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ORIGINAL ARTICLE

Anterior Cage Fixation in Spinal Injuries

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ABSTRACT:

Introduction: *In the operative treatment of spinal injuries, the reconstruction of the anterior column of the thoracolumbar spine is still controversial. Spine stability and canal decompression, in case of a neurological deficit, are recognized treatment objectives. Various conservative and surgical strategies have been proposed to achieve these goals. Anterior reconstruction using Titanium mesh cage is one of them. There is little in the literature that describes the efficacy or outcomes of using cylindrical mesh titanium cages for anterior reconstruction. This retrospective study evaluates the benefits and efficiency of titanium mesh cage implantation in thoracolumbar Spine fractures at various levels.*

Methods: *The study comprised 121 patients (98 men and 23 women) between ages 15-70 years with one spinal fracture with two or three column destruction, who underwent with expandable cage placement, between January 2005 to January 2009. Neurological status was classified using American Spinal Injury Association (ASIA) impairment scale and motor index. The fusion status and spine alignment were examined by radiological imaging.*

Results: *All patients in this study achieved solid fusion with significant neurologic improvement. Mean follow up time was 6 months. Neurologic status in 41 patients (pre op: ASIA-E post op-unchanged). 30 patients (pre-op: ASIA-D, post-op improved to ASIA-E). 6 patients (pre op: ASIA-B, 2 patients improved to ASIA-D and 5 patients improved to ASIA-D). Pain improved in all case and sensations were last to recover.*

Conclusion: *The TMC is an effective adjunct in restoring and maintaining sagittal plane alignment after thoracolumbar vertebrectomy to achieve canal decompression and in this context it provides an effective method for anterior column reconstruction. It has been found to be a rapid and safe procedure for lumber spine fusion, with a high fusion rate and clinical success with rare serious complications.*

Key words: *Thoracolumbar spinal trauma, Titanium Mesh Cage, Anterior Column Reconstruction of spine, Spinal stability.*

INTRODUCTION

The rate of spinal fracture is difficult to determine in our country because of lack of reporting. According to a study accidents are the 4th leading cause of death in US with 3% of these deaths due to direct trauma to spine. The National Spinal Cord Injury Registry, established by Ducker and Perot, reported that 40% of spinal injuries were caused motor vehicle accidents, 20% by falls, and 40% by gunshot wounds, sporting accidents, industrial accidents and agricultural accidents combined. It can also be the result of child abuse. In developed countries, traffic accidents seem to be the most common cause, whereas in less developed countries, the most common cause seem to be falls. Vertebral Column instability is a major issue in the traumatic afflictions of spine. Trauma constitutes the predominantly major cause of spinal instability. Commonest site after cervical to be involved in trauma is thoracolumbar followed by lumbar and dorsal spine. As the former two areas have a potential for recovery despite initial profound deficit therefore decompression is of immense importance. Since most of the axial

load of spine is carried by the anterior column, therefore anterior column reconstruction is the most important component in the restoration of normal spinal biomechanics. In recent years several artificial materials and implants have been developed for anterior reconstruction. Titanium mesh cage is one of them which are becoming increasingly popular among surgeons.[1,20] In last decade use of TMCs has been increased greatly but little literature is there to describe its efficacy when used for anterior reconstruction.[10-12] This work evaluated the stability of the TMCs when used for single level corpectomy reconstruction of throraco-lumbar spine and resulting improvement in the neurological status.

MATERIAL AND METHODS

Objectives

The objective of the study is:

1. To check the efficiency of TMC for achieving goals of surgical intervention which are:
   - To decompress the neural elements.
   - To restore vertebral height.
   - To correct angular deformity.
   - To stabilize the columns of spine.
2. To access the improvement in neurological status after anterior reconstruction of spine.

Inclusion Criteria

- Age: 13-70 years.
- Sex: either sex.
- Patients with single level thoracolumbar fracture including 2 or 3 column destruction were added included in this study.
- Patients considered suitable for cage implantation were recruited.

