Surgical management of primary and metastatic sarcoma of the mobile spine

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Object. Sarcomas of the spine are a challenging problem due to their frequent and extensive involvement of multiple spinal segments and high recurrence rates. Gross-total resection to negative margins, with preservation of neurological function and palliation of pain, is the surgical goal and may be achieved using either intralesional resection or en bloc excision. The authors report outcomes of surgery for primary and metastatic sarcomas of the mobile spine in a large patient series.

Methods. A retrospective review of patients undergoing resection for sarcomas of the mobile spine between 1993 and 2005 was undertaken. Sarcomas were classified by histology study results and as either primary or metastatic. Details of the surgical approach, levels of involvement, and operative complications were recorded. Outcome measures included neurological function, palliation of pain, local recurrence, and overall survival.

Results. Eighty patients underwent 110 resections of either primary or metastatic sarcomas of the mobile spine. Twenty-nine lesions were primary sarcomas (36%) and 51 were metastatic sarcomas (64%). Intralesional resections were performed in 98 surgeries (89%) and en bloc resections were performed in 12 (11%). Median survival from surgery for all patients was 20.6 months. Median survival for patients with a primary sarcoma of the spine was 40.2 months and was 17.3 months for patients with a metastatic sarcoma. Predictors of improved survival included a chondrosarcoma histological type and a better preoperative functional status, whereas osteosarcoma and a high-grade tumor were negative influences on survival. Multivariate analysis showed that only a high-grade tumor was an independent predictor of shorter overall survival. American Spinal Injury Association scale grades were maintained or improved in 97% of patients postoperatively, and there was a significant decrease in pain scores postoperatively. No significant differences in survival or local recurrence rates between intralesional or en bloc resections for either primary or metastatic spine sarcomas were found.

Conclusions. Surgery for primary or metastatic sarcoma of the spine is associated with an improvement in neurological function and palliation of pain. The results of this study show a significant difference in patient survival for primary versus metastatic spine sarcomas. The results do not show a statistically significant benefit in survival or local recurrence rates for en bloc versus intralesional resections for either metastatic or primary sarcoma of the spine, but this may be due to the small number of patients undergoing en bloc resections.

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Key Words • chondrosarcoma • histology • metastasis • sarcoma • spine

Primary and metastatic sarcomas of the spine present a significant treatment challenge. These tumors may involve multiple levels of the spine, the paraspinal musculature, and the epidural space; accordingly, many patients present with progressively worsening pain and/or neurological deficit. As a general principle, musculoskeletal sarcomas are most effectively treated using resection with chemotherapy and radiotherapy used in the adjuvant or neoadjuvant setting.3 Resection should improve or preserve function, palliate pain, and, if possible, provide a survival benefit and minimize local recurrence. Outcomes of surgery for spinal sarcomas are drawn from a few large patient series and several case reports, most of which describe the results of various surgical techniques and heterogeneous pathologies.1,2,5,7,8,15,16,19,20,23,25,31,33–35,41–43,45,49,50,52,57–60,62,63,66

71,72,73,77,81 Taken together, the existing literature from large patient populations supports a paradigm of aggressive resection of spinal sarcomas for providing neurological and functional improvement and possibly extending patient survival.

In extraspinal sites, en bloc resection with negative margins (marginal or wide) has been shown to offer the best opportunity for local tumor control and long-term patient survival.13,14,16,18,21,24,36,37,45,49,50,52,57–60,62,63,66,71,72,73,77,81 This approach has been

