

Anterior Column Reconstruction Using Titanium Mesh Cages after Thoracolumbar Corpectomy: Clinical and Radiological outcome

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Abstract

Background Data: The optimal treatment of unstable thoracolumbar spine due to trauma, tumors, and tuberculous spondylitis remains controversial. Treatment goals of thoracolumbar corpectomy are: to prevent neurological deterioration; enhance neurological recovery; stabilization, and to prevent late pain and deformity.

Purpose: This retrospective study was conducted to determine the safety and efficacy of stabilization using titanium mesh cage reconstruction filled with autogenous bone graft and anterior plating after thoracolumbar corpectomy due to trauma, tumors or tuberculous spondylitis.

Study Design: A retrospective clinical case study.

Patients and Methods: A series of patients underwent reconstruction of the anterior column after thoracolumbar corpectomy between June 2006 and June 2011 were reviewed. Sixteen patients underwent reconstruction using titanium mesh cages, and retrospectively analyzed data from the medical records and radiographs including immediate postoperative and latest follow up. The etiology due to trauma in ten cases, tuberculosis in three cases, metastasis in two cases and myeloma in one case. An average duration of follow up was 18 months [8-58 months], single level reconstruction done in trauma and tumor cases, two level corpectomy done in tuberculous spondylitis cases. The degree of kyphosis, construct height and the subsidence of the cage in relation to the vertebral endplates were measured preoperatively, early post operative, and at the latest follow up. The surgical approach was thoracoabdominal in 10 cases and retroperitoneal in 6 cases.

Results: Neurological recovery in our study; 4 patients were neurologically intact, Frankel grade E on admission , and all of them remains intact postoperatively. Of the 6 patients with Frankel D on admission, all had recovered full motor and sensory function. Of the 6 patients with Frankel C on admission, three improved one grade, the other three improved two grades. The mean construct height of the involved vertebrae before surgery was 41 mm and the mean construct height immediate after surgery and at follow up were 47 and 44 mm respectively. Solid fusion was observed in all patients, there were no hardware failure. The sagittal alignment of the fractured segment was satisfactorily restored immediately after surgery as a significant decrease in the local kyphotic angle.

Conclusion: Anterior instrumentation is an effective and safe treatment for thoracolumbar instability by demonstrating satisfactory clinical and radiological outcomes. (2012ESJ028)

Keywords: thoracolumbar; corpectomy; anterior column reconstruction

Introduction

The optimal treatment of unstable thoracolumbar spine due to trauma, tumors, and tuberculous spondylitis remains controversial. Primary goals in management of thoracolumbar instability are preservation of remaining spinal cord function, restoring of spinal alignment, maximize neurological recovery and early rehabilitation. This can be by optimizing neural decompression while providing stable internal fixation over the least number of spinal segments.¹⁶

Anterior decompression and reconstruction supplemented with instrumentation is generally believed to be superior to fixation with posterior pedicle screw instrumentation for highly unstable thoracolumbar spine but the indications and methods for anterior approach has not been fully documented.^{6,17}

The objectives of this study was to evaluate the clinical and radiological results of anterior reconstruction and instrumentation using titanium mesh cages after thoracolumbar corpectomy.

Patients and Methods

Sixteen patients underwent reconstruction using cylindrical titanium mesh cages and plating after thoracolumbar corpectomy. Corpectomy done after trauma in 10 cases, tuberculosis in three cases, metastatic deposit in two cases and myeloma in one case. The mean age of the patients was 43.5 years. There were 10 males and 6 females. Neurological status was assessed using Frankel motor scoring system. Inclusion criteria were a: incomplete paraplegia, b: radiological evidence of mechanical instability; greater than 40% canal compromise and 50% loss of vertebral body height.

An average duration of follow up was 18 months (8-58 months), single level reconstruction done in trauma and tumor cases, two level corpectomy done in tuberculous spondylitis cases. This study included sixteen patients, ten with traumatic thoracolumbar instability, three with tuberculous spondylitis and two with metastatic deposits and one case with myeloma. The level was LV1 in 6 cases, DV12 in 4 cases and LV2 in 6 cases.

