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A modified posterolateral transpedicular approach to thoracolumbar corpectomy with nerve preservation and bilateral cage reconstruction

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Conflicts of Interest/Disclosures

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Abstract

This retrospective study investigated the early results of a single-stage posterolateral transpedicular corpectomy and fusion in the thoracolumbar spine. A modified technique with nerve preservation and bilateral expandable cage implantation is described. Four patients with vertebral metastasis and one patient with vertebral osteomyelitis were included in this series. Two patients underwent two level corpectomies, whereas three patients underwent single level corpectomy. The mean follow-up was 3.3 months. No perioperative complication was encountered. Improvement in neurological status was observed in patients with preoperative neurological deficits. Vertebral height and sagittal and coronal deformity were corrected using the current technique. Bilateral cage implantation offers an additional advantage of asymmetrical reconstruction of the ventral column in cases of hemicorpectomy. Single-stage posterolateral transpedicular corpectomy and fusion is a useful approach to treat ventral thoracolumbar pathologies.

Keywords: Expandable cage; Posterolateral approach; Thoracolumbar corpectomy

1. Introduction

The thoracolumbar spine is commonly involved in many pathological conditions, such as tumour, fracture or infection. Surgeries are often indicated for neural decompression and spinal stabilisation in these cases. Access to thoracolumbar vertebral bodies or discs via traditional transthoracic or retroperitoneal approaches carries significant morbidity [1, 2]. Additional posterior stabilisation or decompression is often required, thus further increasing the risks of the operation [3, 4].

Single-stage posterolateral transpedicular corpectomy has been described in an attempt to simplify the surgical approach for circumferential decompression and simultaneous stabilisation of the thoracolumbar spine [5-9]. Nerve roots are often sacrificed in order to accommodate the passage of a large ventral supporting construct. The present study describes a modified posterolateral transpedicular corpectomy with bilateral cage placement and nerve preservation.

2. Methods

This is a retrospective series of thoracolumbar corpectomy and fusion performed in the Department of Neurosurgery at The Royal Melbourne Hospital in 2012. All patients had preoperative MRI. CT scans were performed before and after surgery. American Spinal Injury Association (ASIA) impairment score was used to document the neurological function. Intraoperative blood loss, operative time, pre- and postoperative neurological function and the duration of hospital stay were analysed.

2.1. Surgical technique

Corpectomy and decompression was achieved via a single-stage posterolateral transpedicular approach (Fig. 1). All patients were anaesthetised with an endotracheal general anaesthesia. The patients were placed prone on a Wilson frame. An intraoperative radiograph was taken to localise the pathological level. A midline incision was made, thoracolumbar fascia was divided and paraspinal muscles were dissected in a subperiosteal fashion and retracted. Bilateral pedicles screws three levels above and below the corpectomy level were placed under fluoroscopic guidance and electromyographic monitoring. Laminectomies were

performed to decompress the spinal cord at the levels of the pathology. Pedicles at the diseased levels were removed to further decompress the spinal cord and the nerve roots. Discectomies were performed above and below the level of corpectomy. Corpectomy was performed via a transpedicular approach using a combination of rongeurs, curettes and osteotomes. Compressive lesions ventral to the spinal cord were removed from a posterolateral angle. Posterior longitudinal ligament was removed to ensure a circumferential decompression of the spinal cord. The ventral limit of the corpectomy was reached once the anterior longitudinal ligament was seen. Depending on the primary pathology, a thin layer of bone was often left unresected posterior to the anterior longitudinal ligament to protect the great vessels. Adjacent cartilaginous endplates above and below the corpectomy site were removed.

To prepare for cage insertion in the thoracic spine, the medial parts of the rib heads were partially removed to create a space fitting the diameter of the cage. A titanium expandable cage (TeCorp, Alphatec Spine, Carlsbad, CA, USA) of the appropriate size was then placed into the corpectomy site. The cage was first inserted in an anteroposterior trajectory between adjacent nerve roots above and below the corpectomy site (Fig. 1b). Once inside the corpectomy space, the cage was turned 90 degrees to align with the sagittal plane. The cage was then expanded and locked under fluoroscopic guidance to correct the loss of vertebral height, kyphotic or coronal deformity (Fig. 1c). The contralateral cage was then placed in a similar fashion (Fig. 1d). All nerve roots were preserved in this procedure.

Artificial bone grafts were placed around and inside the cages. Bilateral rods were placed and locked. In patients with kyphotic deformity, compression was applied over the corpectomy level to further correct the deformity. Two crosslinks were placed. Transverse processes, facet joints and laminae of the stabilised levels were then decorticated and posterolateral fusion with artificial bone grafts was performed. A large suction drain was placed in the epidural space. The wound was closed in layers.

