Original Article

Total *enbloc* spondylectomy for metastatic high grade spinal tumors
Early results

Sanganagouda S Patil, Abhay M Nene

Abstract

Background: High grade metastatic spinal tumors are most common and are invasive. These patients can succumb to disease progression if not treated timely. Although considered as invasive and morbid, total *enbloc* spondylectomy (TES) in selected cases has better survival rates. The authors describe the results of TES for high grade metastatic spinal tumors.

Materials and Methods: Five patients (four females and one male) underwent TES for solitary metastatic vertebral lesion between November 2012 and January 2014. These patients presented to us with spinal instability, unrelenting severe spinal pain and/or with severe progressive radiculopathy. Average age was 46.2 years (range 39–62 years). After complete investigations, computed tomography scan, magnetic resonance imaging scan and positron emission tomography (PET) scan, it was confirmed that these patients had high grade solitary vertebral metastatic tumor.

Results: Average duration of followup was 18 months (range 16–20 months). The average preoperative visual analog scale score of 9.4 (range 9–10) improved to 2 (range 1–4) at last followup. Average blood loss was 1440 mL (range1000–2000 mL). Average duration of surgery was 198 min (range180–240 min). Significant pain relief was noticed in each patient in the immediate postoperative period and during followups. These patients attained complete functional activities of daily living with in a month. The imaging showed implants *in situ*, no recurrence of tumor, and no activity on PET scan at the final followup.

Conclusion: The present series shows favorable short term results of TES for solitary, metastatic, high grade vertebral body tumors by a team approach.

Key words: High grade tumor, total *enbloc* spondylectomy, vertebral metastasis
MeSH terms: Vertebral, spinal neoplasm, metastasis, tumors

Introduction

Primary malignant tumors of the spine are rare.[1-3] The treatment of metastatic spinal tumors has evolved significantly with greater understanding of molecular biology of the tumors and advances made in the diagnostic and therapeutic modalities.[4-6] High grade metastatic spinal tumors are invasive and without timely treatment, patients can succumb to progression of their disease.[7] Despite being an invasive and morbid surgery, current evidence suggests that only total *enbloc* spondylectomy (TES) with free tumor margins in selected cases has better survival rates.[8,9] With this background, the authors describe their results of TES for solitary high grade metastatic spinal tumors with 18 months followup.

Materials and Methods

Five patients underwent TES for solitary metastatic vertebral lesion between November 2012 and January

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2014. All patients underwent complete preoperative investigations, computed tomography (CT) scan, magnetic resonance imaging (MRI) scan, and positron emission tomography (PET) scan to know any other metastatic lesions in the body. After thorough investigations, it was confirmed that each patient had high grade, solitary, metastatic vertebral body tumor. All patients had presented to us with spinal instability, unrelenting severe spinal pain and one patient with severe progressive radiculopathy. Visual analog scale (VAS) score was used to record pain score.

Operative procedure

All patients underwent a single posterior approach TES. All patients had eccentrically located metastatic lesion, in a single vertebral body (confined to operable zones as per WBB classification).

All patients underwent preoperative digital subtraction angiography (DSA) guided arterial embolization of major feeding vessel to the tumor, 24 h prior to surgery. This not only helped in decreasing the tumor vascularity but also helped surgeons with clear bloodless operative field during surgery.

The patient was placed in prone position, a midline incision extending three levels cephalad and three levels caudal was made. Skin, fasciae, and paraspinal muscles were elevated bilaterally, up to tips of transverse processes, on both sides. Pedicle screws were inserted two levels proximally and two levels caudally on both sides of proposed TES vertebra. Using Kerrison punches (or osteotomes some times), bilateral pars osteotomy and posterior soft tissue release were performed. The posterior elements consisting of lamina, spinous process, and inferior articular process were removed in toto (first piece). The pedicle was osteotomied inside out at its junction with the vertebral body on the uninvolved side. Thus, the transverse process, superior articular process, and pedicle were removed in toto (second piece).