Operative Techniques:

The surgical approach was via thoracoabdominal in 10 cases and via retroperitoneal approach in 6 cases. A left sided approach is preferred to avoid

retraction of the liver and inferior vena cava. In thoracolumbar approach, exposure above and below the diaphragm is needed to obtain adequate working area for decompression and placement of the instrumentation.

All patients underwent corpectomy and decompression of the spinal canal with anterior column reconstruction using a cylindrical titanium mesh cage. Great care was taken to preserve the bony endplates as much as possible while preparing the endplates after corpectomy, the inferior and superior ends of the cage were trimmed to match the sagittal alignment of the vertebral endplates. Each cage is filled and surrounded laterally and anteriorly with bone chips mixed with demineralized bone matrix and synthetic bone as allograft especially in metastatic spine. Autograft was harvested from iliac bone and the fractured vertebral body in traumatic cases but in neoplastic and tuberculous cases; iliac bone graft was used to fill the cage. In traumatic cases; the corpectomy was subtotal leaving a small rim of the vertebral cortex on the contralateral side of the approach, so as to avoid injury to the contralateral segmental vessels. The plate device is placed, and distractive forces are applied to reduce the kyphotic deformity (Figure 1,2,3).

Radiologic Evaluation:

Kyphotic deformity was assessed on lateral radiographs of the thoracolumbar spine using the Cobb method. Cobb angle was measured between the superior endplate of the upper level vertebra to the corpectomy and the inferior endplate of the lower level to the corpectomy. Kyphotic angle was measured preoperatively, early postoperative at one month and at the latest follow up. Check of the construct height by measuring the distance between the inferior endplate of superior vertebra to corpectomy and the inferior vertebra to the corpectomy on lateral x ray.

In all patients, dynamic x-ray and CT scan were performed 3 months postoperatively to document stability, fusion, subsidence and possible hardware displacement. Determination of fusion can be difficult with anterior thoracolumbar instrumentation, a construct was deemed stable in absence of motion on flexion/extension films, lack of significant radiolucency at the interbody graft vertebral body junction, and no evidence of interval change in angulation in one year period.

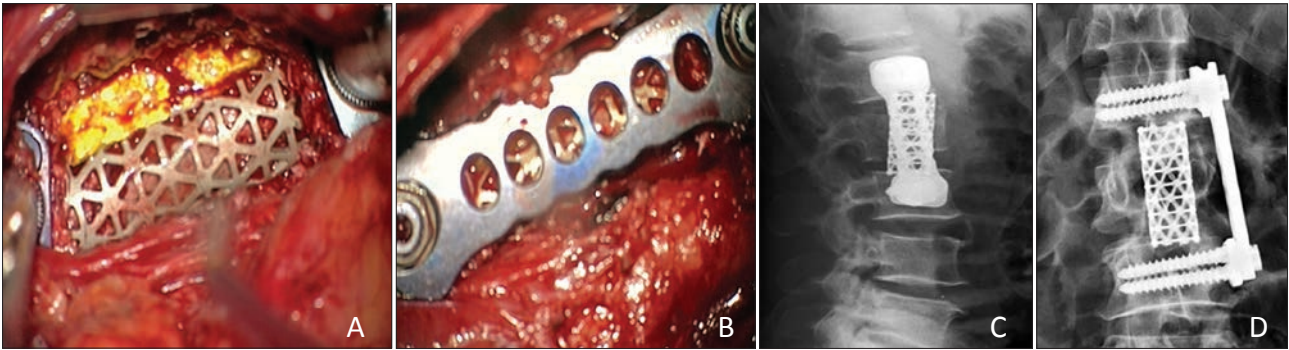


Figure 1. A: operative foto after corpectomy and cage insertion. B: foto after plating. C,D: postoperative AP, lat radiographs.

