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Anterior Thoracolumbar Fixation for Management of Thoracolumbar Spine Injury

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Abstract: A retrospective analysis was carried for sixty patients with thoracolumbar spine injury operated during Jan 2001 to Dec 2003. Fifty (84%) were male and ten were female patients. Thirty six (60%) sustained injury by vehicular accident and 24 (40%) due to fall, ejection and obstacle crossing. There were four patients with associated head injury, seven with extremity, four with chest and two patients with abdominal injury. All patients presented with features of spinal cord/ cauda equina injury and evaluated with Frankel's neurological grade at admission. Eight patients presented with grade 'A', two grade 'B', thirty six grade 'C', fourteen grade 'D' neurological deficit as per Frankel's classification. Plain radiography, Computerised Tomography (CT) scan, and Magnetic Resonance Imaging (MRI) of thoracolumbar spine revealed fracture L1 in 32, D12 in 14, D11 in 07, L2 in 07. Corpectomy + bone grafting in 06; corpectomy + bone grafting + plating in 07; corpectomy, cage placement in 07; corpectomy, cage placement + plating in 40, were carried out. Outcome was evaluated at two months, six months and one year in Frankel's grade. The outcome was Frankel's 'A' 08, Frankel's 'B' 02, Frankel's 'D' 23 and Frankel's 'E' 27. Ten patients did not show any recovery. There was wound infection in two, mal-alignment of cage in two and lateral placement screws were found in two patients. Revision surgery was not carried out, as the patients were stable. The implants were in position during post-operative follow up. The study revealed, there was good reduction, decompression and stabilisation in all patients. The patients were mobilised early with external support after spinal stabilisation. Patients with incomplete spinal cord injury showed excellent to good recovery and patients with initial Frankel's 'A' & 'B' did not show any recovery.

Keywords: Anterior Thoracolumbar Z-Plate fixation, Corpectomy Thoracolumbar Spine injury, Titanium Cage Placement

Introduction

Spine injury is a devastating, traumatic event, experienced by young people, which produce severe disability and even morbidity and mortality. Spine injury imprisons its victims with life long sentence of paralysis, sensory loss & dependence. There is an increase in incidence due to road traffic accidents, violence and fall. Knowledge of biomechanics, mechanism of injury, pathophysiology and newer investigation modalities like Magnetic Resonance Imaging (MRI) has improved management protocol and outcome. In recent years, neurosurgeons and orthopedic surgeons have seen the field of spine surgery invaded by multiple instrumentations and now the development is such that it is difficult to keep abreast of the different instrumentations available in the market. Faced with thoracolumbar fracture, the initial goal is to save life in those patients who are often victims of multiple trauma. Prevention of neurological function comes second, and finally spinal alignment, stability, rapid mobilization and early rehabilitation has to be considered.

A retrospective analysis was performed for 60 patients surgically treated with anterior thoracolumbar spine stabilisation to evaluate the mode, extent of neurological deficit, type of injury, associated injury, surgical procedures performed and functional outcome.

Material and Methods

Over the past three years from Jan 2001 to Dec 2003, 94 patients with thoracolumbar spine injury were admitted and managed in our institution. Amongst them, 60 patients underwent anterior thoracolumbar fixation surgery during the same period for neurological deficit and instability of the spine.

Patients were clinically evaluated for mode of injury, extent of Neurological deficit (Frankel's grade) and associated injuries. Anterior Posterior (AP) and lateral radiographs, Magnetic Resonance Imaging (MRI) scan of thoracolumbar spine was carried out in all patients. Computerised Tomography (CT) scan of the spine was

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carried out to study detail bony and type of injury. The patients were operated within one day to six weeks of their injury. The outcome was evaluated with Frankel's scale after two months, six months and one year following surgery.

Anterolateral transthoracic transpleural and lumbotomy approach was carried out with the following consideration.

(a) Thoracolumbar junction injury with incomplete or complete neurological deficit with a large retropulsed fragment in the spinal canal.

(b) Canal compromise of more than 67%.

(c) Anterior column communition and marked kyphosis (>30 degrees).