Now,the proposed vertebral body undergoing TES is bluntly dissected to free the paravertebral soft tissue attachments (starting from side to front and cephalad disc to caudal, bilaterally). This involved combination of blunt dissection with finger tips, mono/bipolar cautery, and isolation with ligation of segmental arteries using vascular clips. The major vessel pair in front was separated from vertebral body using finger tip dissection. A large size sponge placed skirting the front and sides of the vertebral body, separating it from major vessels. The spinal cord/thecal sac/exiting roots were isolated throughout and secured bilaterally. Now, the rod was placed on the involved side, connecting the proximal and distal screws. Now with the spine being stable, proximal and distal discectomies were performed. The annulus was excised circumferentially using Kerrison punches or number 15 blade. Once the vertebral body is loose enough for removal, the connecting rod is exchanged to uninvolved side. Multiple attempts to extract the vertebral body in to were tried, releasing the loose tags hindering the extraction during each attempt. Due care is taken to secure the neurological structures during extraction attempts. Extreme care is also taken not to use any metal extraction devices during these attempts, so as to avoid fracture at tumor-bone junction and subsequent tumor spillage. With these cares in place, the vertebral body containing the tumor was extracted in toto (third piece).

After vertebral body extraction, the sponge behind the major vessels was removed and the tumor bed was inspected for any active bleed or any suspicious looking tissue. All three in toto pieces were reassembled to re-structure the vertebral body and were examined for any cortical violations/missing bony pieces. The interbody reconstruction was done using appropriate sized metal cage, filled with polymethyl methacrylate (PMMA) cement. Inserting these large sized cages is also a challenge, which requires multiple attempts of negotiation and repositioning. With cage in proper place, the screw rod assembly is tightened and held under compression over the cage.

Following surgery, all the patients were put on appropriate chemotherapy by oncologists and radiotherapy was started once the surgical wound was fully healed. All patients were ambulated by 3rd postoperative day and were discharged from the hospital in 5 to 7 days.

Results

There were four females and one male with an average age of 46.8 years (range 39–61 years). All these patients presented to us with progressive, severe midback pain with typical history of rest pain and nocturnal aggravations (average VAS of 9.4/10, range 9/10–10/10), although one patient presented with severe upper limb radiculopathy and ipsilateral motor weakness. All these patients had solitary, high grade, metastatic spinal tumors which were histopathologically proven. On follow up MRI scans, these lesions showed pure vertebral body lesions and soft tissue effacement around the spinal cord/thecal sac. On further CT and PET scan screening, it was confirmed that the existing active spinal metastasis was the only skeletal lesion in the body [with average maximum standardized uptake value (SUV max) of 8.4, range (6–11)]. There were three patients of symptomatic, metastatic lesion to L3vertebra, followed by metastatic lesion to T1 vertebra in one patient and to L2 vertebral body was seen in another patient [Table 1].

Table 1: Clinical details of patients and surgical outcome

Age (in years)	Sex	Diagnosis	Location	Presentation	WBB staging	Karnofsky score		Follow-up (months)	Recurrence
						Pre operative	Final follow-up		
39	Female	Metastatic, non-small cell lung carcinoma	L2	Mid back pain	6/11 B/D	50	90	20	Nil
42	Female	Metastatic, moderately differentiated non-keratinizing squamous cell carcinoma, uterine	L3	Low back pain	4/10 A/D	40	90	18	Nil
61	Male	Metastatic, high grade, poorly differentiated, adenocarcinoma	T1	Left upper limb radiculopathy with hand weakness	4/10 B/D	40	80	18	Nil
47	Female	Metastatic Hurthle cell adenoma-thyroid	L3	Low back pain	3/8 B/D	50	100	16	Nil
44	Female	Metastatic, follicular carcinoma thyroid	L3	Low back pain	2/8 B/D	40	90	16	Nil

TES=Total *enbloc* spondylectomy

Individually, the lesions were nonsmall cell lung carcinoma with L2 vertebral body metastasis, nonkeratinizing squamous cell carcinoma with moderate degree of differentiation with L3 vertebral metastasis, poorly differentiated adenocarcinoma of unknown primary with metastasis to T1 vertebral body, Hurthle cell adenoma with metastasis to L3 vertebral body and follicular carcinoma of thyroid with unknown primary with metastasis to L3 vertebral body.

