantly different than survival after intralesional resection on Gehan-Breslow-Wilcoxon test (p = .049). The survival difference was not statistically significant on Mantel-Cox testing (p = .07).

### Discussion

This subset of malignant spinal tumors encompasses chondrosarcomas, osteosarcomas, and a variety of other sarcomatous tumors, including Ewing sarcoma. Although previous studies have examined the broad epidemiologic outcomes of patients at multiple institutions, these studies did not investigate outcomes relative to the specifics of treatment [10–12]. Our review highlights the important aspects of surgical management, namely the benefit of en bloc resection for spinal sarcoma.

Surgical management of sarcomas is diverse and is dependent on the location of tumor burden. For example, the orthopedic literature recommends wide excision or amputation of extremity sarcoma when feasible, with the use of adjuvant treatments such as phenol, radiation, and chemotherapy as needed [13]. En bloc strategies available to patients include corpectomy, sacral amputations, and finally, hemipelvectomy [14]. However, surgical resection of spinal sarcomas cannot extend this concept of amputation at mobile spine levels because of the necessity of adjacent anatomical structures. The results of this study suggest that en bloc resection, when feasible, should be offered to patients with diverse sarcomatous pathologies in the spinal column to optimize patient survival.

Chondrosarcoma patients have shown to have a 5-year survival rate close to 70% and a median survival ranging from 70 to 160 months [15–17]. Our data showed a median survival of 60 months. This variation can be accounted for in part by our small patient pool (10 chondrosarcoma patients) and with not all patients reaching 5 years of follow-up (median follow-up 11.8 months, range 0.1–71.6). Osteosarcoma patients are shown to have a median survival range from 7 to 23 months [18,19]. Our data demonstrate that the osteosarcoma patients had a median survival of 16.8 months (range 0.5–28.5 months) for osteosarcoma (range 0.5–28.5 months).
survival of almost 17 months. This is in accordance with previously published data from Schwab et al., who noted increased survival of 60 months in their cohort of 17 patients over two decades [20].

Prior studies have shown that an en bloc resection of spinal sarcomas with adequate margins decreases the recurrence rates [21–23]. However, a number of other studies have shown the dangers of an en bloc resection in the spine, including the increased morbidity of the procedure and the varying difficulties in different locations of the spine [24–26]. Through our database, we have shown that en bloc resection of spinal sarcomas does increase the patient survival as compared with purely intralesional resection (p = .049).

The authors acknowledge the limitations of this study. This study was limited by its small cohort size, which resulted in some of the trends observed not reaching statistical significance. Our findings add to the growing amount of sarcoma literature, with a focus on cancer varieties and surgical approaches. In the future, these studies can be used to provide a better quality of care to patients affected by the disease.

Conclusion

Sarcomas of the spine are a unique group of highly aggressive and malignant spinal tumors that represent a surgical and management challenge for the surgeon and the entire health-care team. Reports continue to demonstrate high morbidity and mortality in this population. However, the results of this study suggest that en bloc resection of these tumors, when possible, may increase patient survival. Continued improvement in surgical and adjuvant treatments will undoubtedly continue to further alter the survival curve for this population of spinal tumors.

References