Abbreviations used in this paper: ASIA = American Spinal Injury Association; CI = confidence interval; LOS = length of stay; NRS = Numerical Rating Scale; RR = rate ratio.
Advocated because it allows maximum tumor resection and a decreased likelihood of leaving residual tumor. Application of a similar strategy to the resection of spinal sarcomas should presumably provide similar benefits. Resection, including removal of affected bone elements and using complex stabilization techniques, has been shown to be superior to laminectomy alone for treatment of metastatic spine tumors. Recently, surgical techniques for en bloc excision of tumors (either primary or metastatic) involving the cervical, thoracic, and lumbar spine have been developed. The terminology and surgical staging described for primary bone tumors of the spine may also be applied to spinal sarcomas in an effort to facilitate consistent descriptions of these tumors and appropriate surgical treatment. In general, en bloc excisions are technically complex, require extensive reconstruction methods, and are ideally performed in favorable anatomical situations in which the tumor can be resected without violating the tumor capsule. These constraints may limit the instances in which such techniques can be effectively utilized. Application of these methods, however, has been shown to result in improved local tumor control and longer patient survival in specific malignancies, as surgical series may help in developing treatment strategies for individual patients with sarcoma involving the spine. Moreover, with continuing advances in operative techniques, radiation therapy, and chemotherapy, it is important to document and critically examine a historical cohort to provide a context within which these newer strategies can be evaluated. We reviewed the experience at The University of Texas M. D. Anderson Cancer Center with resected primary and metastatic sarcomas of the cervical, thoracic, and lumbar spine with particular attention to the factors predictive of patient survival and local tumor recurrence.

Methods

Patient Population

A retrospective review of prospectively collected data from patients undergoing surgery for either primary or metastatic sarcoma of the mobile spine was performed. The Multidisciplinary Brain and Spine Center database at The University of Texas M. D. Anderson Cancer Center was utilized. Patients treated between 1993 and 2005 were included in this study.

Tumor Classification

Intralesional resections were defined as those in which a primary or metastatic sarcoma of the mobile spine was performed. The Multidisciplinary Brain and Spine Center database at The University of Texas M. D. Anderson Cancer Center was utilized. Patients treated between 1993 and 2005 were included in this study.

Tumor Classification

Sarcomas were classified as primary or metastatic. Tumors were considered primary if no other site of origin was determined throughout the treatment period. Tumors were considered metastatic if a primary site of origin elsewhere was known. Sources of metastatic tumor included: an extremity, the uterus, paraspinal musculature, other region of the axial skeleton, head/neck, chest, abdomen/pelvis, retroperitoneum, and unknown. We determined if the sarcoma was induced by radiation for treatment of another malignancy. The histological types of each sarcoma were identified and confirmed by a pathologist at M. D. Anderson Cancer Center. These types included: chondrosarcoma, leiomyosarcoma, liposarcoma, rhabdomyosarcoma, synovial cell sarcoma, unclassified sarcomas, and other (including alveolar soft part sarcomas, meningioma sarcomas, and malignant fibrous histiocytoma). Sarcomas were further dichotomized according to the classification of Enneking and colleagues of soft tissue sarcomas as either high (G2) or low (G1) grade. Low-grade tumors are well differentiated, have few mitoses, and moderate cytologic atypia. High-grade lesions are characterized by poor differentiation, a high cell/matrix ratio, a high mitotic rate, necrosis, and microvascular invasion. We excluded patients with other mesenchymal tumors such as chordoma and radiosensitive tumors such as Ewing sarcoma. Our study involving a series of patients with Ewing sarcoma of the mobile spine has been previously reported. Tumors exclusively in the sacrum were excluded because the experience with this group of patients has already been reported by our institution and because the anatomical and biomechanical considerations for resection of sacral tumors are unique. The study proposal was reviewed and approved by the Institutional Review Board.

Data recorded included: demographic information, surgical dates, types of surgical procedures performed, surgical approach, type of resection, levels of disease, preoperative and 3-month postoperative ASIA scale grades, severity of pain both preoperatively and approximately 3 months postoperatively based on the NRS, surgical complications, length of follow-up, tumor recurrences, and survival status.