The patient with L2 vertebral body metastatic lesion was a known case of non small cell lung carcinoma. The patient had previously undergone pneumonectomy and had received six cycles of chemotherapy with gemcitabine, carboplatin, and avastin for the same. Upon investigation for progressive, severe mid back pain, with typical history of rest pain and nocturnal aggravations, the patient showed persistent L2 vertebral body lesion with soft tissue shadow effacing the thecal sac, on MRI scan. Based on CT scan and PET scans, it was further confirmed that there was no lesion in the lung and L2 vertebral body lesion was the only active metastatic lesion (SUVmax = 8.9) in the body. Hence, TES of L2 vertebra was performed from all posterior approach, L1 to L3 interbody reconstruction with mesh cage filled with PMMA cement, two levels cephalad and two level caudal pedicle screw rod stabilization was done [Figure 1a-g (i-iii), h and i]. At 20 months follow up, the patient was pain free with no tumor recurrence on PET scan and roentgenograph showed implants in good position [Figure 2a and b].

The patient of non keratinizing squamous cell carcinoma with metastasis to L3 vertebral body was treated previously with chemo and radiotherapy, 10 years back for uterine carcinoma. Patient presented with severe, progressive low back pain since 6 months with worsening left lower limb radiculopathy since 2 months, an expansile lesion involving L3 vertebra, with mild extension into left pedicle causing lateral recess stenosis and some posterior marrow retropulsion effacing the anterior thecal sac was seen on MRI scan. PET scan showed abnormal, intense degree of FDG uptake involving L3 vertebral body (SUV max = 11.4) and there was no other FDG concentrating lesion anywhere in the body. CT guided biopsy of the L3 vertebral body lesion, followed by histopathological examination confirmed metastatic nonkeratinizing squamous cell carcinoma with moderate degree of differentiation. Hence TES of L3 vertebra was performed from all posterior approach with interbody reconstruction using mesh cage filled with PMMA cement, and posterior stabilization was performed by two level cephalad and two level caudal pedicle screw rod stabilization. At 18 months follow up, patient is ambulatory with no tumor recurrence.

The patient with poorly differentiated adenocarcinoma of unknown primary (based on CT guided biopsy of the skeletal lesion) with symptomatic metastasis to T1 and left humerus was initially treated with chemotherapy and surgery for humeral lesion. The skeletal lesion resolved following surgery and six cycles of chemotherapy with Gemcyte and Taxol (SUVmax = 2.1) and 5 cycles (20Gy) of radiotherapy to both lesions, but T1 vertebral body lesion showed very mild improvement, with progressive weakness in both upper limbs (right side 3/5, left side 2/5). Hence, TES of T1 vertebra was done from all posterior approach, interbody reconstruction with 11 mm polyetheretherketone (PEEK) cage filled with PMMA cement was done and posterior stabilization from C5 to T3 was performed [Figure 3a-f]. The patient experienced three episodes of hypotension and intermittent tachycardia intraoperative, which improved with fluid challenge and 98% oxygen therapy. The patient did not have any recurrence at 18 months followup with significant improvement in symptoms.

Patient with asymptomatic, Hurthle cell adenoma with metastasis to L3 vertebral body was under regular follow up after total thyroidectomy, performed 5 years back. This

