

Total En Bloc Spondylectomy for Vertebral Tumors

Khalil Salame MD^{1,2}, Gilad Regev MD^{1,2,3}, Ory Keynan MD^{1,3} and Zvi Lidar MD^{1,2}

¹Spine Unit, and Departments of ²Neurosurgery and ³Orthopedic Surgery, Tel Aviv Sourasky Medical Center, affiliated with Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

ABSTRACT: **Background:** Most spine tumors are resistant to radiation and chemotherapy. Complete surgical removal provides the best chance for long-term control of the tumor. Total en bloc spondylectomy (TES) is a radical new technique that entails total removal of the tumor and affected vertebrae with clean margins. **Objectives:** To review our initial experience with TES, focusing on feasibility, surgical challenges and the short-term outcome. **Methods:** We retrospectively reviewed the hospitalization charts and follow-up data of all patients treated with TES for spine tumors in the spine unit at Tel Aviv Medical Center. **Results:** TES was performed in 12 patients aged 13–78 years. Nine patients had primary spinal tumors and three had metastasis. Total en bloc removal was achieved in all cases with spondylectomy of one to three affected vertebrae. There was no perioperative mortality and only one major intraoperative complication of injury to a major blood vessel. Late complications were mainly related to hardware failure. **Conclusions:** Total en bloc spondylectomy is feasible and effective for the management of selected patients with extradural spinal tumors. Since the surgical procedure is demanding and carries significant risk, careful preoperative evaluation and collaboration with colleagues from other specialties are crucial.

IMAJ 2015; 17: 37–41

KEY WORDS: en bloc spondylectomy, spinal metastases, vertebral tumors

Tumors of the spine are classified into three categories according to their anatomic location: intramedullary (arising from neural cells within the spinal cord), intradural extramedullary (arising from the nerve root sheath or the meninges of the spinal cord), and extradural (located in the bony structures of the vertebral column and comprising the largest group). Some of the extradural tumors are primary, either malignant or benign, but the vast majority of all spine tumors are metastatic.

Surgery is the mainstay of spinal tumor management, followed by oncological treatment. The goals of surgery are oncological removal of the tumor, decompression of the spinal cord to preserve neurological function, maintenance of mechanical stability, relief of pain, and histological diagnosis [1]. Surgical removal of these lesions was traditionally based on intralesional resection, where piecemeal removal of the tumor is performed with the resection margins actually made by the residual tumor rather than healthy tissue. Disadvantages of this

technique are incomplete tumor removal and contamination of the surrounding tissues by tumor cells, leading to a high rate of local tumor recurrence [2]. In order to reduce the risk of local recurrence, several authors reported total spondylectomy (corpectomy or vertebrectomy) for removal of vertebral tumors, with favorable results [3–6]. Although this technique represented significant progress, it provided only a partial solution to the clinical problem.

To achieve better oncological results, several surgeons pioneered a new surgical procedure called total en bloc spondylectomy (TES). This is a radical and complex operation defined as complete removal of the tumor and all the affected vertebrae, with normal tissue as margins, without violation of the tumor capsule. During the last decade, this technique gained significant recognition among spine surgeons and oncologists as the preferred method for certain patients with definite indications [7–11]. We present our experience with total en bloc spondylectomy for resection of spinal tumor and report the short-term results.

PATIENTS AND METHODS

MANAGEMENT STRATEGY

All patients with extradural spinal tumors are first subjected to a computed tomography (CT)-guided needle biopsy of the lesion. In the rare cases where needle biopsy is not possible or inconclusive, an open incisional biopsy may be performed. The patient is then assigned to the most appropriate treatment: surgery, radiotherapy, chemotherapy, or a combination of these modalities. Total body CT scan is performed to rule out systemic metastases. Surgical staging is then determined according to the Weinstein-Boriani-Biagini (WBB) staging system [12].

The surgical procedure suitable for the patient is elected based on the classification and recommendations published by Tomita et al. [13].