Exclusion Criteria

- Age below 12 years.
- Patients with complete neurological deficit which didn't improve after 48 hours.

Outcome

The outcome was assessed by using ASIA impairment scale and Motor Index.

Motor Index: Muscle strength and weakness are graded from a strength of 5/5, considered normal, to a strength of 0/5, considered paralysis, as follows:

- Grade 0 - No contraction.
- Grade 1 - Muscle contraction.
- Grade 2 - Ability to move through a full range of motion when gravity is eliminated.
- Grade 3 - Ability to move through full range of motion against gravity.
- Grade 4 - Ability to move against resistance.
- Grade 5 - Normal strength.

The ASIA introduced the **ASIA impairment scale**, which consists of 5° of impairment, as follows:

- A: No motor or sensory function is preserved below the neurologic level of injury extending through the sacral segments S_4-S_5.
- B: Sensory function, but not motor function, is preserved below the neurologic level of injury and extends through the sacral segments S_4-S_5.
- C: Motor function is preserved below the neurologic level of injury, and most of the key muscles below the neurologic level have a muscle grade of less than 3.
- D: Motor function is preserved below the neurologic level of injury, and most of the key muscles below the neurologic level of injury have a muscle grade of 3 or higher.
- E: Normal motor and sensory function are preserved.

Study Design

Retrospective study.

Sample Size

121 patients.

Sex Distribution

Male 98.
Female 23.

Sample Technique

Purposive / Convenient Sampling.

Data Collection Procedure

121 patients fulfilling the inclusion criteria were included in this study. These included 98 male and 23 female patients. The age range was between 13 to 45 years.

The distribution of level of fracture was as follows:

Table 1:

Level of Spinal Injury	Level of Trauma	Total Patients	Male	Female
Dorsal	D4 – D11	19	14	5
Junction	D11 – L2	79	70	9
Lumbar	L2 – L5	23	14	9

Neurological Status of the Patients according to ASIA was as follows,

Table 2:

No. of Patients	ASIA Grade
37	E
41	D
30	C
13	B

According to Motor Index Neurological status of the patients was as follows

Table 3:

No. of Patients	Grade
37	5
41	4
30	3
8	2
5	1

Surgical Technique

In the lumbar spine a pure retroperitoneal approach is used whereas in the thoracolumbar region in addition to the former transthoracic approach is also applied depending upon the involved segment. Retroperitonial approach for lumbar vertebrae is done through Morrison incision. Rib resection incision is given for $D_{12} – L_1$, and rib splitting incision is given for thoracotomy to approach dorsal lesions. Pure retroperitoneal approach is done for $D_{12} – L_4$ lesions by muscle cutting and blunt dissection whereas D_{12} can only be properly exposed by detaching the left lateral crus of the diaphragm and retro pleural dissection. Psoas muscle is detached from the affected area and reflected laterally. The affected vertebral body along with the retro pulsed bony fragments and adjacent discs are removed with the help of bone roungers and high speed drill to decompress the thecal sac. The end plates of the adjacent vertebrae are drilled off for proper bony fusion. According to the length of the removed vertebral body, an adjustable or fixed titanium mesh cage filled with corpectomy site bone graft is placed at corpectomy site and internally fixed with plates and screws. The detached crus of the diaphragm are restitched before wound closure.