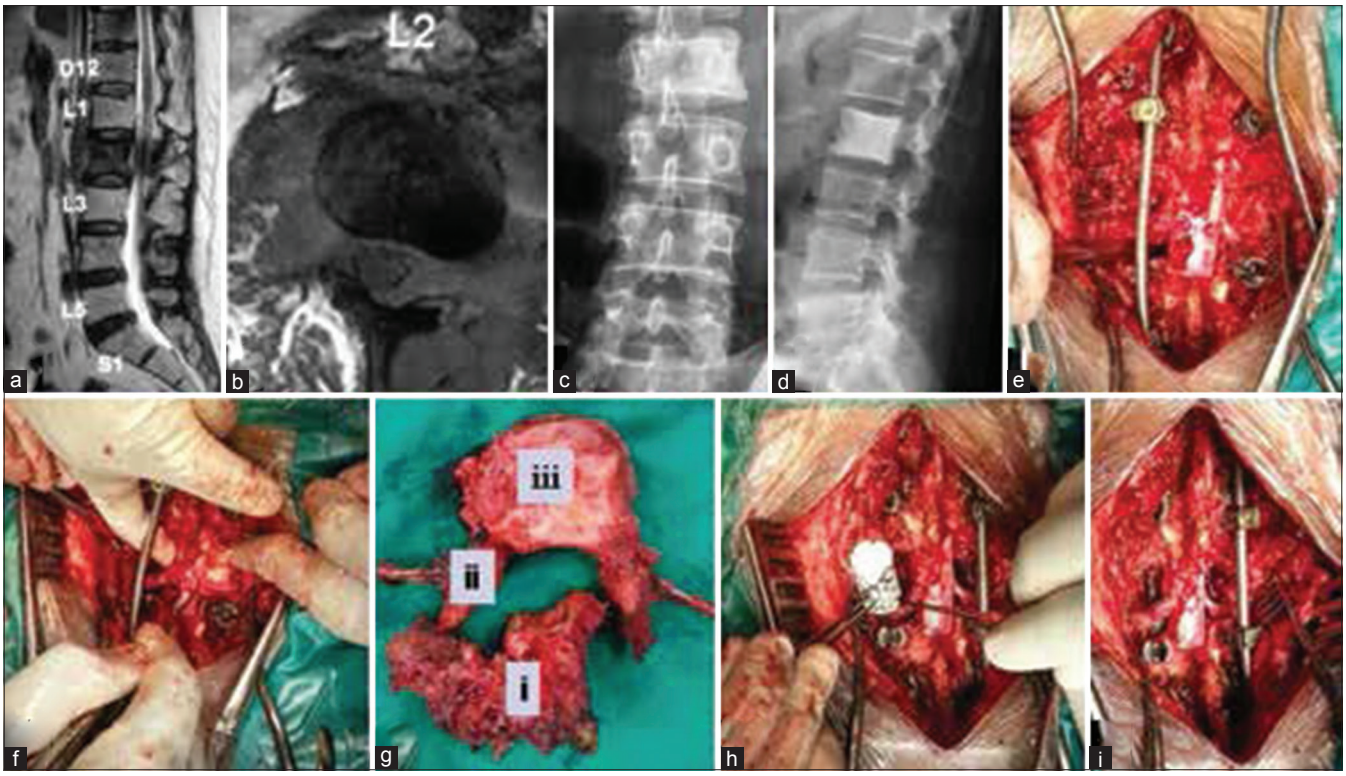

Figure 1: 39 year old patient with known L2 vertebral body metastatic lesion. (a and b) T2W mid sagittal and axial view MRI scan showing panvertebral body pathologic lesion. (c and d) Anteroposterior and lateral x-rays of lumbosacral spine showing panvertebral sclerotic lesion (e) Peroperative photograph showing *En bloc* L2 posterior vertebral removal and osteotomy of un-involved left pedicle (f) Peroperative photograph showing circumferential separation of soft tissues bluntly and en bloc extraction was done (g) Post-extraction re-assembly showing three complete, separate en bloc elements (i), (ii) and (iii) (h and i) Peroperative photographs showing intervertebral reconstruction by titanium metal cage filled with PMMA cement and spinal stabilization