Using the terminology described by Borian and colleagues, en bloc excisions were specifically defined as those in which the surgeon’s intent was to remove the tumor mass as a single specimen without disruption of the tumor capsule to minimize potential contamination of the resection cavity with tumor cells (Fig. 1). Ultimately, the pathologist’s review of the surgical specimen determined whether the margin was intraskeletal, marginal, or wide. En bloc resections, when technically feasible, were offered to patients with either primary tumors or metastatic lesions. The decision to attempt an en bloc or intraskeletal resection was based on multiple factors. Although not absolute, patients with a single site of disease in the spine (either from a primary or metastatic sarcoma) were considered more suitable for en bloc resection. The feasibility of an en bloc resection was also a major consideration.

The method of en bloc excision was generally based on the location of the tumor within the vertebra using the Weinstein, Boriani, and Biagini staging system as described by Boriani et al., which divides the vertebra into 12 sectors in a clock-face arrangement, in addition to 5 concentric tissue layers. Although we applied the Weinstein, Boriani, and Biagini staging system to our en bloc excision cases, we did not rely on this system exclusively to determine our surgical approach.

Intraskeletal resections were defined as those in which a tumor was removed in a piecemeal fashion. Typically, resection of the involved bone elements was performed using curettage or a high-speed drill. Contamination of the resection cavity with tumor was expected in these cases although a gross-total resection may have been achieved.
Several surgeries were performed as staged procedures (particularly for en bloc resections) and were counted as a single surgical procedure although they may have been separated by an interval of 2–3 days. Recurrent lesions requiring resection were counted as additional surgeries. Complications recorded included any major medical complications (we excluded minor complications such as urinary tract infections, limited febrile illnesses, or postoperative ileus), hardware failure, or neurological compromise within 30 days of surgery. Complications were identified by reviewing the medical record. Death within 30 days of an operation was also recorded.

**Data Analysis**

Frequencies and descriptive statistics of demographic and clinical variables were performed. The chi-square and Fisher exact tests were used for categorical variables, and the t-test and Mann–Whitney U-test were used for continuous and ordinal variables as appropriate. The Wilcoxon signed-rank test was used to compare the paired outcomes at various follow-up points. The Kaplan–Meier method was used to estimate postoperative survival, and survival curves were compared using a log-rank test. Univariate and multivariate predictors of overall survival and local recurrence were assessed using the Cox proportional hazards model. The predictors investigated were: age, sex, months from diagnosis to surgery, pre- and postoperative ASIA scale grades, pre- and postoperative NRS scores, histological type, tumor grade (dichotomized as high or low), status of systemic disease (progressing or stable), whether or not the patient’s cancer was recurrent, if the spine tumor was a recurrence, type of surgical approach (posterior, anterior, or combined), and type of resection (en bloc or intralesional). Rate ratios and their corresponding 95% CIs were computed. A probability value \( \leq 0.05 \) was considered statistically significant.

**Results**

Eighty patients underwent 110 surgeries for resection of either a primary or metastatic sarcoma of the spine at the
Surgical management of spine sarcoma

M. D. Anderson Cancer Center between 1993 and 2005. There were 39 males (49%) and 41 females (51%). The median patient age at the time of diagnosis of the sarcoma was 48 years (range 8–75 years). The median patient age at the time of the index surgery was 51 years (range 9–77 years). Primary sarcomas were resected in 29 patients (36%); and metastatic sarcomas were resected in 51 patients (64%). Seven (9%) sarcomas were radiation-induced. The median age at the time of index surgery for patients with a primary spine sarcoma was 49 years (range 9–77 years), and for patients with a metastatic spine sarcoma was 53 years (range 24–73 years). For patients with a metastatic sarcoma, the median time from diagnosis of their primary sarcoma to their spinal metastasis was 32 months (range 0–127 months). Fifty-eight patients had died and 22 were alive at the last study follow-up. The median follow-up duration after resection among those 22 patients was 26 months (range 1–131 months).