3. Results

The current series included five patients, four men and one woman. The average age of this group was 65 years, with a range from 58–77. The primary pathologies were vertebral

metastases in four patients, and vertebral osteomyelitis and collapse in one patient. Four cases involved the thoracic spine, whereas one was in the lumbar region. Single level corpectomy was performed in three patients and two level corpectomies were done in two patients. Bilateral cages were placed into the corpectomy site in all patients. No nerve root was damaged or sacrificed during the procedures. The average operative time was 6.6 hours and the average intraoperative blood loss was 1100 ml. The data are summarised in Table 1.

No perioperative complication was encountered. The average length of postoperative hospital stay was 7 days. The mean duration of follow-up was 3.3 months. No implant failure was seen in follow-up CT scans.

Two patients presented with intact neurology preoperatively and they were unchanged after the surgeries. The three patients who had neurological deficits before the operations all improved postoperatively by one grade on the ASIA scale.

Improvement of sagittal alignment was achieved in all patients who presented with a kyphotic deformity. An illustrative case was Patient 3 who presented with a significant kyphotic deformity from a T11 lung metastasis and pathological fracture. Her preoperative sagittal Cobb angle was 29 degrees which was corrected to 14 degree after the surgery (Fig. 2). Excluding Patient 2 who had a corpectomy at L2 and an increased lumbar lordosis as well as postoperative sagittal Cobb angle, the sagittal Cobb angle in all thoracic cases was reduced, with a mean reduction from 21 to 12 degrees.

Correction of coronal deformity was achieved in patients who had a preoperative scoliosis. This was illustrated by Patient 5 who had a T12 pathological fracture from a tongue squamous cell carcinoma. This patient had a preoperative coronal Cobb angle of 26 degrees which was improved to 15 degrees postoperatively (Fig. 3).

Vertebral height was improved in all patients. The mean vertebral height was increased from 38 mm to 47 mm after the surgeries.

In Patient 4 a hybrid ventral reconstruction was achieved using bilateral cage placement. This patient presented with a malignant spinal cord compression from multiple myeloma at T11–T12. The tumour involved almost all of the T11 vertebral body but only half of T12 body.

The normal half of the T12 body was preserved in order to prevent further vertebral collapse given the patient's old age and osteopenia. Thus a taller cage was placed into the side of the two level corpectomies and a shorter cage was fitted into the single-level corpectomy (Fig. 4).

4. Discussion

Historically the need to access the anterior spinal column arose as a result of the treatment of tuberculous spondylitis [10]. A surgical approach to the thoracic vertebral bodies was first described by Menard in 1895 via a costotransversectomy to treat Pott's paraplegia [11]. It was not until 1934 that Ito et al. published their series of the retroperitoneal approach to anterior lumbar spine [12]. The transperitoneal approach to the lumbar spine was also described at around the same time [13-15]. By the 1950s, the transthoracic exposure to the anterior thoracic spine was being described to treat Pott's disease [16, 17]. Thoracotomy soon became the preferred exposure to the anterior thoracic spine [18, 19].

However, anterior spinal decompression via a transthoracic or retroperitoneal approach carries significant morbidities, including vascular injury, pleural effusions, pneumothoraces, decreased pulmonary function, postthoracotomy pain, abdominal hernias, and impotence or retrograde ejaculation [1, 2]. In cases of vertebral metastases, local tumour extension in the thoracic or peritoneal cavity may further impede the viability of the anterior approach. Moreover, some cancer patients are poor candidates for an anterior approach due to concurrent medical comorbidities, poor pulmonary function, previous surgery or radiotherapy. The inability of the anterior approach to decompress tumour in the posterior column may necessitate combined anterior and posterior surgery, significantly increasing the risks of the operation [3, 4].

Single-stage posterolateral transpedicular corpectomy aims to circumvent the morbidities associated with traditional anterior approaches. In addition to ventral decompression and reconstruction, the posterolateral approach allows for simultaneous posterior decompression and stabilisation. Results from the current small series agree with previous studies that the posterolateral approach is associated with a relatively low risk of complications compared with anterior or combined anterior and posterior approach [4, 20-22]. The neurological

benefit of the circumferential decompression is manifested by the improvement on the ASIA scale in all patients with pre-existing deficits in this series.

Various materials have been used to reconstruct the ventral column, including polymethylmethacrylate bone cement, autologous or allogenic strut grafts, titanium mesh, or carbon fibre cages [23-26]. However, the placement of these constructs often requires the sacrifice of nerve roots due to their fixed height, thus rendering them unsuitable for use in the lumbar spine. The use of expandable titanium cages in the current series allowed for the insertion of the ventral construct in a collapsed size. The initial anteroposterior trajectory of the cage placement utilised the space between adjacent nerve roots, thus negating the need for nerve sacrifice (Fig. 1b).

