Acta Orthop. Belg., 2013, **79**, 457-462

ORIGINAL STUDY

Primary osteosarcoma of the spine
A review of 10 cases

Jason B.T. Lim, Himanshu Sharma, Elaine MacDuff, Anthony T. Reece

From the Western Infirmary, Scottish Bone Tumour Registry, Glasgow, U. K.

The authors describe 10 cases of osteosarcoma of the spine treated between January 1951 and December 2010, and obtained from the Tumour Registry of their hospital. The mean age at presentation was 38.8 years (range : 16-73 years) ; the mean duration of symptoms was 5.1 months (range : 3 weeks-1 year). Pain was the commonest complaint (9 patients), followed by neurological compromise (6 patients). The thoracic spine and male gender were predominant. Seven patients underwent marginal resection, 3 underwent intralesional resection. All, except one, had adjuvant chemotherapy and radiotherapy, pre- and/or postoperatively. This rare sarcoma has a dismal prognosis : the median survival period was only 2.3 years. The 1-year, 3-year and 5-year survival rates were 80%, 40% and 20%. Astonishingly, marginal resection (7 cases) did not lead to a longer survival than intralesional resection (3 cases) : respectively 30 months and 42 months. Quite logically, local recurrence in 6 patients was linked to a survival of only 36 months, while the other 4 patients survived 52 months. Age below 40 was a positive factor, but not significantly. All patients had a reasonable quality of life with outcomes consistent with the available literature. Recent literature stresses that there is a trend toward improved survival with en bloc resection.

Keywords : osteosarcoma ; spine.

INTRODUCTION

Primary osteosarcoma of the spine is rare, accounting for 0.85-3% of all osteosarcomas (*1*) and for 3.6-14.5% of all primary tumours of the spine (*4,10,16*). The literature is scarce, due to its low incidence. The optimal treatment strategy is controversial and often guided by the results of various small series and case reports.

The treatment of choice is wide excision of the tumour, which has been reported to have a high local control rate (*13*). Combined chemotherapy and irradiation has been recommended and may be beneficial for some patients. The prognosis of osteosarcoma has remained poor, but in recent years

■ Jason B.T. Lim, MBChB (Hons), MRCSEd, Orthopaedic Resident.
Department of Orthopaedic Surgery, Singapore General Hospital, Republic of Singapore.
■ Himanshu Sharma, FRCS (Tr &Orth), Consultant Orthopaedic Spinal Surgeon.
Spinal Unit, South West Neurosurgery Centre, Derriford Hospital, Plymouth, Devon, United Kingdom.
■ Elaine MacDuff, FRCPath, Consultant Pathologist.
University Department of Pathology and Scottish Bone Tumour Registry, Western Infirmary, Glasgow, United Kingdom.
■ Anthony T. Reece, FRCS (Ortho), Consultant Orthopaedic Spinal Surgeon.
Department of Orthopaedic Surgery, Western Infirmary, Glasgow, United Kingdom.
Correspondence : Jason Beng Teck Lim, 2 South Buona Vista Rd, Singapore (118135), Republic of Singapore.
E-mail : jason.lim@mohh.com.sg

No benefits or funds were received in support of this study.
The authors report no conflict of interests.

aggressive neo-adjuvant and adjuvant chemotherapy have improved the treatment outcome (*1,14,15,18, 19,20*).

PATIENTS AND METHODS

The hospital Tumour Registry yielded 10 cases between January 1951 and December 2010. All patients were followed-up until death.

The statistical analysis was performed using SPSS (Version 18, Chicago, IL). Kaplan-Meier curves were used for survival analysis. The log-rank (Mantel-Cox) test was used to compare the survival analysis between two patient groups (6 below and 4 above age 40). A p value < 0.05 was seen as statistically significant.

RESULTS

The study population (Table I) comprised 7 male (70%) and 3 female (30%) patients. The mean age at presentation was 38.8 years (range : 16-73 years), the median age 39 years. The mean follow-up period was 2.8 years. All 10 patients were dead at the time of review.

The mean duration of symptoms at presentation was 5.1 months (range : 3 weeks-1 year). Pain was the most common presenting complaint, occurring in 9 patients (90%), followed by neurological compromise in 6 patients (60%). The only patient (case 7) who did not experience any pain presented primarily with cord compression symptoms (paresthesiae which progressed to quadriparesis).

Five of the 9 patients whose initial problem was pain subsequently developed neurological compromise. Three of these had cord compression symptoms (paraesthesiae, myelopathy or quadriplegia), while the other two developed a cauda equina syndrome with saddle paraesthesiae and incontinence.