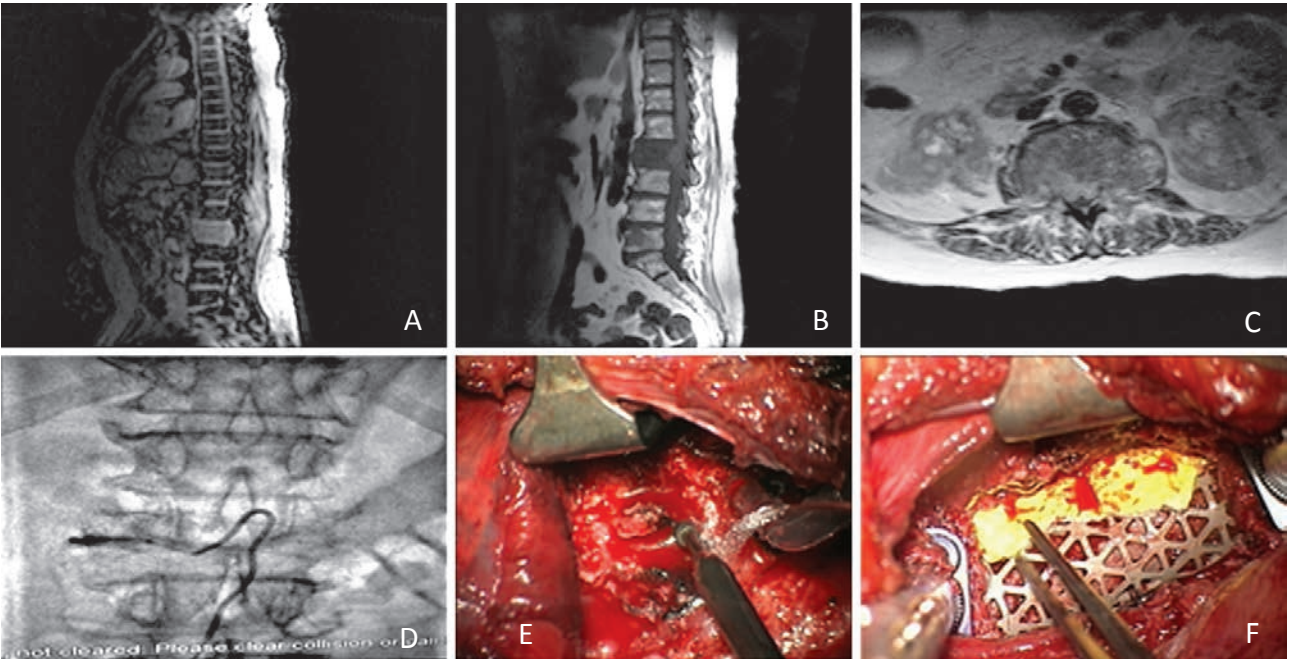


Figure 2. A,B,C: MRI showing LV2 mets. D: preoperative embolization. E,F: operative foto after corpectomy and cage insertion.

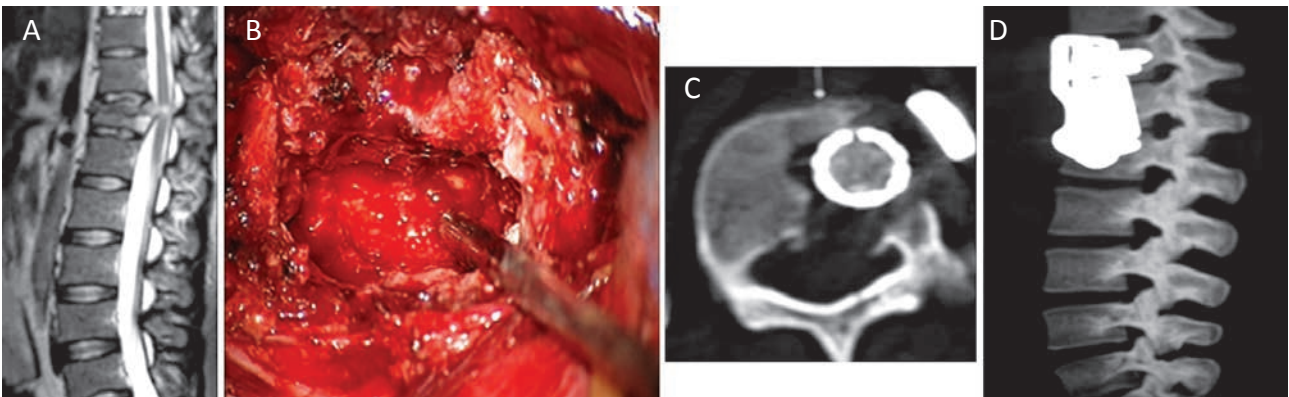


Figure 3. A: Preoperative Sagittal MRI showing DV12 fracture with retropulsed fragment. B: operative foto after corpectomy. C: axial CT-scan showing good decompression. D: sagittal CT-scan reformate after plating.