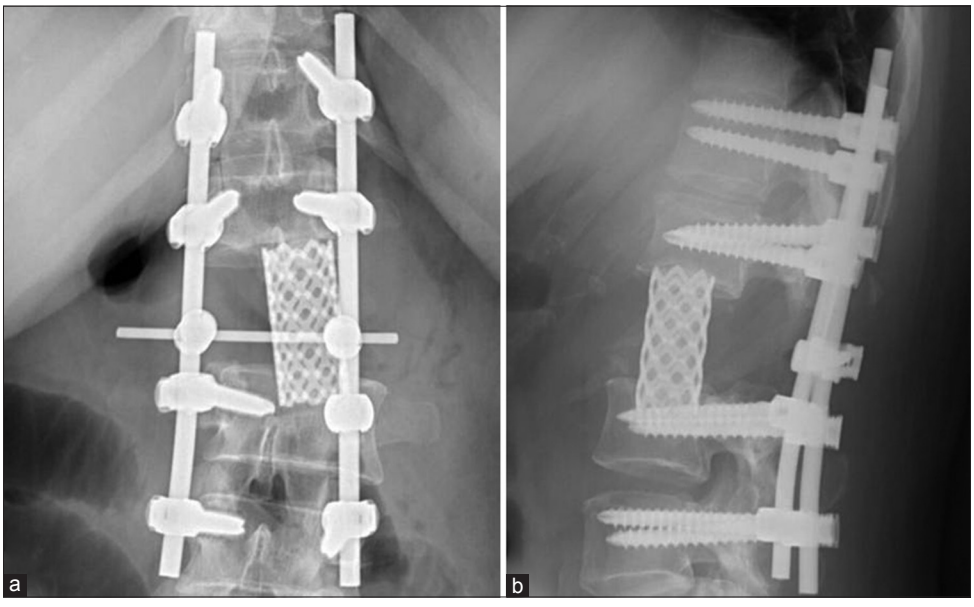

Figure 2: (a and b) X-ray anteroposterior and lateral views of dorsolumbar spine at 20 month followup showing no recurrence of the lesion, and implants *in situ*

patient presented with severe progressive low back pain with bilateral lower limb radiculopathy since 5 months. The patient also complained of difficulty in standing, walking with tingling, and numbness in both legs. New MRI scan showed solitary, expansile, L3 vertebral body lesion with partial collapse and posterior bony retropulsion compressing thecal sac. PET scan showed metabolically active lesion present isolated in L3 vertebral body. A CT

Figure 3: Sagittal (a) and axial (b) CT scans; sagittal (c) and axial (d) T2W MRI scans showing high grade metastatic tumor involving T1 vertebral body (e) X-ray anteroposterior view of cervicodorsal junction immediate post TES showing implant and cage *in situ* (f) X-ray lateral view of cervicodorsal spine at 18 months followup showing no recurrence and implant *in situ*

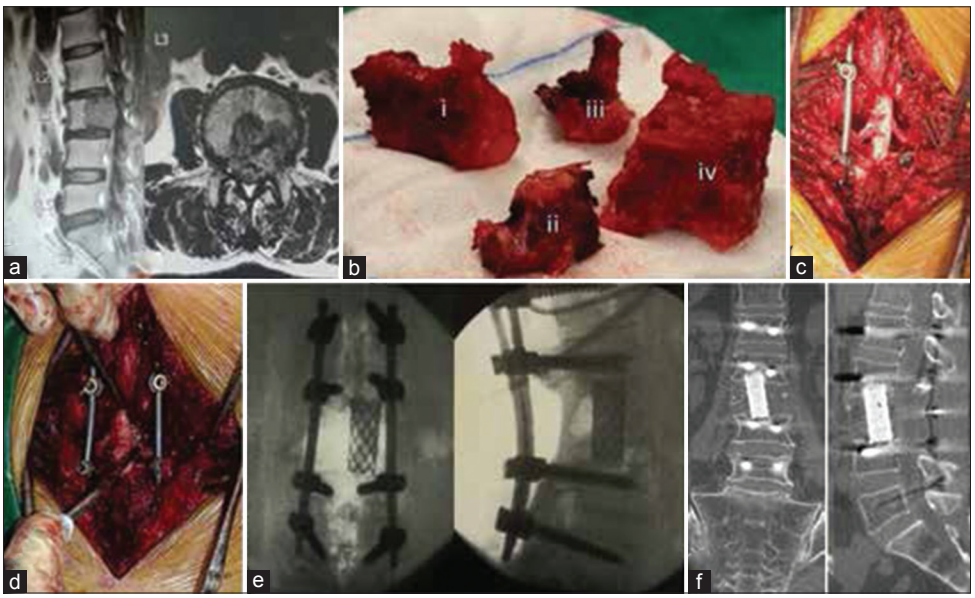

Figure 4: (a) Sagittal and axial T2W MRI pictures showing L3 vertebral body (Hurthle cell adenoma of thyroid) metastasis (b) Post TES pictures of specimen showing parts of vertebral body removed [b (i, ii, iii and iv)] (c) Intraoperative picture of surgical field showing implants *in situ* on one side (d) Intraoperative picture showing interbody reconstruction using PMMA impregnated mesh cage and bilateral pedicle screw rods (e) Fluoroscopic view anteroposterior and lateral pictures showing surgical reconstruction (f) Anteroposterior and lateral x-ray of lumbosacral spine showing implants *in situ* and no tumor recurrence after 16 months of followup