Intralesional resections were performed in 68 (85%) of the 80 patients (representing a total of 98 of the 110 resections). Among the 110 operations, the most common location for a sarcoma of the spine was the thoracic spine. En bloc resections were performed in 12 patients (15%). All en bloc excisions achieved marginal or wide margins (that is, none were intralesional). No patient had a tumor that violated the dura. Six patients underwent en bloc resection of a primary spine sarcoma, and 6 underwent en bloc resection of a solitary metastatic spine sarcoma. The median postoperative LOS in the hospital for all procedures was 12.5 days (range 3–78 days). The median postoperative LOS in the hospital for en bloc resections was 17 days (range 5–41 days), and the median postoperative LOS for patients undergoing intralesional resections was 9 days (range 3–78 days). This difference was not statistically significant (p = 0.17).

Among all 80 patients, the most common tumor histological type was leiomyosarcoma (28%); followed by chondrosarcoma (26%; see Table 1 for the frequency of the other sarcoma histological types). Among the 110 procedures, the most common histological type was a chondrosarcoma (32%). In patients with a primary sarcoma of the spine, the most common histological type was a chondrosarcoma (55%). For patients with a metastatic sarcoma of the spine, the most common histological type was leiomyosarcoma (41%). The number of procedures per patient ranged from 1 to 5, with 58 patients (72.5%) undergoing 1 procedure. The 29 patients with primary sarcomas underwent a total of 47 procedures (range 1–5 procedures, with 66% undergoing 1 procedure). The 51 patients with metastatic sarcomas underwent a total of 63 procedures (range 1–2 procedures, with 76% undergoing 1 procedure). There were 11 complications recorded for 110 procedures (10%), including wound complications in 6 patients, hardware failure in 2 patients, neurological compromise in 1 patient (an epidural hematoma evacuated 6 hours after completion of the initial surgery resulting in improved neurological function), spinal instability in 1 patient, and pulmonary embolus in 1 patient. Complications occurred in 2 (17%) of the 12 en bloc resections; these complications were spinal instability after stabilization, necessitating another procedure for stabilization, and pulmonary embolus. The remaining 9 complications occurred in the other 98 intralesional resections (9%). The 30-day mortality rate was 0.

### Table 1

**Distribution of sarcoma histological types among the 80 patients with primary or metastatic sarcomas of the spine***

<table>
<thead>
<tr>
<th>Sarcoma Group</th>
<th>Histological Type</th>
<th>Primary</th>
<th>Metastatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>chondrosarcoma</td>
<td>16</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>leiomyosarcoma</td>
<td>1</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>osteosarcoma</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>liposarcoma</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>rhabdomyosarcoma</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>synovial cell sarcoma</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>unclassified sarcoma</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>other</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

* Data in columns represent numbers of patients. Some neoplasms were resected more than once.

### Functional Outcomes

Of the 110 procedures, 18 (16%) received a preoperative ASIA scale grade between A and C, whereas 92 (84%) had a grade of D or E. The preoperative and 3-month postoperative ASIA scale grades remained unchanged in 91 patients (83%), improved in 15 (14%), and worsened in 4 (3%). The Wilcoxon signed-rank test for the difference between preoperative and 3-month postoperative ASIA scale grades showed maintenance of neurological function with a trend toward statistical improvement (p = 0.11, Wilcoxon signed-rank test). Preoperative and 3-month postoperative NRS scores were unavailable for 13 procedures. For the remaining 97 procedures, NRS scores remained unchanged in 41 (42%), improved in 53 (55%), and worsened in 3 (3%). The median preoperative NRS score was 5 and the median postoperative NRS score was 2 (p < 0.001, Wilcoxon signed-rank test). The comparison of pre- and postoperative ASIA grades and NRS scores is displayed in Table 2.

We also evaluated functional outcomes for primary and metastatic sarcomas independently. In the 47 procedures performed for primary sarcomas, postoperative ASIA scale grades were unchanged in 39 procedures (83%), improved in 4 (8%) and worsened in 4 (8%). In the 63 procedures performed for metastatic sarcomas, postoperative ASIA scale grades were unchanged in 52 procedures (83%) and improved in 11 (17%), and no patient worsened. For the 41 procedures (with available NRS data) performed for primary sarcomas, the postoperative NRS score was unchanged in 19 (46%), improved in 21 (51%), and worsened in 1 (2%). For the 56 procedures (with available NRS data) performed for metastatic sarcomas, postoperative NRS scores remained unchanged in 22 (39%), improved in 32 (57%), and worsened in 2 (4%).

