Total vertebrectomy for primary malignant tumours of the spine

P. Krepler, R. Windhager, W. Bretschneider, C. D. Toma, R. Kotz

From the University of Vienna, Austria

Primary malignant tumours should be resected with wide margins. This may be difficult to apply to lesions of the spine. We undertook total vertebrectomy on seven patients, four males and three females with a mean age at operation of 26.5 years (6.3 to 45.8). The mean follow-up was 52.3 months. Histological examination revealed an Ewing’s sarcoma in two patients and osteosarcoma, leiomyosarcoma, spindle-cell sarcoma, chondrosarcoma and malignant schwannoma in one each. In five patients, histological examination showed that a wide resection had been achieved. At follow-up there was no infection and a permanent neurological deficit was only seen in those patients in whom the surgical procedure had required resection of nerve roots. Despite the high demands placed on the surgeon and anaesthetist and the length of postoperative care we consider total vertebrectomy to be an appropriate procedure for the operative treatment of primary malignant lesions of the spine.

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Metastases in the spine are common and account for 40% to 60% of secondary osseous lesions. Surgical treatment involves intralesional or marginal resection and stabilisation in order to release the neural structures, provide relief from pain and allow walking. In contrast to metastases, primary malignant tumours affect the spine in only 1% to 2% of patients. Of the 4767 lesions listed in the Vienna Bone Tumour Registry, 1715 were primary malignant tumours of which 44 were in the spine, 2.5% of all primary malignancies of bone.

Adequate surgical treatment of primary malignant bone tumours of the limbs involves wide or radical resection in combination with neoadjuvant chemotherapy and, if responsive, radiotherapy. The aim of preoperative chemotherapy is to reduce the viable tumour mass and to prevent further dissemination. The combination of systemic and surgical treatment offers the patient a good chance of survival with a satisfactory quality of life.

If these principles are applied to primary malignant tumours in the spine, patients can be offered similar rates of survival. We have therefore analysed the oncological and functional outcome in a series of patients on whom this type of surgery had been undertaken and describe the surgical procedure in detail.

Patients and Methods

Between February 1989 and January 1997, seven patients (four males and three females) underwent total vertebrectomy. Their mean age at the time of operation was 26.5 years (6.3 to 48.9).

The diagnosis was Ewing’s sarcoma in two patients and osteosarcoma, chondrosarcoma, leiomyosarcoma, spindle-cell sarcoma and malignant schwannoma in one each. In five patients, the tumour was in the thoracic spine (T2+T3; T6 to 8; T6,7; T10; T12) and in two in the lumbar region (both in L3).

Two patients had an emergency laminectomy because of acute paraparesis. In three others the diagnosis was obtained by an image-intensifier-guided minimally invasive biopsy and in two by planned open transpedicular biopsy. Since the biopsy tract is considered to be contaminated with tumour it is resected at the time of the operation. The patients with osteosarcoma or Ewing’s sarcoma were treated with neoadjuvant chemotherapy according to standardised protocols. Three patients received preoperative radiotherapy, two with Ewing’s sarcoma and one with a malignant schwannoma (Table I).

Surgical planning. Preoperative staging of the tumour was done using conventional radiographs, MRI and angiography. CT of the chest, abdominal sonography and radionuclide imaging were also carried out to exclude secondary lesions.

In order to define the planned surgical margins it was
necessary to assess accurately the intra- and extraosseous extent of the tumour, and its relationship to neighbouring structures. Total vertebrectomy was considered to be feasible if at least one half of the lamina was free from tumour.