In this study the average extent of canal encroachment in our series was 55% (range 40-75%) according to the measurements in axial CT of the compromised vertebra. The mean preoperative kyphotic deformity in the current group was 13 degree (Range 5-16 degree).

Results

Neurological Outcome:

Four patients were neurologically intact, Frankel grade E on admission, and all of these remained intact postoperatively. Of the six patients with Frankel D on admission, all had recovered full motor and sensory function. Of the six patients with Frankel C on admission, three improved one grade and the other three improved two grades (Table 1).

Table 1. Shows the Preoperative and Postoperative Frankel Grades

Frankel grade before operation	No of cases	Frankel grade after operation				
		A	B	C	D	E
A						
B						
C	6				3	3
D	6					6
E	4					4

Radiological outcome:

The mean (\pm SD) preoperative kyphosis was 2.0 \pm 13.5 degree. The mean kyphosis immediately after surgery was 2.6 \pm 14.5. The mean kyphosis at final follow up was 3.4 \pm 13.5. There was no significant difference between the postoperative and final kyphosis measurement in this study. The mean construct height of the involved vertebrae before surgery was 41 mm and the mean construct height immediate after surgery and at follow up were 47 and 44 mm respectively. However, there were no case of severe collapse or significant recurrence of the deformity. All patients achieved solid fusion with significant neurological improvement and no significant correction loss.

Morbidity:

Two patients developed intercostal neuralgia that was improved after intercostal nerve block and medical treatment, postoperative pneumonia was reported in one patient, superficial wound infection in another one. There were no intraoperative or late vascular injuries. Complications directly attributed to the use of titanium mesh cage were not reported in this study.

Discussion

The vertebral body plays a significant role in maintaining the biomechanical instability of the spine and is responsible for transmitting up to 80% of the axial load applied to the spine.⁴ Pathological processes such as trauma, malignancy, infection can involve the vertebral bodies, resulting in incapability of maintaining anterior column support and stability.^{3,6,17}

Vertebral body destruction can result in ventral compression of the neural elements and compromise of neurologic stability. Under these circumstances, after indirect decompression of neural elements through ligamentotaxis alone is not as effective as direct anterior decompression. The patients may need to undergo vertebrectomy and anterior reconstruction.^{2,5}

Anterior approaches can achieve sufficient decompression and immediate stabilization of the spinal column.⁷ The ideal reconstruction device of anterior column should provide a mechanical stability and spinal alignment maintenance while facilitating stable fusion. The anterolateral approach provides a more direct and complete decompression of the spinal canal, bone fragments can be removed from the canal under direct vision potentially allowing a better neurological outcome. This approach protects the integrity of the posterior column and is associated with a sustained correction of angular deformity. Disadvantages of anterior surgery include the more extensive approach required, lack of familiarity to many spinal surgeons, the potential for thoracic pain, and the potential for pulmonary complications.^{6,9}

Tricortical iliac graft and rib graft have been used extensively to construct the corpectomy defect. Disadvantages of them are less ideal shape for corpectomy reconstruction and lack of intrinsic stability. Resorption of the graft during fusion will

leads to graft collapse, which places an increased bending moment at the screw/plate interface and precipitates fatigue and subsequent failure of the construct.^{4,10,19}

The anterior approaches in patients with vertebral fractures requires fixation of only one level rostral and caudal to the fractured vertebral body, whereas in posterior approach instrumentation may span five or more levels whereas the anterior column has been disrupted with secondary deformity.^{1,8}

To optimize fusion, bone grafts are better maintained under compression, and this is achieved more effectively by using an anterior approach and the plating with bicortical screws.^{8,11} There is little evidence in the literature that describes the efficacy of outcome using cylindrical mesh titanium cage for postcorpectomy reconstruction. Mc Afee⁹ reported on complications associated with the anterior approach when used in patients with thoracolumbar fractures undergoing decompression and stabilization. The failure rate was 96% (two of 35 patients).