### Overall Survival

The Kaplan–Meier estimate for median overall survival of the 80 patients from the initial resection at M. D. Anderson Cancer Center was 20.6 months (95% CI 12.3–29.0 months).

**Tumor Type.** The type of tumor (primary vs metastatic) significantly affected survival. Patients with primary sarcomas had a median survival of 40.2 months (95% CI 0–131 months).
months (95% CI 10.9–23.7 months; p = 0.01, log-rank test; Fig. 2). Based on this finding we analyzed the survival data from the primary and metastatic tumor subgroups separately."

**En Bloc Versus Intralesional Resections.** For all cases, patients with en bloc resection had a median survival of 26.2 months (95% CI 0.4–52.0 months), and those with intralesional resection had a median survival of 18.6 months (95% CI 13.3–24.0 months). This difference was not statistically significant (p = 0.51, log-rank test). For primary sarcomas, patients undergoing intralesional resections had a median survival of 40.2 months (95% CI 0.0–83.4 months). Less than 50% of patients undergoing en bloc resections reached the end point of death in the Kaplan–Meier estimate. The difference in the Kaplan–Meier estimates between the 2 groups was not statistically significant (p = 0.68, log-rank test). Patients with metastatic sarcomas undergoing intralesional resection had a median survival of 17.3 months (95% CI 13.4–21.2 months), and those undergoing an en bloc resection had a median survival of 26.2 months (95% CI 2.1–50.3 months). This difference was also not statistically significant (p = 0.57, log-rank test). The lack of a statistically significant prognostic effect of method of resection in these patient subgroups was likely attributable to the small number of patients with en bloc resection rather than to a true lack of a prognostic effect, and the differences were deemed potentially clinically significant. As a result, we also performed secondary analyses in the subgroups of primary and metastatic tumors excluding the patients with en bloc resections. These analyses did not produce any new findings (data not shown).

**Histological Type.** The median duration of survival for patients with each histological type is presented in Table 3. Among the classified histological types, osteosarcoma had the most negative influence on overall survival in the whole group; patients with osteosarcoma had a median survival of 6.5 months (95% CI 6.3–6.7 months) compared with a median survival of 26.2 months (95% CI 17.1–35.3 months) for patients with other types (p < 0.0001, log-rank test). This statistically significant negative influence was apparent in both the metastatic and primary sarcoma subgroups (medians 6.4 and 6.5 months, respectively). Conversely, chondrosarcoma had a positive influence on overall survival; patients with this type had a median survival of 56.5 months (95% CI 19.6–93.5 months) compared with 16.3 months (95% CI 11.5–21.2 months) for patients with other histological types (p < 0.001, log-rank test). With the exception of the 1 patient with metastatic rhabdomyosarcoma who survived 35.2 months, patients undergoing surgery for a primary or metastatic chondrosarcoma had longer median survival durations (70.8 and 33.3 months, respectively) than patients with other histological types (13.0 and 16.3 months, respectively), although the difference was not statistically significant in the metastatic sarcoma group. Neither histologic type remained as an independent predictor of survival in the various multivariate analyses.

**Tumor Grade.** The tumor grade had a significant impact on patient survival. Patients with a high-grade tumor had a median survival of 14.0 months (95% CI 9.4–18.6 months). Patients with a low-grade tumor had a median survival of 33.3 months (95% CI 14.8–51.8 months; p = 0.002, log-rank test). This statistically significant negative influence of a high-grade tumor was apparent in both the metastatic and primary sarcoma subgroups. Of the 12 procedures performed as en bloc resection, 8 (67%) were for a high-grade sarcoma and 4 (33%) were for a low-grade sarcoma. Of the 98 procedures performed as intralesional resections, 70 (71%) were for patients with high-grade sarcomas and 28 (29%) were for patients with low-grade sarcomas.