RESULTS

Between Jan 2005 to Jan 2009, 121 patients with thoracolumbar fracture at single level with age range of 13 – 51 years with a mean of 29 .67, including 98 males (80.99%) and 23 females (19.01%) were operated for titanium cage implantation. Of these 121 patients 19 patients (15.70%) sustained trauma to dorsal spine ($D_4 – D_{11}$) including 14 males (73.68 %) and 5 females (26.32%). 79 patients (62.29%) received injury to thoracolumbar junction ($D_{11} – L_2$) including 70 male (88.61%) and 9 female (11.39%) patients.23 patients (19.01%) had lumbar region ($L_2 – L_5$) trauma including 14 male (60.87%) and 9 female (39.13%) patients. All these patients underwent surgery and anterior column reconstruction with TMCs. There was no remarkable intraoperative complication. Postoperatively there was improvement in pain in all the cases (100%). The neurological status improved in all patients at a mean of 6 months follow up.37 patients (30.58%) included in this study had normal motor and sensory functions which remained intact. 41 patients (33.88%) had pre-op ASIA-D which was improved to ASIA- E.30 patients (24.79%) had pre-op ASIA – C which was improved ASIA- D. 13 patients (10.74%) with ASIA- B improvement occurred, in 8 patients (6.61%) to ASIA – C and in 5 patients (4.13%) to ASIA-D. Post-op complication included CSF leakage in 1 case (0.83%) of dorsal spine fracture following thoracotomy in chest tube. Lumbar drain was placed in the patient with complete stoppage of leakage on 3rd post-op day. 2 patient showed post-op transient weaknesses of the limbs which were subsided on 2nd post op day. In 1 case (0.83%) fracture of the cage occurred 3 months postoperatively due to improper mode of cage fixed in 13 yrs of female.

20 patients showed improvement in sensations at 8 months follow up.

Mortality rate was zero in our study.

Illustrated Case

Fig. 1: *Case of traumatic fracture of thoracolumbar junction X-ray lateral view.*

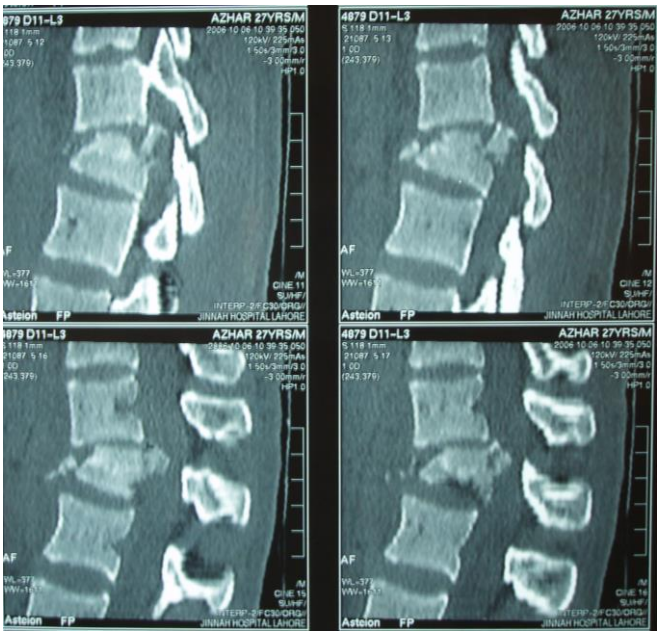

Fig. 2: *CT Scan of the same patient saggital view.*

A

B

C

Fig 3: *CT Scan showing axial view.*

DISCUSSION

The surgeon who treats the spinal trauma must be able to apply a variety of management techniques to