Three cervical, 4 thoracic, one lumbar, and 2 sacral localizations were seen. Radiologically, a combination of osteoblastic and osteolytic lesions was noted (Fig. 1-3). All 10 patients had a definite histological diagnosis : primary 'conventional' osteogenic osteosarcoma.

All patients were treated surgically. Three patients (30%) had an intralesional resection (including open biopsy), and survived on an average 3 years and 6 months ; 7 patients (70%) had a marginal resection, and survived on average 2 years and 6 months, somewhat paradoxically. Nine patients received pre- and/or postoperative chemotherapy and radiotherapy. Four patients had no local recurrence and survived on an average 4 years and 4 months ; 6 patients had a local recurrence, and survived on an average 3 years and 1 month. The survival analysis of the patients above and below age 40, irrespective of metastases, showed that patients below age 40 survived on average 3 years and 5 months, while those above age 40 survived only 1 year and 9 months. The difference was not statistically significant, probably due to the small number of cases ($p = 0.117$). Two male patients below age 40 and with thoracic involvement survived more than 5 years. One (case 2) underwent intralesional resection with radiotherapy and adjuvant chemotherapy, and died of persistent disease. The other one (case 3) had a marginal resection without receiving any adjuvant therapy and subsequently had a recurrence at 4 years.

All but one patient died of the disease (persistent disease or lung metastases) with a median survival of 2.3 years. The 1-year, 3-year and 5-year survival rates were 80%, 40% and 20% (Figs. 4 & 5).

DISCUSSION

Most spinal surgeons will see only a few patients with an undiagnosed primary bone tumor of the spine during their entire career (*17*). Primary osteosarcoma of the spine is extremely rare (*1,10,18*). The authors found only 10 cases in the hospital Tumor Registry in a 59 year period (1951 through 2010). The mean age at presentation was 38.8, the median age 39, in keeping with other series (*10,14*). Thus there was a tendency for spinal osteosarcoma to affect the older age group, in sharp contrast with appendicular osteosarcoma (*8*). There was a male predominance, in contrast to a slight female predominance in other series (*10,14*). The mean duration of symptoms at presentation was 5.1 months, similar to other reports (*2,14*).

Clinical picture

The principal modes of presentation for osteosarcoma of the spine are back pain and neurological

Table I. — Demographics and follow-up data of 10 patients with primary 'conventional' osteogenic osteosarcoma

Patient No.	Age / Sex	Site	Duration of symptoms	Clinical presentation symptoms	Pre-operative RT / CT	Surgery	Adjuvant RT / CT	Recurrence / Period after initial management	Survival / Cause of death
1	20 / F	L4, L5	2 months	Radicular leg pain	N	Marginal resection	Y	N	10 months / Persistent disease
2	16 / M	T9	1 year	Lower back pain, myelopathy (progressive unsteadiness and paraplegia)	N	Intra-lesional resection	Y	Y / 3 years	5 years and 1 month / Persistent disease
3	39 / M	T4	9 months	Intercostal root pain	N	Marginal resection	N	Y / 4 years	6 years and 5 months / Persistent disease
4	20 / M	Sacrum	6 months	Lower back pain, radicular leg pain	N	Intra-lesional resection	Y	N	4 years / Unrelated illness
5	41 / M	C5, C6	1 year	Neck pain and radicular arm pain	N	Marginal resection	Y	N	2 years and 3 months / Persistent disease
6	55 / F	C4	1.5 months	Neck pain and quadriplegia	N	Marginal resection	Y	Y / 9 months	12 months / Persistent disease
7	73 / M	C6–C8, T1	2 months	Upper limb paraesthesia and progressing to quadriparesis	N	Marginal resection	Y	N	2 years and 6 months / Persistent disease
8	60 / M	T9–T12	5 months	Lower back pain, buttock paraesthesiae, urinary and faecal incontinence	N	Intra-lesional resection	Y	Y / 4 months	1 year and 5 months / Lung metastases
9	25 / F	T4–T7	1 month	Lower back pain and loss of sensation from mid-thoracic level down	Y	Marginal resection	Y	Y / 2 years	3 years and 1 month / Lung metastases
10	39 / M	Sacrum	3 weeks	Lower back pain, radicular leg pain, buttock paraesthesia, urinary and faecal incontinence	Y	Marginal resection	Y	Y / 10 months	1 year and 2 months / Persistent disease

NB : M = Male, F = Female, C = Cervical, T = Thoracic, L = Lumbar, RT = Radiotherapy, CT = Chemotherapy, Y = Yes, N = No.