(d) Greater than 4 days from the time of injury

Operative Technique

The fractured vertebral is exposed by a left sided transthoracic intrapleural/lumbotomy retroperitoneal approach. We prefer a left sided approach to avoid retraction of the liver and inferior vena cava. We have found that exposure above and below the diaphragm is usually needed to obtain an adequate working area for decompression and placement of the instrumentation. The patient is placed in the true lateral position, with sufficient axillary roll under the right armpit and the fracture level over the break of the table. The table is then flexed to open up the vertebral interspaces. In most cases an 11^{th} rib exposure is used, and the bone is saved for later use as part of the autograft. Ligating the segmental vessels exposes one vertebral level above and below the fracture. The neural foramen (and therefore the anterior wall of the canal) is identified to define the posterior extent of the corpectomy. The disc spaces are incised and a Cobb elevator is used to scrape the endplates. Care is taken to avoid injuring the vertebral endplates of the adjacent vertebral bodies. The disc material is then removed using a combination of pituitary rongeurs and curettes. With the neural foramen as a posterior landmark, the bulk of the vertebrectomy is performed with an osteotome to preserve as much bone as possible for use as autograft. Alongwith the harvested rib, this quantity of bone has always been adequate to pack our cages fully and has obviated the need for harvesting iliac crest autograft. A high-speed drill is used to finish the corpectomy, drilling the bone to a thin layer of cortical bone ventral to the posterior longitudinal ligament, which is carefully removed by using the curette to push it ventrally into the corpectomy defect. The dura is always visualised from pedicle to pedicle, and epidural venous bleeding is controlled. The Z-plate device is placed, and distractive forces are applied to help reduce the kyphotic deformity. An appropriate-sized titanium interbody cage is measured. It is then tightly packed with the corpectomy bone and rib and tapped gently into place, and care is taken to avoid impinging on the dural sac. The cage and bone graft are placed under compression by removing the flexion from the table and compressing across the Z-plate. The wound is then irrigated with antibiotic solution and closed in layers with a thoracostomy tube postoperatively if pleura is opened. The following operative techniques were carried out :

Anterolateral Transthoracic Transpleural/ Lumbotomy Approach

Corpectomy & bone grafting

Corpectomy, bone grafting & 'Z' plate fixation

Corpectomy and Titanium cage placement

Corpectomy, Titanium cage placement & 'Z' plate fixation.

Post operative Orthotic Use

All patients were fitted with a custom-made thermally moulded plastic thoracolumbosacral orthosis and were encouraged to ambulate within 7 days of surgery. Patients underwent brace therapy for 3 months postoperatively and were then weaned from the brace over an additional 2 to 3 weeks.

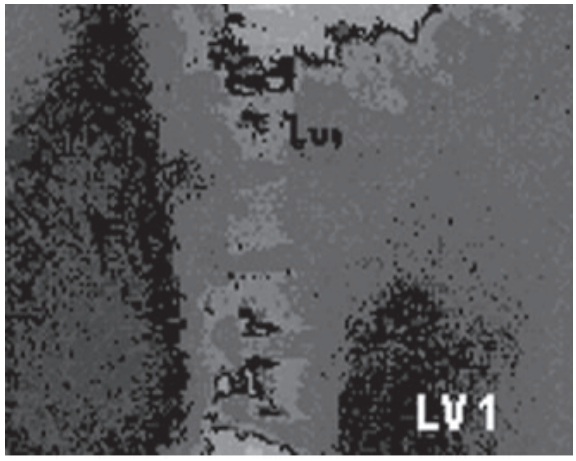
Results

Forty five patients (75%) in the present series were young adults in the age group of 21 to 40 yrs. Males 50 (84%) were affected predominantly. The maximum number of patients 36 (60%) sustained injury due to road traffic accident, other causes of injury were fall from height in 16(27%), ejection 02 (03%), and 06(10%) during obstacle crossing.

The extent of Neurological deficit as per Frankel's grade was as follows : Grade 'A' 08, grade 'B' 02, grade 'C' 36, and grade 'D' 14. The maximum number of patients 07 had associated extremity bony injury, 04 had head, 04 chest and 02 patients had abdominal injuries.