INDICATIONS

TES is reserved for a particular group of patients. This operation is indicated for malignant tumors (primary spine tumor, and solitary metastatic lesions in carefully selected patients) or aggressive benign tumors. Systemic investigation must be completed and multiple metastases excluded. The tumor must show no spread to adjacent visceral organs, with little or no adhesion to the great blood vessels, so that it can be dissected

Table 1. Patient characteristics

| Patient no. | Age/Gender | Tumor type, extent | Location | Previous treatment | Complication | Outcome |
|-------------|------------|---|-------------------------|-------------------------|---------------------|---------------------------|
| 1 | 40/M | Met. parotid | Thoracic 1 level | Intralesional resection | Disease progression | Died 26 months |
| 2 | 33/M | Giant cell tumor | Thoracic 1 level | Intralesional resection | Kyphosis | Disease free 29 months |
| 3 | 33/M | Osteogenic sarcoma | Thoracic 3 level | CTX, RTX | Kyphosis | Disease free 31 months |
| 4 | 32/F | Chondrosarcoma | Thoracic 1 level | None | None | Disease free 23 months |
| 5 | 35/F | Desmoid | Lumbar 2 level | None | Recurrence | Recurrence 18 months, CTX |
| 6 | 78/M | Peripheral malignant nerve sheath tumor | Thoracic 2 level | Intralesional resection | Recurrence | Died 8 months |
| 7 | 28/M | Osteogenic sarcoma | Cervicothoracic 2 level | Intralesional resection | Recurrence | CTX 17 months |
| 8 | 45/F | Met. liomyosarcoma | Cervical 1 level | None | None | Disease free 20 months |
| 9 | 13/M | Ewing sarcoma | Lumbar 1 level | None | Vena cava tear | Disease free 12 months |
| 10 | 52/F | Chondrosarcoma | Lumbar 1 level | None | None | Disease free 9 months |
| 11 | 59/M | Met. hyperneophroma | Lumbar 1 level | None | None | Disease free 18 months |
| 12 | 61/F | Chondrosarcoma | Thoracic 3 level | None | None | 1 month |

CTX = chemotherapy, RTX = radiotherapy, Met. = metastatic

off them without injury [8,13]. The general systemic condition of the patient, his functional status and life expectancy must be assessed before a strategy is chosen.

SURGICAL TECHNIQUE

Technical details of the surgical procedure are beyond the scope of this manuscript but the main steps will be described briefly. Basically, the procedure consists of en bloc removal of the posterior vertebral elements (spinous process, laminae, facets, transverse processes) and en bloc removal of the anterior part (en bloc corpectomy). The operation may be performed with a single posterior approach, posterior anterior double approach, or anterior posterior double approach. Mechanical stabilization is achieved by placement of a cage prosthesis filled with bone graft or bone substitute at the site of the removed vertebral body and supported by screws and rods posteriorly [13,14].

OPERATIVE RISKS

TES is an aggressive procedure that requires extensive dissection of the spine and adjacent structures. The main risks of the operation are:

- Massive intraoperative bleeding that may result from tumor tissue, epidural veins and adjacent bones, or from injury to major vessels. Blood loss may be life threatening and blood transfusion is routinely required
- Mechanical or vascular injury to the spinal cord

- Inadvertent violation of adjacent structures, depending on the anatomic location of the tumor
- Dural tears and nerve root injury
- Sacrifice of nerve roots or blood vessels in some cases
- Mechanical instability of the spine
- Contamination of surrounding tissues by tumor cells
- The general risks of anesthesia, postoperative infection, etc., are higher than usual due to the long duration of surgery, extensive dissection, hemodynamic changes and other issues.