Per operative Details

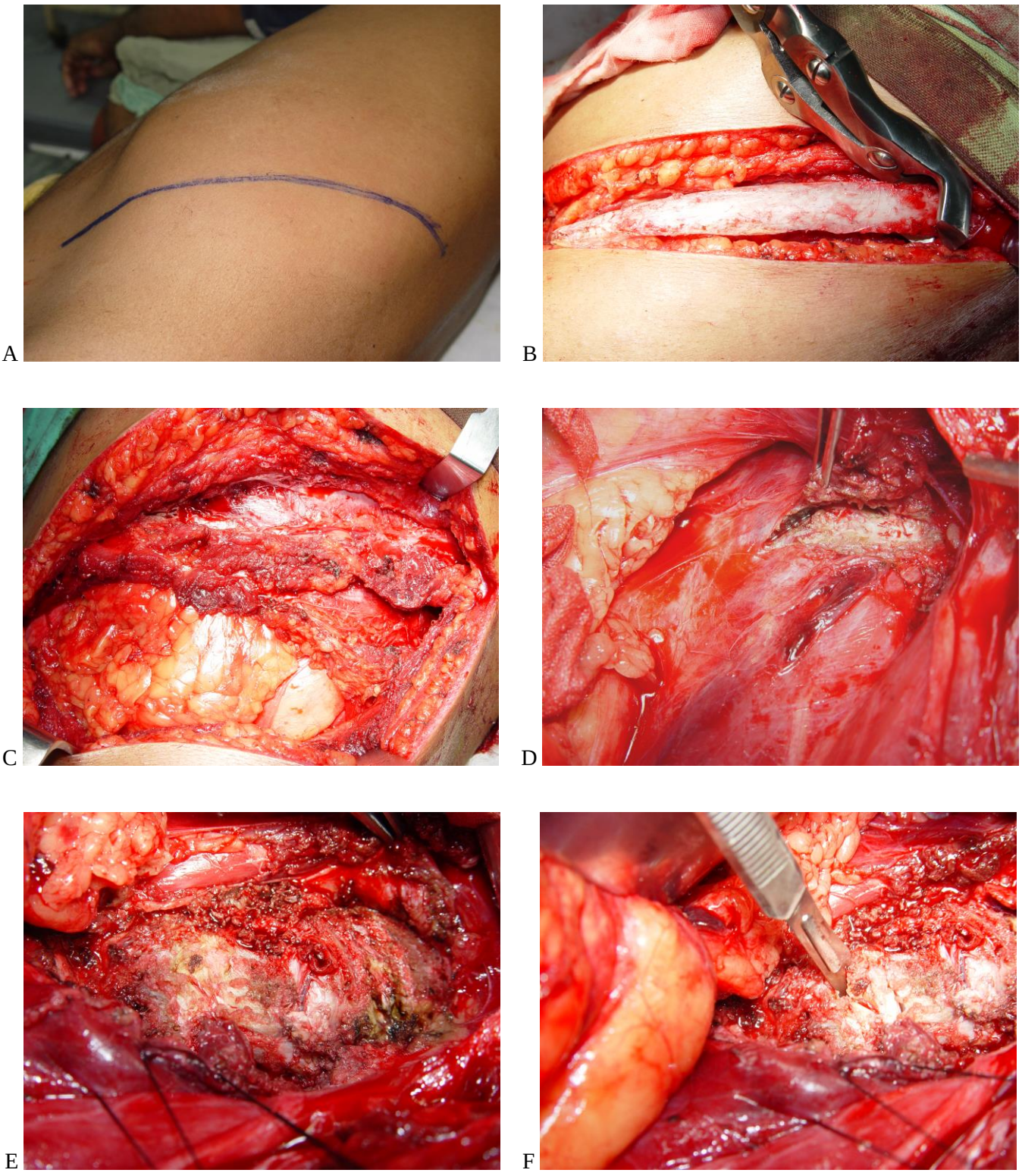

Fig 4: *Per operative steps.*

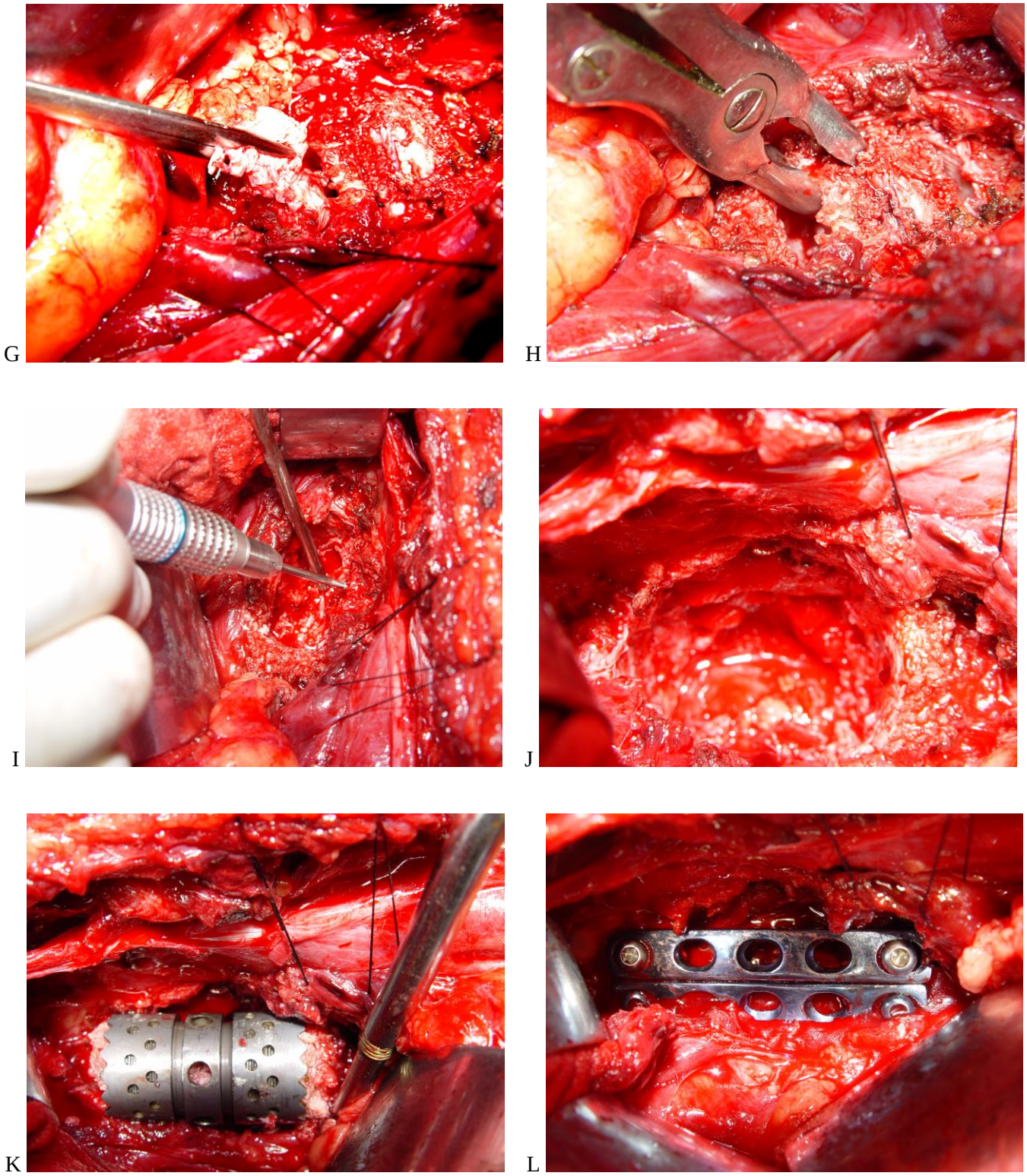

Fig 4: *Per operative steps.*

achieve optimal care of the patient.[5] In cases of unstable thoracolumbar fractures ideal approach is to provide immediate stability after canal decompression to prevent neurological damage. Literature shows

several studies using short segment posterior pedicular fixation following trauma with high rate of instrumentation failure, even with transpedicular bone grafting. The major cause of failure is cantilever bending forces which act on the screws in the absence of competent anterior column. On the other hand, anterior constructs have some obvious advantages and offer a short segment for stability.[11,12] Several biomechanical studies have revealed that in the thoracolumbar area, anterior constructs were more rigid in axial compression, torsion and flexion loading then posterior constructs.