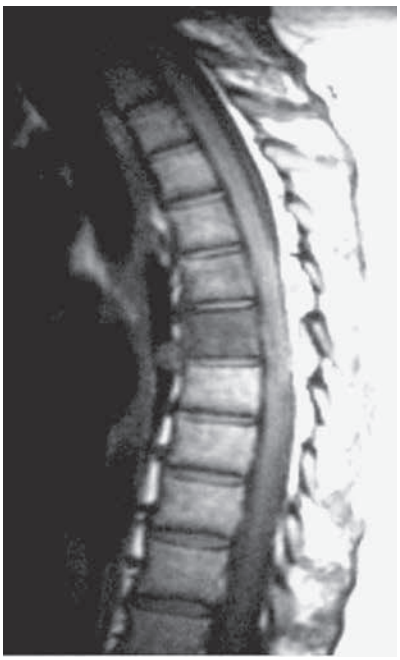

Fig. 1. — MRI scan (T1W) of the thoracic spine image showing malignant marrow replacement affecting T4-7 levels.

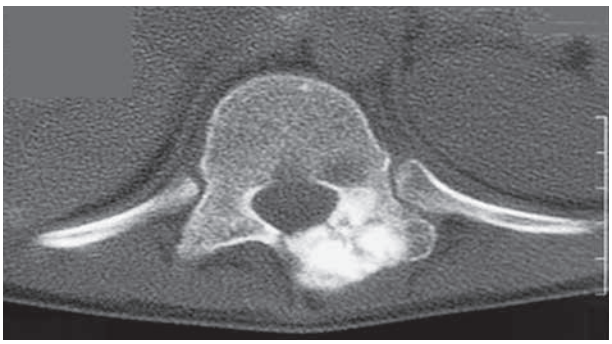

Fig. 2. — CT scan of thoracic spine axial slice showing mixed osteoblastic & lytic lesion affecting T11 vertebra.

Fig. 3. — MRI scan (T1W) of the thoracic spine showing malignant lesion of T7-9 vertebrae with paravertebral tissue infiltration and cord compression with complete block.

deficit (*1,2,5,7,10,14*). The authors noted a similar trend : a majority (90%) experienced non-mechanical back or radicular pain, followed in 60% by significant neurological compromise (either cord or cauda equina compression). Two patients with initial back pain developed an early neurological deficit which progressed to quadriplegia in 1.5 and 2 months. Patients presenting with non-mechanical back pain along with rapid neurological deterioration should raise the spectre of a primary spinal malignancy.

Osteosarcoma has been reported to occur at all levels of the spine, most frequently at the sacral level, followed by the lumbar, thoracic and cervical levels (*5*). In the current series, the most common site was the thoracic spine, followed by the cervical, sacral and lumbar spine.

Plain radiographs (*14*) and CT-scans display a mixture of osteoblastic and osteolytic areas. However, purely osteolytic lesions (moth-eaten pattern) have been reported in previous series at a rate of 13.7% to 35% (*3,5,6,10*). These can be misdiagnosed as benign osteoblastomas (*12*). Chondrosarcoma and sclerotic metastases can also mimic the radiological appearance of pure sclerotic osteosarcoma (ivory, dense cloud-like appearance). Radiological features favoring the diagnosis of primary malignant tumour include : soft tissue mass, periosteal reaction, long lesion (> 6 cm), expansion of bone, and solitary lesion (*21*).

These tumours commonly invade the spinal canal as a soft-tissue mass, which makes cross-sectional imaging like CT-scan and magnetic resonance imaging (MRI) essential for staging and treatment

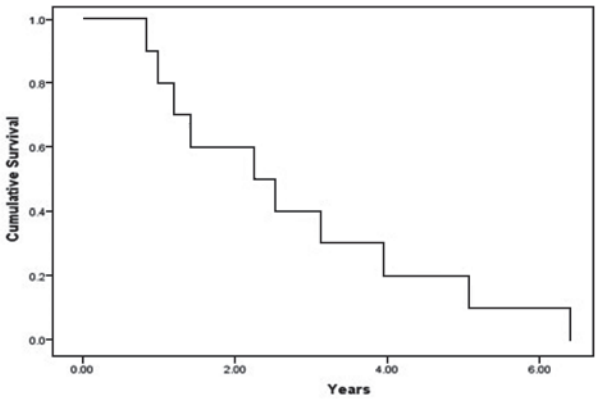

Fig. 4. — Overall survival of 10 patients with primary spinal osteosarcoma.