To reduce the complication rate, several steps are taken routinely:

- Extreme caution in patient selection and meticulous preoperative evaluation
- Preoperative angiography for assessment of the blood supply to the tumor and embolization of supplying vessels. This is especially important for lesions with high vascularization such as hemangioma, renal cell carcinoma, thyroid carcinoma and hepatocellular carcinoma
- Collaboration with colleagues from other specialties: general surgeons, vascular surgeons, plastic and head and neck surgeons, and medical oncologists [9-11].

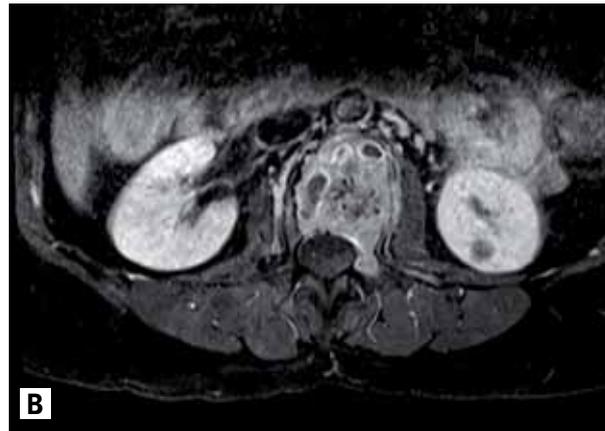
RESULTS

Twelve patients with spinal tumors underwent TES in our spinal unit between April 2010 and December 2013. The age range

Figure 1. MRI with gadolinium



[A] Sagittal view shows the tumor with pathological fracture at L2



[B] Axial view shows the tumor invading the vertebral body and left pedicle

of the 7 males and 5 females was 13–78 years. Nine patients had primary spinal tumors and the other three had metastatic tumors. The tumor was located at the cervical segment in one patient, at the cervicothoracic in one, at the thoracic level in six, and at the lumbar spine in four. The number of vertebrae removed during surgery was as follows: one in seven patients, two in three patients and three in two patients.

The surgical approach was posterior only in four patients and combined anterior and posterior in eight. Total en bloc removal was achieved in all cases. The only major intraoperative complication was a tear of the inferior vena cava which occurred in a child with Ewing sarcoma at a lumbar vertebra. The tear was managed by the vascular surgeons and necessitated closure of the vessel. However, the patient made a good recovery without late sequelae. Late complications included hardware failure leading to kyphotic deformity in two patients and deep wound infection that required surgical revision in one patient. Tumor recurrence occurred in three patients at 8 months, 12 months and 18 months after surgery, respectively. Two of these patients had previously undergone intralesional resection before TES. All three patients underwent chemotherapy with good response in two of them; the third patient died 9 months after surgery. Another patient died 26 months after surgery due to systemic disease progression. Seven patients remain disease free at 1 to 39 months after surgery.

CASE PRESENTATION

A 47 year old woman suffered from low back pain radiating to the right leg for 2 years before admission. Neurological

examination was normal. CT and magnetic resonance imaging (MRI) of the lumbar spine revealed a tumor at the second lumbar vertebra [Figure 1]. CT-guided biopsy showed a giant cell tumor. Spinal angiography demonstrated a highly vascularized tumor. The lumbar arteries L1 to L3 were occluded with onyx. Surgery was performed 2 days later. Starting with the anterior approach and assisted by a general surgeon, we dissected the tumor off the blood vessels and made cuts through the L1-L2 and L2-L3 disks using a special saw. The operation was performed via the posterior approach: the laminae and facets were removed bilaterally as one unit, the nerve roots at L1 and L2 were cut bilaterally, the lateral aspects of the L2 vertebral body were released, and the tumor with the involved vertebra was removed en bloc without violation of the tumor. Stabilization was completed with insertion of a titanium cage filled with bone graft into the intervertebral space from L1 to L3 and transpedicular screws from D12 through L4 [Figure 2]. The patient was transferred to the intensive care unit where she remained on mechanical ventilation for 48 hours. After an additional 10 days in the hospital she was transferred to rehabilitation with proximal motor weakness of both legs, which was expected due to sacrifice of the nerve roots L1 and L2. At the last visit, 16 months after surgery, she was ambulatory without aid and her leg weakness had ameliorated significantly. CT scan showed no tumor recurrence and good spinal alignment with adequate position of the fixation hardware.