Operative technique. The patient was placed in the prone position. A dorsomedial skin incision was extended bilaterally cranially and caudally to achieve a folding-door skin flap and excision of the biopsy tract. In addition, 3 cm of the dorsal aspects of the ribs attached to the affected vertebrae were resected. Segmental vessels were ligated in patients with extraosseous extension of the tumour. Nerve roots were sacrificed if within the tumour. Laminectomy on the unaffected side of the involved and of the neighbouring vertebra was carried out. After dissection of the anterior and posterior longitudinal ligament, at a safe distance from the tumour, osteotomy within the neighbouring discs or, if considered safer, within the adjacent vertebral bodies was undertaken. Dorsal unilateral spinal instrumentation with pedicle screws and/or hooks in combination with rods was introduced before resection of the tumour. Intraoperatively frozen sections from various sites were examined histologically to ensure adequate margins of resection. The resected specimen was then rotated through almost 180° around the longitudinal axis in the direction of the side of the laminectomy (Fig. 1). The complete specimen was then removed by carefully manipulating the spinal cord through the gap created by the laminectomy.

Anterior reconstruction was carried out through the same approach using a titanium mesh cage filled with autologous bone graft from resected ribs or the iliac crest. Finally, posterior instrumentation was completed by stabilising the spinal column two levels above and two levels below the resected vertebra.

If resection of the biopsy tract left a soft-tissue defect which could not be closed primarily, reconstructive techniques such as a split skin graft, a pedicled musculocutaneous flap or a free flap were used.

Results

The duration of the operation was determined by the number of vertebrae which were resected. The mean time was 9.8 hours (7.3 to 13). The mean amount of blood transfused was 24.6 units (7 to 40). Postoperatively, the patients stayed in the intensive care unit for a mean of 5.4 days (2 to 22).

Oncological outcome. All resected specimens, except one, were examined histologically. In four patients, wide margins were achieved, and in two these were marginal margins adjacent to the epidural space. Two patients died from their disease, one at 12 months, and the other at two years after the procedure. The woman who had had a vertebrectomy (case 6) for a malignant schwannoma, showed symptoms of a spinal infarction at the level of the cervical

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender</th>
<th>Age (yrs)</th>
<th>Histology</th>
<th>Site</th>
<th>Neurology preoperatively</th>
<th>Chemotherapy</th>
<th>Follow-up (mths)</th>
<th>Surgical margins</th>
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<td>M</td>
<td>45.8</td>
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<td>27</td>
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</table>

* DOD, died of disease; NED, no evidence of disease; AWD, alive with disease

Fig. 1

Surgical scheme for total vertebrectomy. The resection is possible if one hemilamina is free from tumour.
spine three months after operation. She died from an intracranial haemorrhage.

The remaining patients were followed for a mean of 48.8 months (27 to 67). Four showed no evidence of disease. One patient (case 3), a man with a spindle-cell sarcoma, developed metastases in the lungs and the acetabulum. He had had massive soft-tissue extension of tumour at the time of the vertebrectomy, and required a partial lobectomy to achieve adequate margins.

**Functional outcome.** Postoperatively, the patients were mobilised with a custom-made brace after a mean of 27.8 days (7 to 90), and it was worn for a mean of 2.3 months. Because of delayed mobilisation, two patients did not require a brace. At follow-up all surviving patients were free from pain and none required a brace. All returned to their previous occupations, which were mainly sedentary.

**Neurological outcome.** In both patients with Ewing’s sarcoma located at L3, the nerve root was resected unilaterally in order to achieve adequate margins. This resulted in a moderate loss of quadriceps function in one patient (case 5). Two patients developed transient postoperative sensory and motor dysfunction which settled with steroid treatment. Another patient (case 4) had a transient bilateral postoperative paresis of the brachial plexus because of the position adopted during the long operation.

**Complications.** There were no intraoperative complications, no postoperative pulmonary, gastrointestinal or renal complications and no cases of infection.

Three patients developed wound necrosis which required revision. Two underwent debridement (cases 3 and 6) and one required a pedicled latissimus dorsi flap (case 5).

Failure of the implant occurred in three patients. In two (cases 3 and 5) breakage of a screw was successfully treated by revision and reinstrumentation. In the other (case 1), who had been operated on in 1989 with the diagnosis of a leiomyosarcoma, the instrumentation was changed twice because of progressive scoliosis and kyphosis.