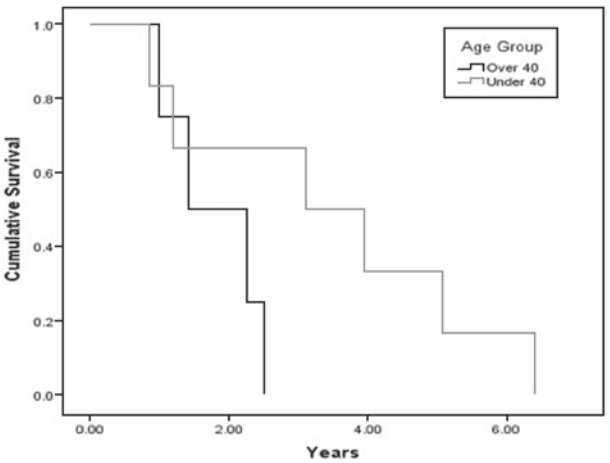

Fig. 5. — Survival analysis of patients above and below age 40 with primary spinal osteosarcoma.

planning. A CT-scan is also useful for the diagnosis of soft tissue involvement and lung metastases (*11*). CT-guided needle biopsy may be optimal to prevent contamination with tumour tissue (*7*). MRI is superior to CT-scan in assessing intra-osseous tumour spread and neural compression or invasion (*5*).

There are several different histological variants of osteosarcoma, based on the predominant tissue (osteoblastic, chondroblastic or fibroblastic) ; "conventional" osteoblastic osteosarcoma is the commonest. In the current series all patients had a histologically confirmed 'conventional' osteoblastic osteosarcoma.

Surgery

The aim of spinal surgery is usually palliative rather than curative, due to the aggressive nature of osteosarcoma with soft tissue extension and involvement of multiple levels of the spine. Palliative management should focus on pain control and management of acute cord or cauda equina compression through surgical decompression and stabilization. Surgery may produce a transient improvement of neurological signs and symptoms, but curative treatment is rarely feasible or possible. Indeed, local recurrence occurred in 6 out of 10 patients (60%), on an average 1.8 years after the initial management. Four of the 6 patients with local recurrence were initially managed with marginal resection, and the two others with intralesional resection.

Improving the prognosis

The prognosis of primary osteosarcoma of the spine is dismal. Shives *et al* (*14*) report a one year survival rate of 26.9% in 26 patients treated between 1909 and 1980. Other authors (*1,15*) note a median survival rate of 6 to 10 months. A combination of complete resection and intensive chemotherapy is often recommended for the treatment of primary spinal tumors (*9,10,14,15*) : the overall survival is better when compared to patients without this modality. Ozaki *et al* (*10*) report a better outcome after aggressive interdisciplinary treatment : an 86% survival rate of > 1 year and a 13.6% survival rate of > 6 years. In the current series, 9 out of 10 patients were treated with a combination of surgery and pre- and/or postoperative chemo- and radiotherapy. Only two patients received neo-adjuvant chemo/radiotherapy, marginal resection and postoperative chemo/radiotherapy. They had a dismal survival of one year and 2 months, and 3 years and one month respectively. Eighty percent of patients survived > 1 year with a median survival of 2.3 years. The 3-year and 5-year survival rates were 40% and 20%. These results are comparable to those of other authors (*9,10,12*). Two patients in the current series had a greater than 5 year survival. Both were male patients below age 40 with osteosarcomas involving the thoracic spine. Only one

subsequently progressed to a survival of more than 6 years. According to the literature, poor prognostic factors are : metastases, a large tumour volume and intralesional surgery or no surgery at all (*9,10*). There were similar poor prognostic factors in our series.

Improvement of the surgical techniques in the last 20 years, with wide or marginal excision, may improve the survival. Schwab *et al* (*13*) report a trend towards improved survival with en bloc resection when compared with intralesional resection. However, wide resection is difficult in the spine, with high complication rates which can affect limb, bladder and bowel function (*4*).

When wide or marginal excision is impossible, a combination of chemotherapy and external radiation therapy may be of benefit in selected patients (*14,15,18,19*). It is important to note however that the effects of chemotherapy are temporary : without ensuing surgery re-growth is inevitable (*14*). In one of the two patients who received marginal resection and pre- and postoperative chemo/radiotherapy, survival was only 1 year 2 months in spite of absence of co-morbidities. Patients should be counseled in detail about the likelihood of persistent primary disease, local recurrence and metastatic lesions regardless of treatment modality.