The primary function of the titanium mesh cage is to provide structural support to the anterior column.^{3,8} The cage can be filled with autogenous graft which also enables to maintain osteoinductivity and osteoconductivity.¹⁴ The largest endplate is selected to reduce the incidence of subsidence and telescoping of the graft within the vertebral body adjacent to the fracture. With the advent of newer instrumentation techniques and use of anterior approaches, the degree of neurological recovery appears favorable than earlier reports.⁸

Multiple cages with varying diameters and heights are available and can be filled with autogenous bone graft which also enable to maintain osteoinductivity and osteoconductivity.⁸ Titanium mesh cage with cancellous bone after corpectomy provide immediate structural support to the anterior column while the cancellous bone inside the cage promotes fusion and the traditional stability can be achieved with anterior stabilization device. The cages give resistance to axial compression, lateral flexion and axial rotation. The additional stability can be achieved with anterior stabilization device.

Spinal metastasis often requires corpectomy through an anterior approach followed by posterior column reconstruction and subsequent instrumentation. This circumferential reconstruction

is often associated with significant risks.^{12,13,18} In this study, two patients had spinal metastasis underwent preoperative embolization followed by stand alone anterior column reconstruction with neurological improvement.

The fusion rate in our study was 100% and in accordance with the literature.^{2,3,9,15,16} Proper fit of the cage and gentle axial loading may create biomechanically and biologically favorable conditions for fusion. Bony fusion at the implant/vertebral body interface is sufficient for solid fusion. We have not closely evaluated radiological fusion but rather accepted radiological stability when the clinical results have been acceptable. Because it is well established that radiologic methods of fusion assessment are not completely reliable. So we depend on the fusion mass outside and surrounding the cage is easier to assess with plain radiography than the fusion within the cage. Thus, we filled the bone chips around the cage to help the assessment later. The 1 mm slice CT scans with sagittal reconstruction is superior to plain radiographs for assessment of fusion within and around the cage.

Davarok et al³ recommended anterior and posterior in thoracolumbar vertebral reconstruction to avoid mechanical failure. As a result of biomechanical improvements in anterior instrumentation, several investigators reported good results with anterior decompression and stand alone instrumentation.^{7,15,17} Our results data are in agreement with previous studies that suggest titanium mesh cages provide a durable biomechanical stability. This study demonstrates that titanium mesh cages were effective at maintaining sagittal alignment over a postoperative period of 18 months.

Conclusion

Titanium mesh cages with cancellous autograft bone after corpectomy of the thoracolumbar spine provides immediate structural support to the anterior column and it offer biomechanical stability without any evidence or any significant recurrence of the deformity. The present study has shown that anterior instrumentation is an effective and safe treatment for thoracolumbar instability by demonstrating satisfactory clinical and radiological outcomes.

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الملخص العربي

إعادة البناء الأمامي باستخدام أقفاص تيتانيوم بعد استئصال الفقرات الصدرية و القطنية. دراسة النتائج السريرية و الأشعية
مازال هناك اختلاف في استخدام الطريفة المثلي لتثبيت الفقرات في منطقة التقاء الفقرات الصدرية و القطنية بعد كسور الفقرات والأورام والإصابة بدران الفقرات.
تهدف الدراسة إلي تقييم فاعليه استخدام المدخل الأمامي في تثبيت الفقرات في منطقة التقاء الفقرات الصدرية و القطنية باستخدام الأقفاص المعدنية مع الشرائح و المسامير.
أجريت الدراسة علي ستة عشر مريض. عشرة حالات كسور الفقرات وثلاث حالات كسور الفقرات والأورام و ثلاث حالات إصابة بدران الفقرات. وكانت مدة الدراسة ثمانية عشر شهرا. وتم استخدام المدخل عن طريق الصدر والبطن في عشرة حالات وعن طريق مدخل خلف الغشاء البيرتوني في ستة حالات.
وقد اظهر استخدام مقياس فرانكل تحسن الحالات من الناحية الغصبية و أظهرت الأشعات في المتابعة تحسن درجه انحناء العمود الفقري مع ثبات و التئام جيد للأقفاص المعدنية.