Plain radiographs (Fig 1), CT scan & MRI scan (Fig 2, 3) revealed L1 fracture in 32, D12 in 14, D11 in 07, L2 in 07 patients. Corpectomy and bone grafting in 06, corpectomy, bone grafting and plating in 07, corpectomy & titanium cage placement in 07 (Fig 4), corpectomy, titanium cage placement & 'Z' plate fixation (Fig 5,6,7,8) was carried out in 40 patients. There was no vessel injury, neurological deterioration or death in operated patients. However, two patients had wound infection, which was managed by antibiotics and wound dressings. Post operatively the Neurological recovery of the patients was

assessed as per Frankel's grade after two months, six months, and one year. Excellent recovery was observed in 27 patients and good recovery in 23 patients. Patients with Frankel's grade 'A' and 'B' did not show any neurological recovery post operatively. None of the patients had implant failure. There was mal-alignment of cage in 02 patients and lateral placement of screws in 02 patients. Revision surgery was not carried out, as the patients were stable.



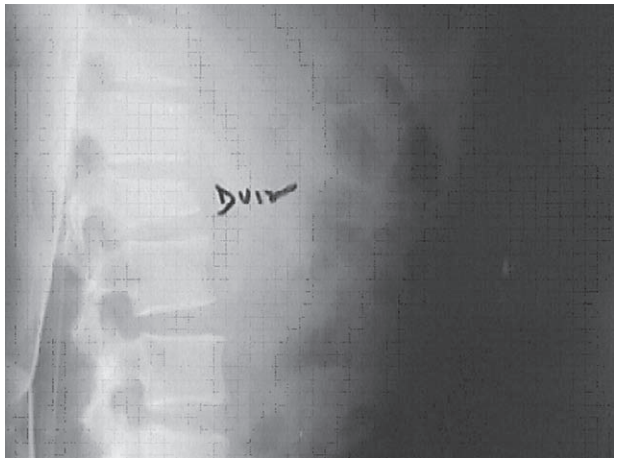
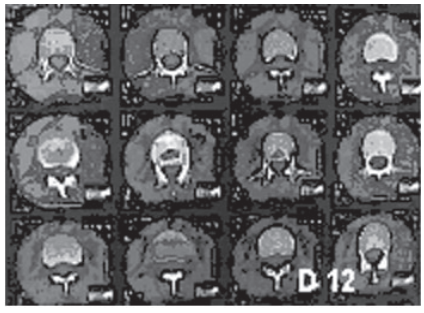
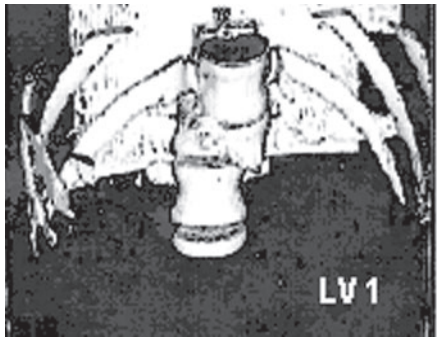


FIGURE1. Plain Radiographs showing compression fracture





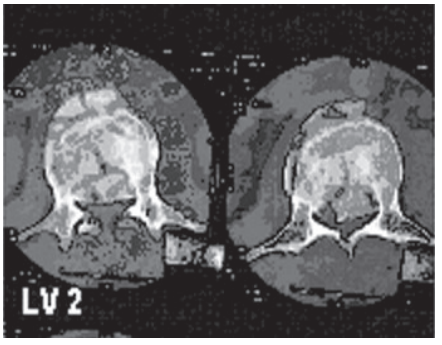
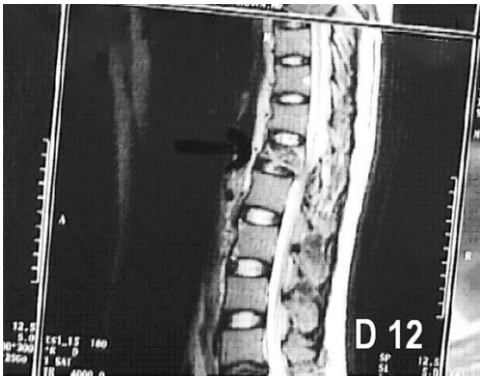
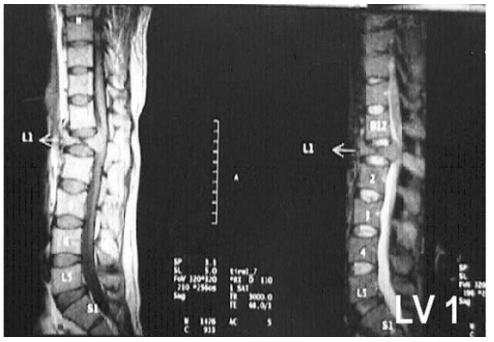