guided biopsy of the lesion was reported as metastatic Hurthle cell adenoma with unknown primary. Hence, TES of L3 vertebral body was done from all posterior approach with interbody reconstruction using mesh cage filled with PMMA cement, and posterior stabilization was performed by two level cephalad and two level caudal pedicle screw rod stabilization system [Figure 4a, b (i-iv) and c-e]. The patient was administered 8 fractions of radiotherapy in the postoperative period (24 Gy). The patient did not have tumor recurrence at 16 months followup with significant improvement in symptoms [Figure 4f].

A post thyroidectomy patient under regular follow up (with MRI scan and PET scan) for her L3 vertebral body metastasis presented to us with severe progressive low back pain with rest pain and nocturnal aggravations. New MRI and PET scans showed highly active L3 vertebral body soft tissue lesion and there was no other metastatic lesion in the body. CT guided biopsy of the lesion was diagnosed as high grade follicular carcinoma of thyroid with unknown primary. TES of the L3 vertebral body was done from all posterior approach with interbody reconstruction using mesh cage filled with PMMA cement, and posterior stabilization was

performed by two level cephalad and two level caudal pedicle screw rod stabilization. The patient did not have any recurrence at of 16 months followup with significant improvement in symptoms.

The average preoperative VAS score of 9.4 (range 9–10) improved to 2 (range 1–4) at last follow up. Average blood loss was 1440 mL (range 1000–2000 mL). Average duration of surgery was 198 min (range 180–240 min).

Complications

There was one mortality in the immediate postoperative period due to septicemic shock (this patient was not part of the study). One patient suffered intra hepatic inferior vena cava thrombosis in the postoperative period, which was treated with anticoagulants. The same patient had to receive six units of fresh frozen plasma and Vitamin K injections (with anticoagulants stopped) for deranged coagulation profile during antithrombotic treatment. One patient developed hematuria during chemotherapy in the postoperative period, which subsided following completion of chemotherapy course.

Discussion

Late presentation of spinal tumors (primary as well as metastatic) makes a surgical treatment challenging, often leading to choose palliative treatment. TES wherein, the entire tumor within the vertebra with a cuff of healthy tissue around it, is removed as one specimen and has proven to be beneficial (due to its lower recurrence rates) in extending the long term survival rates and functional outcome for patients, especially with solitary metastatic disease of the spine.[5,10-12] Traditionally, TES for spinal tumors has been considered as morbid procedure.[13-15] However, with more understanding of surgical techniques and team approach with two spine surgeons trained in spine onco-surgeries, operating from either side as in this series, helps to reduce the complication rates.

The average duration of surgery and blood loss was low to comparable, as compared to other existing series of TES procedures.[16-18] The team approach works in favor of reducing the surgical duration, complications, and thereby morbidity associated with TES surgery. The use of metal cages has been adequately supported in literature as it is believed to offer excellent day 1 stability to the spine.[19,20] Although stacked carbon fiber reinforced polymer (CFRP) cages with biocompatibility and modulus of elasticity similar to that of cortical bone are ideal for vertebral body replacement following TES,[21] issues associated with cost constraints and availability limit us from their usage. The fears of donor site morbidity with autograft/disease transmission with allograft usage lead us to use of PMMA cement, which is known to resist compressive forces almost immediately once it solidifies. The irradiation of PMMA cement during adjuvant radiotherapy causes no objective changes in its shear strength, compressibility or durability.[22-24] This was also due to the authors belief that relying on bony fusion may not be reliable in patients that will be subjected to irradiation and chemotherapy.

This is a short case series, and further longer term followup is needed.

Conclusion

The present series shows favorable short term results of TES for solitary, metastatic, high grade vertebral body tumors by a team approach.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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