**Functional Status.** Patient preoperative functional status had a significant impact on overall survival. Patients with an ASIA scale grade of A–C had a median survival of 6.7 months (95% CI 0.0–18.2 months); those with a grade of D or E had a median survival of 22.2 months (95% CI 13.8–30.6 months; p = 0.02, log-rank test). Unfortunately, the distribution of the data did not allow adequate adjustment for the effect of functional status in the multivariate or subgroup analyses. The effect of the other prognostic factors was assessed in patients with a good preoperative functional status (ASIA Grade D or E). These analyses did not
alter the findings (data not shown). Of the 12 procedures performed as en bloc resections, all patients (100%) were ASIA Grade E. Of the 98 procedures performed as intrale- sional resections, 11 (11%) were for patients who had ASIA scale grades of A–C, and 87 (89%) were for patients who had ASIA scale grades of D or E.

**Patient Age.** The prognostic effect of age in this patient population was apparent at the 70-year cut-off point; however, only 6 patients were ≥ 70 years of age. There was no significant difference in survival duration when the median age of 51 years was used as the cut-off point (p = 0.63, logrank test). No significant effect of age was observed in the metastatic group, but among patients with a primary tumor, those < 65 years old had significantly longer survival duration than their older counterparts (p < 0.05), but this difference was based on very few patients.

**Active Systemic Disease.** The presence of active extraspinal systemic disease (including primary spinal disease that spread outside the spine) at the time of surgery did not significantly impact survival duration; those patients with active extraspinal systemic disease had a median survival duration of 17.8 months (95% CI 14.9–20.7 months) compared to a median of 22.2 months (95% CI 19.7–24.7 months). The difference between the 2 groups was not statistically significant (p = 0.35, log-rank test). Similarly, there was no effect in the subgroups of patients with metastatic or primary sarcomas.

In all analyses, a high-grade tumor was the only consistent statistically significant independent predictor of short-er overall survival (p = 0.05), although the prognostic role of age (mainly among patients with primary tumors), osteo- sarcoma and chondrosarcoma histological types, and preoperative functional status cannot be dismissed.

**Local Recurrence**

Similar to the findings from the survival analysis, factors such as a high tumor grade (RR = 2.5, 95% CI 1.2–5.3; p = 0.01) and an osteosarcoma histological type (RR = 6.4, 95% CI 2.2–18.3; p = 0.001) were associated with significantly higher rates of local recurrence, whereas the method of resection and the activity of the systemic disease were not. On the other hand, neither the source of the tumor (primary vs metastatic), a chondrosarcoma histological type, or the patient’s age affected the rates of local recurrence. A locally recurrent spine tumor was more likely to recur locally as opposed to distally after surgery (RR = 1.9, 95% CI 1.1–3.6; p = 0.05). A poor preoperative functional status (ASIA Grade A–C) had a RR of 2.2 (95% CI 0.8–5.7), but that ratio did not reach statistical significance (p = 0.11). Patients with a primary spine sarcoma undergoing an intrale- sional resection had a local recurrence rate of 65%, whereas patients undergoing an en bloc resection had a local recurrence rate of 20%. Furthermore, patients with a primary spine sarcoma undergoing an intrale- sional resection had a duration until local recurrence of 27.2 months (95% CI 14.1–40.42 months). Less than 50% of the patients with a primary spine sarcoma undergoing en bloc resections reached the end point of local recurrence in the Kaplan–Meier estimate; however, this difference was not statistically significant (p = 0.90). For metastatic spine sarcomas, patients undergoing an intrale- sional resection had a local recurrence rate of 35%, whereas patients undergoing an en bloc resection had a local recurrence rate of 25%. Patients with a metastatic spine sarcoma undergoing an intrale- sional resection had a median time to recurrence of 22.7 months (95% CI 0.2–45.24 months). Less than 50% of patients with metastatic sarcomas reached the end point of local recurrence in the Kaplan–Meier estimate, a difference that was not statistically significant (p = 0.36). In the sub- group analyses, high tumor grade and osteosarcoma histo- logical type were the most significant predictors of local recurrence in the primary and metastatic tumor subgroups, respectively.