Post operative

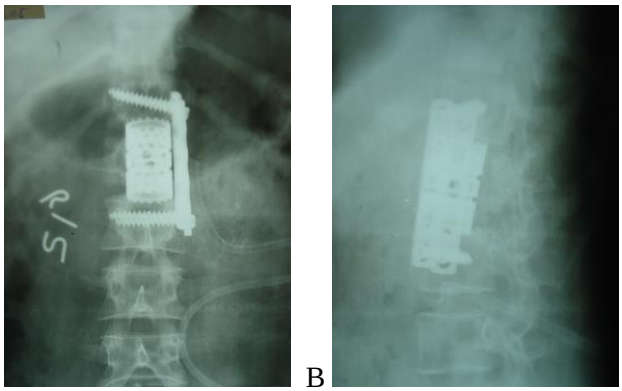

Fig. 5: *Postoperative radiographs showing cage placement.*

Preferred graft material for anterior reconstruction is cancellous bone but it is too soft to maintain the space during fusion without mechanical support. Various methods have been used in the past to maintain the graft integrity during fusion development. The use of interbody device such as Titanium mesh cages has become increasingly common over the last decade.[7] TMCs offer several advantages including immediate anterior stabilization, reapproximation of intervertebral disc heights and obviation of bone graft harvesting from outside the surgical site [9]. Unlike bone grafts, Sharp edges with end tip spikes of TMCs allow them to anchor into the adjacent vertebral bodies and provide torsional stability. Vertical placement of the cage allows room for autogenous grafting and for contact of the graft with the vertebral endplates.[6]

In addition to that TMCs help bending movements on accessory instrumentation, such as anterior plating system or transpedicular fixation by providing a stable anterior column. Subsidence of the sharp edges into adjacent endplates acts against dislocation. This results in less chance of instrumentation failure after anterior corpectomies.

A recent advancement is the expandable titanium cage.[3] These are versatile and help to reconstruct the column defect and restore saggital alignment of spine. They help to facilitate distraction across the resected vertebral defect for correction of deformity, allow immediate load bearing after corpetomy, and provide a satisfying long term functional result.

Stability

Post operative stability consists of two stages: initial stability and long term stability. The initial stability depends on the internal fixation, and the long term stability comes from the bony fusion.[14]

Indeed, bony fusion rates with TMCs are significantly higher than non instrumented fusion rates (95-100% vs. 89.7%) [19]. Epari et al.[2] have theorized that fusion may be aided in the cage by their proclivity for subsidence. As the intervertebral height decreases slightly, loading on the bone graft within the cage increases, providing mechanical signals for bone growth. Histological review of bone within the cage in two different series found evidence of viable bone in 100% of cases at an average of two years post operatively, attesting to the high fusion rates of these cages.[17,18]

One potential complication with the expandable cage that they prevent adequate radiographic assessment of fusion and offer a smaller surface as a fusion bed than titanium mesh.[6]

Complications may result from the surgical approach and from the placement of spinal instrumentation. The interior approach may cause a risk of great vessel injury as well as internal organ injury because of unfamiliar anatomical landmarks or excessive traction. A retroperitoneal approach also requires careful protection of the ureter, lumbosacral plexus, and sympathetic chain. In a recent retrospective study, Oskouian and Johnson reported a 5.8% incidence (12 of 207 patients) of vascular complications in patients who underwent anterior approaches in the thoracic and lumbar spine, but without serious consequences. In our series we observed no vascular and internal organ complications. There was one case of cage fracture due to improper implantation.

CONCLUSION

In this study, the reconstruction of stability was achieved through the anterior approach with the titanium

mesh cage packed with autogenous bone graft and an anterior bypassing plating fixation. In comparison with the auto graft of the ileum or rib,[15,16] the titanium mesh cage packed with autogenous bone graft can better support the stability of the spine, reduce the loss of the interbody height, prevent the secondary kyphotic deformity, decrease the load sustained by the plate and screws, avoid the loosening or fatigue fracture of the screw, ensure the bone fusion at the functional areas of the spine, avoid an incision for the ileum bone harvesting and its complications, reduce the operative trauma, and take advantage of the bony pieces from the excision of the fractured vertebral body.[14] In addition, since the upper and below ends of the cage have a large contact surface, and the cage is tightly implanted into the intervertebral space, the stability and the fusion of the bone graft is better.

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