Despite using expandable cages, many surgeons continued to divide nerve roots in the thoracic spine in order to accommodate a larger cage [20, 27, 28]. Cages with a smaller footprint are often used in the lumbar spine in order to preserve nerve roots [21, 28]. On the other hand, *in situ* distraction of a centrally placed cage can result in nerve root injury [20]. The bilateral cage placement in the present study further improves the technique of ventral reconstruction via a posterolateral approach. The off-centre position of cages on each side places them closer to the cortical rim which is the strongest part of the vertebral endplate, thus reducing the risk of cage subsidence [29]. Expansion of the cages even using distractors designed for anterolateral approach is easier because the cages are often sat partially lateral to the thecal sac (Fig. 1d). Bilateral cages often fit snugly into the corpectomy site, thus further eliminating the risks of coronal cage movement.

Correction of kyphotic deformity was achieved in the current series via the distraction of ventral corpectomy cages and compression of dorsal pedicle screws. A single-stage posterolateral transpedicular approach allows for simultaneous adjustment of both ventral and dorsal structural elements, thereby potentially achieving better results than separate anterior and posterior surgeries. Bilateral cage placement augments the strength of the ventral distraction in the correction of kyphosis. In the case of coronal deformity such as in Patient 5, differential cage expansion further aided the restoration of normal spinal alignment (Fig. 3).

A further advantage of bilateral cage placement was the ability to reconstruct the ventral column after an asymmetrical corpectomy, as seen in Patient 4 (Fig. 4). Each side of the

corpectomy can be reconstructed independently of the other. Based on Kostuik's six column classification of vertebral anatomy, metastases involve an average of 4.9 columns [30]. Thus a hybrid ventral construct is particularly useful in vertebral metastases when a partial corpectomy is indicated.

5. Conclusions

This study demonstrates that single-stage posterolateral transpedicular corpectomy is a useful approach in vertebral osteomyelitis and metastases. The described technique enabled bilateral cage reconstruction and nerve preservation. No complication was encountered in the current small cohort. Preoperative neurological deficits improved after the surgeries. Correction of vertebral height and sagittal and coronal deformity was achieved using the described technique. Bilateral cage implantation offers an additional advantage of asymmetrical reconstruction of the ventral column in cases of partial corpectomy. A larger study is currently underway to fully assess the results of the current technique in thoracolumbar diseases.

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Figure legend

Fig. 1. Intraoperative photographs showing (a) L2 corpectomy in Patient 2 via a posterolateral transpedicular approach, showing circumferential decompression at corpectomy site and exiting L2 nerve roots, (b) insertion of expandable cage in an anteroposterior direction through the space between adjacent nerve roots, (c) distraction of expandable cage using standard cage distractor and (d) final position of bilateral expanded cages. (e) Preoperative sagittal T2-weighted MRI. Postoperative (f) sagittal CT scan and (g) coronal CT scan showing cage placement.

Fig. 2. (a) Preoperative sagittal CT scan of T11 lung metastasis in Patient 3 showing kyphotic deformity. (b) Postoperative sagittal CT scan demonstrating correction of kyphosis.

Fig. 3. (a) Preoperative coronal CT scan of T12 tongue squamous cell carcinoma in Patient 5 illustrating coronal deformity. (b) Postoperative coronal CT scan displaying improved coronal alignment.

Fig. 4. (a) Preoperative coronal CT scan showing myeloma involving T11 and partial T12 bodies in Patient 4. (b) Postoperative coronal CT scan of a hybrid reconstruction of the ventral column using bilateral expandable cages.

Table 1 Demographic and clinical data of patients who underwent thoracolumbar corpectomy and fusion

Patient	Age	Sex	Diagnosis	Corpectomy levels	Follow-up (months)	Operative time (hours)	Intraoperative blood loss (ml)	Postoperative stay (days)
1	65	M	Osteomyelitis	T7–T8	1.5	7.5	1200	12
2	58	M	Lung carcinoma	L2	1	6	1000	5
3	62	F	Lung carcinoma	T11	2	6	1200	5
4	77	M	Multiple myeloma	T11–T12	10	7.5	1500	6
5	63	M	Tongue SCC	T12	2	6	1500	7

F = female, M = male, SCC = squamous cell carcinoma.

Figure 1a

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Figure 1b

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Figure 1c

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Figure 1d

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Figure 1g

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Figure 3a

ACCEPTED MANUSCRIPT

Figure 3b

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Figure 4b

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