FIGURE 2. CT Scan showing burst fracture





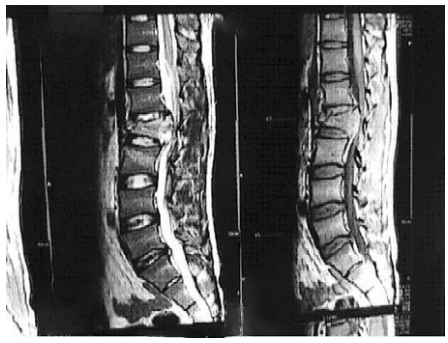


FIGURE 3. MRI showing compression & burst fractures

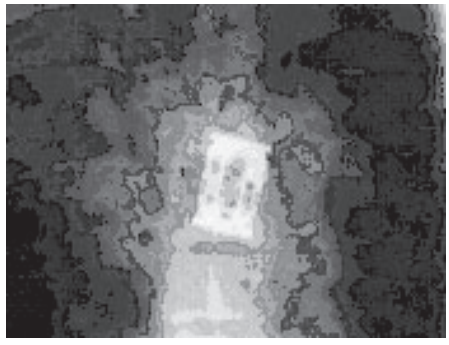
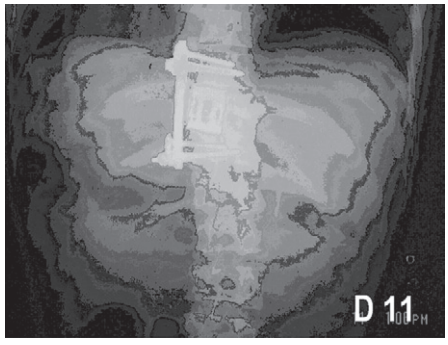


FIGURE 4. Titanium Cage Placement (TSRH)



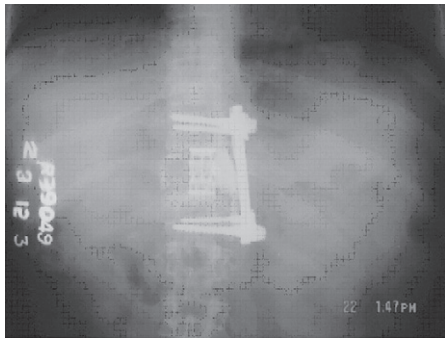
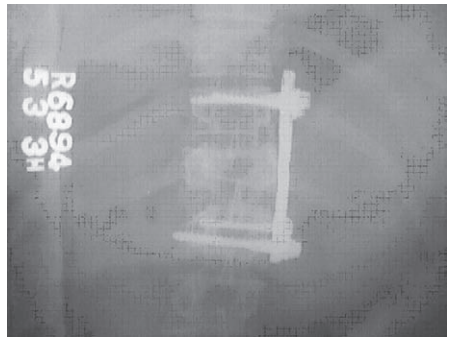


FIGURE 5,6. post operative X-Rays showing cage placement and plating (TSRH)



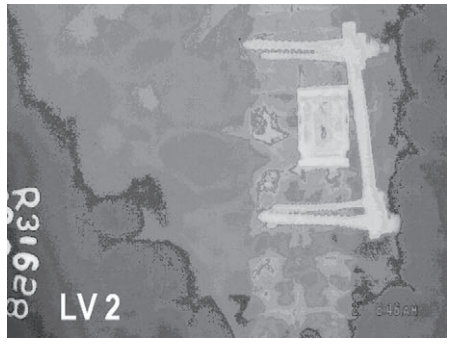


FIGURE 7,8. post operative X-Rays showing cage placement and plating (TSRH)

DISCUSSION

The need for surgery in case of compression fracture of the thoracolumbar spine is not universally accepted. A patient with canal compromise of less than 40% with minimal angulation and without neurological deficit may be treated conservatively with a thoracolumbar brace. In those patients many series have shown that the conservative approach is a satisfactory one and the long-term result is similar with or without surgery[1].