**Discussion**

Sarcomas of the spine, either primary or metastatic, are rare and treatment options are limited. Surgery is a major component of a multimodal therapeutic effort with mainte- nance or improvement in functional status, relief of pain, local tumor control, and possible cure as the major goals of treatment. Although spinal sarcomas may have an indolent course, patients typically present with significant pain, and neurological deficits are not uncommon. Resection of spinal tumors (with subsequent stabilization) has been shown to result in an improved quality of life for the patient, even

<table>
<thead>
<tr>
<th>Histological Type</th>
<th>Primary</th>
<th>Metastatic</th>
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<tbody>
<tr>
<td>chondrosarcoma</td>
<td>70.8 (ND)</td>
<td>33.3 (20.4–46.6)</td>
</tr>
<tr>
<td>leiomyosarcoma</td>
<td>—</td>
<td>13.9 (9.2–18.6)</td>
</tr>
<tr>
<td>liposarcoma</td>
<td>53.2 (ND)</td>
<td>28.8 (25.9–31.8)</td>
</tr>
<tr>
<td>osteosarcoma</td>
<td>6.4 (7.3–9.2)</td>
<td>6.40 (4.8–8.1)</td>
</tr>
<tr>
<td>synovial cell sarcoma</td>
<td>20.6 (1.4–40.2)</td>
<td>11.2 (ND)</td>
</tr>
<tr>
<td>rhabdomyosarcoma</td>
<td>no cases</td>
<td>35.2 (ND)</td>
</tr>
<tr>
<td>unclassified</td>
<td>4.0 (0.21–7.8)</td>
<td>14.3 (6.3–22.2)</td>
</tr>
<tr>
<td>other</td>
<td>—</td>
<td>20.7 (ND)</td>
</tr>
</tbody>
</table>

*Survival duration given in months (95% CI). Abbreviations: ND = not defined; — = all observations censored.

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in those with limited survival. The use of modern surgical techniques (which include circumferential spinal decompression and complex stabilization) are known to result in significant improvement in a patient’s neurological status. This subsequent improvement is an important indication for surgical intervention because quality of life for these patients is severely affected by their ability to ambulate. In this retrospective study of patients undergoing resection for primary or metastatic sarcomas of the spine, we show maintenance or improvement in neurological outcome in 97% of patients. Moreover, pain was significantly improved postoperatively (median preoperative NRS score = 5, median postoperative NRS score = 2; p < 0.001). Given an overall survival duration of > 20 months following initial surgery, maintenance of neurological function and relief of pain are of critical importance.

Previous studies have not demonstrated a significant difference in patient survival between primary and metastatic sarcomas, suggesting that these 2 groups may be homogeneous. Our results indicate a significant difference in survival between metastatic and primary sarcomas, although these groups have similar factors influencing survival and local recurrence. For both primary and metastatic spine sarcomas, factors associated with longer survival included a low-grade tumor, a chondrosarcoma histological type, and patient age < 65 years, whereas an osteosarcoma was associated with shorter survival. The only predictors of a higher rate of local recurrence for patients undergoing surgery for a primary or metastatic spine sarcoma were high tumor grade and osteosarcoma histological type. Our results call attention to the differences in primary and metastatic tumors with respect to patient survival, but similar factors may impact survival and local recurrence in both groups. Chondrosarcoma stands out as a common positive predictor of survival, whereas osteosarcoma appears to be a negative predictor. No difference in survival could be demonstrated for the other sarcoma histological types individually. The influence of these histological subtypes underscores the importance of individualizing treatment for patients with sarcoma involving the spine.