DISCUSSION

Most of the primary malignant and metastatic spinal tumors are resistant to radiotherapy and chemotherapy, making surgery the treatment of choice for these lesions. This is true also for some benign tumors with locally aggressive behavior, such

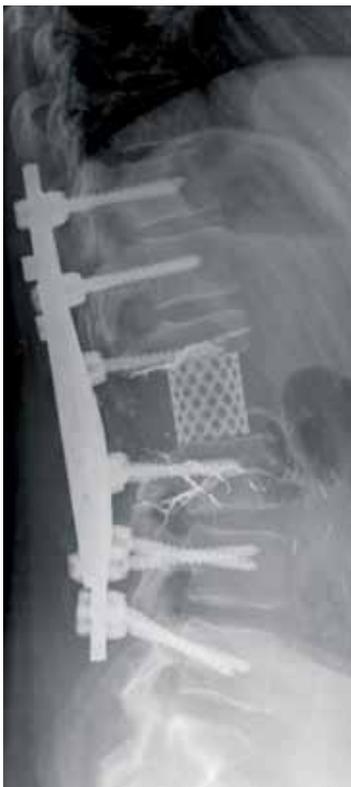


Figure 2.
Postoperative
lateral X-ray of
the lumbar spine

as giant cell tumor. Several studies have shown that total en bloc spondylectomy, i.e., complete removal of the tumor with clean margins, is the best method to achieve cure or long-term local control [15,16]. In a series by Briana and collaborators [17] of 52 cases of spinal chordoma treated over 50 years, only the patients managed with margin-free TES had > 5 years disease-free survival. A multicenter cohort study of patients with primary spinal tumors published by Saravanja et al. [18] showed that local recurrence was significantly lower in patients treated with TES as compared to patients treated with intralesional resection; the patients with local recurrence had a significantly higher mortality rate.

A systematic review by the Spine Oncology Study Group showed that en bloc resection is achievable if staging determines that it is feasible; however, the adverse event profile is high even at experienced centers. The authors concluded that the grade of recommendation for this surgery is strong, although the evidence is still of low quality [19].

Kato et al. [20] examined the satisfaction level of patients and families with en bloc resection of solitary metastatic tumors. Of the 47 patients questioned, 45 were satisfied with the outcome while 2 were neutral; 54 of the 61 family members were satisfied, 5 were neutral and 2 were dissatisfied. The authors found that dissatisfaction correlated with the patient's death less than 2 years after surgery.

In our small series, en bloc spondylectomy was performed successfully in all the cases that were planned after careful preoperative assessment. We encountered one major intraoperative complication – injury to the inferior vena cava that was managed by closure of the vessel – but the patient made a good recovery. There was no neurological deterioration in any patient, except for radiculopathy secondary to intentional sacrifice of involved nerve roots.

The main shortcomings of our study were the small number of patients and the short follow-up. However, the goal of this study was to report our initial experience with a challenging relatively new surgical technique that provides the best chance for cure or local control of disease in this particular group of patients with spine tumors.

CONCLUSIONS

Total en bloc spondylectomy for spinal tumors is feasible and can be performed safely. It has an acceptable complications rate and a favorable outcome.