**Discussion**

The diagnosis and treatment of spinal tumours have improved considerably during the last three decades because of advances in imaging, the introduction of neo-adjuvant chemotherapy and refined surgical techniques including new forms of instrumentation and fixation. Earlier studies indicated that survival for patients with primary malignant spinal tumours was poor with a median survival for patients with osteosarcoma of between six and ten months. Shives et al in 1986, Weinstein and McLain in 1987 and Sundaresan et al in 1988 suggested the introduction of more successful methods of treatment.

The first attempts at total vertebrectomy consisted of peacemeal resection, often with a combined anterior and posterior approach. An intraslesional procedure was used to decompress the cord and stabilise the spine in order to regain function and quality of life while minimising the tumour mass. This met the criteria of a palliative procedure and would nowadays be accepted for the treatment of spinal metastases.

As Stener and Shives et al have stated, and has been established for the treatment of primary malignancies of the limbs, the outcome depends very much on the surgical margins which are achieved.

With the introduction of advanced spinal surgical techniques, and new devices for anterior and posterior instrumentation, it seemed possible to realise the concept of adequate surgery for primary malignant tumours of the spine, which had already been accepted as routine for malignancies of the limbs. The reports of Lièvre et al were followed by those of Stener, Stener and Johnson, Roy-Camille et al, Shives et al, Magerl and Coscia, and Sundaresan et al. Stener and Roy-Camille et al proposed resection of the tumour from a posterior approach. Tomita et al and Kawahara et al also carried out an en-bloc resection by dividing the posterior from the anterior elements of the vertebra at the pedicles. This allowed adequate margins in some patients.

Other groups tried to achieve wide resection, thus applying the concepts of surgical oncology to the spine. Boriani et al described a system of surgical staging for tumours of the spine and their surgical approach was determined by the stage and site of the tumour.

Our procedure differs from the standard technique of Roy-Camille et al or Tomita et al and Kawahara et al. The technique of Tamita et al involves an osteotomy with a modified Gigli-saw (T-saw) and en-bloc removal of the complete lamina without considering extension of the tumour. They routinely carry out a transpedicular osteotomy and this may result in an intraslesional procedure if the tumour extends into the pedicle.

We have placed the laminectomy in a tumour-free area of the lamina. One such hemilamina is required to create a gap large enough for the cord to pass through when the resected area is removed. Therefore, if more than half of the lamina is involved, another surgical procedure should be chosen, for oncological reasons.

A large trapeziform dorsal approach allows a good view of the anterior vital structures without having to reposition the patient. This operation requires a long period of anaesthesia and, when the tumour is in the thoracic spine, a lengthy period of single-lung ventilation. All these factors increase the risks of the operation. Anterior preparation from a posterior approach therefore seems less hazardous. Reconstruction of the anterior column may also be satisfactorily performed from a posterior approach. The device to replace vertebral body can be introduced and positioned from both sides of the cord.

Although Campanacci et al advise wide resection of spinal tumours which are benign and of those primary malignant tumours that cannot be treated with chemotherapy or radiotherapy, such as chondrosarcoma, we believe that the potential risks of the operation are too high.
for its use in benign tumours. It does, however, seem to be justified for primary malignancy, irrespective of whether it is sensitive to conservative treatment or not.

One limitation of total vertebrectomy is infiltration of the epidural space by the tumour. Should this occur posteriorly, resection of the dura with replacement by lyodura can be undertaken. Where there is anterior infiltration resection and reconstruction of the dura although more difficult, is possible through an enlarged incision.

Our findings indicate that by applying the principles of oncological surgery to primary spinal tumours similar results to those of primary malignancies of the limbs may be obtained. Total vertebrectomy is a demanding operation and complications are to be expected. It represents, however, a curative approach. The risks of the operation and the chances of survival should be discussed with the patient. Care should be taken when using this operation for soft-tissue tumours which erode the bone since the possibility of obtaining a wide resection is decreased and the rate of recurrence is higher as a result of the different behaviour of these sarcomas. Total vertebrectomy should only be indicated in patients with primary malignant tumours or isolated metastases with a promising life expectancy.

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References