We were unable to determine the impact of chemotherapy on survival, local recurrence rates, and complications as these regimens vary widely depending on each histological type. Furthermore, these disparate regimens were applied at various intervals during the course of treatment of individual patients. Thus a rigorous statistical evaluation of their influence was not possible, which may be viewed as a limitation of the study, but chemotherapeutic agents have demonstrated a modest survival benefit for certain histological types at best. Although radiation therapy plays a role, resection generally provides the best hope of preventing recurrence and prolonging survival in patients with sarcoma. Surgical extirpation of primary or metastatic sarcomas of the spine may be accomplished using intraleSIONAL resection. Intralesional resection of spine sarcomas has proven to be useful in protecting neurological function but shows high rates of local recurrence. Based on the lessons learned from treating sarcomas of the extremities, in which en bloc resection with wide margins is advocated for tumor control, many spine surgeons have begun to use en bloc excision to treat spine sarcomas. Several investigators have described en bloc resections for various types of spinal tumors. A palliative benefit has been demonstrated for patients undergoing en bloc resections, despite the fact that these operations tend to be more extensive. These are difficult procedures requiring ideal anatomical conditions, extensive surgical approaches, and application of complex instrumentation for stabilization of the spine. Use of en bloc excision techniques is limited to those patients in whom the location of the tumor and its relationship to critical neural, vascular, and visceral structures are favorable for complete extralesional removal. Whereas others have described their experiences with en bloc resection for a variety of lesions, few have reported a statistical comparison with established intraleSIONAL resection techniques.

One purported benefit of en bloc resection is the decreased incidence of local recurrence. Many studies (including ours) that report outcomes for en bloc resection of spinal tumors are hindered by small patient populations, heterogeneous tumor types, and limited follow-up. Tomita and associates reported local recurrences in 2 of 7 patients undergoing en bloc excisions for primary spinal tumors, but they reported on a heterogeneous group of tumors, including “aggressive benign tumors” such as solitary plasmacytomas and giant cell tumors. They did not include a comparison to a control group, and median follow-up was not reported (although a follow-up range of 2–6.5 years was reported).

In their retrospective reviews of surgery for chordoma and chondrosarcoma, Boriani and colleagues suggested that en bloc resection results in prolonged survival and is superior to intraleSIONAL resection in providing local tumor control. In their retrospective study of 22 patients with chondrosarcomas over a 60-year period, en bloc excisions (in 12 of 22 patients) resulted in a 21% recurrence rate with a 90% overall survival rate (mean follow-up 97 months). Patients undergoing an intraleSIONAL resection had a 100% recurrence rate with a 20% overall survival rate (mean follow-up 61 months). However, these investigators did not provide a statistical comparison between these 2 populations regarding local recurrence rates or survival.

Our study did include a comparison group of patients undergoing intraleSIONAL resections. Given the nature of the study group, however, our retrospective review included a heterogeneous group of sarcoma histological types and a small number of patients overall and in the en bloc resection group. Moreover, 6 of 12 patients underwent en bloc resection for solitary metastatic disease, which puts them at a survival disadvantage. In our patient series, local recurrence rates were lower for en bloc resections when compared with intraleSIONAL resections for patients with either primary or metastatic sarcoma. However, we were unable to show statistically significant differences that en bloc excisions of primary or metastatic sarcomas result in prolonged survival or a lower local recurrence rate compared with intraleSIONAL resections. Certainly, long-term follow-up of our surviving patients and continued utilization and refinement of en bloc resection techniques will clarify the role of aggressive surgery in the management of spinal sarcomas.

Conclusions

Sarcomas of the spine, either primary or metastatic, are...
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rare, and treatment options limited. Surgery remains an important option for providing a palliative and functional benefit while potentially extending survival. Our results show that patients with primary and metastatic spine sarcomas have very different survival characteristics, but similar predictors of survival and local tumor recurrence.

References


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