Correspondence

Dr. K. Salame

Dept. of Neurosurgery, Sourasky Medical Center, Tel Aviv 64239, Israel

Phone: (972-3) 697-4446

Fax: (972-3) 697-4362

email: salame@tasmc.health.gov.il

References

1. Sundaresan N, Boriani S, Okuno S. State of the art management in spine oncology. A world perspective of its evolution, current state and future. *Spine* 2009; 34: S7-20.
2. Fujita T, Ueda Y, Kawahara N, Baba H, Tomita K. Local spread of metastatic vertebral tumors: a histologic study. *Spine* 1997; 22: 1905-12.
3. Camille R, Saillant G, Bissiere M, Judet TH, Hautefort E, Mamoudy P. Total resection of thoracic vertebrae via posterior approach. *Rev Chir Orthop* 1981; 76: 421-30.
4. Stener B. Complete removal of vertebrae for extirpation of tumors: a 20 year experience. *Clin Orthop Relat Res* 1989; 245: 72-82.
5. Boriani S, Bigini R, Di Iure F, Di Fiore M, Gamberini G, Zannoni A. Lumbar vertebrectomy for the treatment of bone tumors: surgical technique. *Chir Organi Mov* 1994; 79: 163-73.
6. Sundaresan N, Rosen G, Huvos AG, Krol G. Combined treatment of osteosarcoma of the spine. *Neurosurgery* 1988; 23: 714-19.
7. Tomita K, Toribatake Y, Kawahara N, Ohnari H, Kose H. Total en bloc spondylectomy and circum-spinal decompression for solitary spinal metastasis. *Paraplegia* 1994; 32: 36-46.
8. Tomita K, Kawahara N, Baba H, Tsuchiya H, Fujita T, Toribatake Y. Total en bloc spondylectomy. A new surgical technique for primary malignant vertebral tumors. *Spine* 1997; 22: 324-3.
9. Boriani S, Biagini F, Delure S, et al. En bloc resection of bone tumors of the thoracolumbar spine. *Spine* 1996; 21: 1927-31.
10. Murakami H, Kawahara N, Tomita K. Total en bloc spondylectomy. *Semin Musculoskel Radiol* 2001; 5: 189-94.
11. Chi JH, Sciubba DM, Rhines LD, Gokaslan ZL. Surgery for primary vertebral tumors: en bloc versus intralesional resection. *Neurosurg Clin North Am* 2008; 19: 111-17.
12. Boriani S, Weinstein J, Biagini R. Primary bone tumors of the spine. Terminology and surgical staging. *Spine* 1997; 22: 1036-44.
13. Tomita K, Kawahara N, Murakami H, Satoru D. Total en bloc spondylectomy for

- spinal tumors: improvement of technique and its associated basic background. *J Orthop Sci* 2006; 11: 3-12.
14. Hsieh PC, Li KW, Sciubba DM, Suk I, Wolinsky JP, Gokaslan ZL. Posterior-only approach for total en bloc spondylectomy for malignant primary spinal neoplasms: anatomic considerations and operative nuances. *Neurosurgery* 2009; 65 (ONS Suppl 1): 173-81.
 15. Bergh P, Kindblom L, Gunterberg B, et al. Prognostic factors in chordoma of the sacrum and mobile spine: a study of 39 patients. *Cancer* 2000; 88: 2122-34.
 16. Fourney D, Rhines L, Hentschel S, et al. En bloc resection of primary sacral tumors: classification of surgical approaches and outcome. *J Neurosurg Spine* 2005; 3: 1111-22.
 17. Briana S, Bandiera S, Biagini R, et al. Chordoma of the spine: 50 years of experience. *Spine* 2006; 31: 493-503.
 18. Saravanja D, Dvorak M, Boyd M, et al. Surgical management of primary bone tumors of the spine using the Enneking principle: a multicenter cohort study. Paper presented at: the 9th Annual Canadian Spine Society Meeting, 8-21 March 2009, Gatineau, Quebec, Canada, Abstract.
 19. Yamazaki T, McLoguhlin GS, Patel S, Rhines LD, Fourney DR. Feasibility and safety of en bloc resection for primary spine tumors. A systematic review by The Spine Oncology Study Group. *Spine* 2009; 34: S31-8.
 20. Kato S, Murakami H, Demura S, et al. Patient and family satisfaction with en bloc total resection as a treatment for solitary spinal metastasis. *Orthopedics* 2013; 30 (11): e1424-30.