Nine of ten patients had persistent primary disease at the time of death regardless of the evolution of treatment modalities in the past six decades.

This study has some weaknesses, essentially its retrospective character and the small number of cases. However, no patients were lost to follow-up, and all the case records were reviewed thoroughly.

REFERENCES

1. **Barwick KW, Huvos AG, Smith J.** Primary osteogenic sarcoma of the vertebral column : a clinicopathologic correlation of ten patients. *Cancer* 1980 ; 46 : 595-604.
2. **Dahlin DC, Coventry MB.** Osteogenic sarcoma. A study of six hundred cases. J *Bone Joint Surg* 1967 ; 49-A : 101-110.
3. **deSantos LA, Edeiken B.** Purely lytic osteosarcoma. *Skeletal Radiol* 1982 ; 9 : 1-7.
4. **Dreghorn CR, Newman RJ, Hardy GJ, Dickson RA.** Primary tumors of the axial skeleton. Experience of the Leeds Regional Bone Tumor Registry. *Spine* 1990 ; 15 : 137-140.
5. **Green R, Saifuddin A, Cannon S.** Pictorial review : imaging of primary osteosarcoma of the spine. *Clin Radiol* 1996 ; 51 : 325-329.
6. **Ilaslan H, Sundaram M, Unni KK, Shives TC.** Primary vertebral osteosarcoma : imaging findings. *Radiology* 2004 ; 230 : 697-702.
7. **Kornblum MB, Wesolowski DP, Fischgrund JS, Herkowitz HN.** Computed tomography-guided biopsy of the spine. A review of 103 patients. *Spine* 1998 ; 23 : 81-85.
8. **Kramárová E, Stiller CA.** The international classification of childhood cancer. *Int J Cancer* 1996 ; 68 : 759-765.
9. **Ozaki T, Flege S, Kevric M *et al*.** Osteosarcoma of the pelvis : experience of the Cooperative Osteosarcoma Study Group. *J Clin Oncol* 2003 ; 21 : 334-341.
10. **Ozaki T, Flege S, Liljenqvist U *et al*.** Osteosarcoma of the spine : experience of the Cooperative Osteosarcoma Study Group. *Cancer* 2002 ; 15 ; 94 : 1069-1077.
11. **Resnick D.** Tumors and tumor-like lesions of bone : radiographic principles. In : Resnick D (ed). *Diagnosis of Bone and Joint Disorders*. Saunders, Philadelphia, 2002, pp 3763-4128.
12. **Sar C, Eralp L.** Transoral resection and reconstruction for primary osteogenic sarcoma of the second cervical vertebra. *Spine* 2001 ; 26 : 1936-1941.
13. **Schwab J, Gasbarrini A, Bandiera S *et al*.** Osteosarcoma of the mobile spine. *Spine* 2012 ; 15 ; 37 : E381-E386.
14. **Shives TC, Dahlin DC, Sim FH, Pritchard DJ, Earle JD.** Osteosarcoma of the spine. *J Bone Joint Surg* 1986 ; 68-A : 660-668.
15. **Sundaresan N, Rosen G, Huvos AG, Krol G.** Combined treatment of osteosarcoma of the spine. *Neurosurgery* 1988 ; 23 : 714-719.
16. **Weinstein JN, McLain RF.** Primary tumors of the spine. *Spine* 1987 ; 12 : 843-851.
17. **Widhe B, Widhe T.** Initial symptoms and clinical features in osteosarcoma and Ewing sarcoma. *J Bone Joint Surg* 2000 ; 82-A : 667-674.
18. **Winkler K, Beron G, Delling G *et al*.** Neoadjuvant chemotherapy of osteosarcoma : results of a randomized cooperative trial (COSS-82) with salvage chemotherapy based on histological tumor response. *J Clin Oncol* 1988 ; 6 : 329-337.
19. **Winkler K, Beron G, Kotz R *et al*.** Neoadjuvant chemotherapy for osteogenic sarcoma : results of a Cooperative German/Austrian study. *J Clin Oncol* 1984 ; 2 : 617-624.
20. **Winkler K, Bielack S, Delling G *et al*.** Effect of intraarterial versus intravenous cisplatin in addition to systemic doxorubicin, high-dose methotrexate, and ifosfamide on histologic tumor response in osteosarcoma (study COSS-86). *Cancer* 1990 ; 66 : 1703-1710.
21. **Yochum TR, Rowe LJ.** *Essentials of Skeletal Radiology*. Lippincott Williams & Wilkins, Philadelphia, 2005, pp 1137-1372.