Thoracolumbar fracture with a canal compromise of over 40-50%, a kyphosis over 25-30% with neurological involvement, decompression, open reduction and internal fixation is mandatory[2]. Once internal fixation has been decided upon, a surgeon then has the choice between an anterior approach and a posterior approach. The approach is decided on the basis of instability of spine as per plain radiograph, CT and MRI scans.

Anterior Decompression

The primary indication for an anterior decompression is an incomplete neurologic deficit in a compression or flexion-compression injury with marked canal compromise that portends failure of a posterior indirect reduction. This includes (1) a large retropulsed fragment with significant (>67%) canal compromise, (2) anterior column

communition and marked kyphosis (>30 degrees), and (3) greater than 4 days from the time of injury. The anterior technique provides a direct and therefore more predictable decompression of the ventral canal. Whether this improved decompression leads to an enhanced neurologic recovery rate depends more on the level (cord, conus, cauda equina) and the initial severity of the injury than on the estimate of the static canal compromise. Kostuik[3] recommended the anterior technique after demonstrating an average recovery of 1.6 Frankel grades in his patient series. Other studies indicate that anterior decompression may also be more effective in restoring bladder function, with more than one third returning to normal[4].

Anterior Stabilization

In the past, flexion-compression injuries addressed with anterior decompression and a reconstructive strut-graft fusion were followed by posterior instrumentation to augment stability. Improvements in anterior instrumentation now allow stabilization that is obtained with the combined technique. Anterior instrumentation, however is most effective when balanced by an intact posterior ligamentous tension band[5].

Introduced in 1984, the Kaneda system accomplishes an instrumented reduction with rigid maintenance of fixation[6]. A rigid transverse connector joins the dual vertical rods and contributes to stability in all loading modes[7]. Newer devices, including the Z-plate (Sofamor-Danek, Memphis), continue to improve in terms of their rigidity, low profile, and ability to compress the spanned strut graft. Long-term clinical results have yet to be published. In the present study corpectomy and bone grafting in 06, corpectomy, bone grafting & Z-plate fixation in 07; corpectomy & titanium cage placement in 07; corpectomy, titanium cage placement & Z-plate fixation was carried out in 40 patients.

Titanium Interbody Cages

The use of titanium interbody fusion cages placed in the anterior column has been shown to be efficacious to span a single disc space and promote arthrodesis at that level[8]. In a number of biomechanical studies the authors have shown that these cages, when placed in the anterior column, are able to resist forces in all planes, particularly in axial rotation, whereas posterior segmental instrumentation is least effective[9-13]. The use of interbody cages in the treatment of traumatic instability has been rarely described. In a review of complications associated with the Kaneda device, McAfee[14] has briefly reported on 10 patients with thoracolumbar burst fractures whose vertebrectomies were reconstituted using carbon fibre cages packed with autologus bone. Titanium cages packed with autologus bone graft for vertebral reconstruction was used in 47 patients in this series.

The average follow up time in our study was 18 months (range 2-36 months). In all patients radiographic studies were performed at 2,6 and 12 months follow up visits and then as needed. Titanium cage packed with autologus bone graft for vertebral reconstruction (a) allows for safe and increased decompression of neural structures to promote maximal neurological recovery; (b) provides immediate stability and allows for early mobilisation that should reduce perioperative complications; (c) involves a minimum number of motion segments, possibly minimizing current and subsequent back pain; (d) corrects deformity and restores sagittal alignment, which may also reduce the incidence of low-back pain; (e) allows for compression across the construct to promote arthrodesis; (f) uses the patient's own bone to promote arthrodesis; (g) allows for interpretable postoperative imaging studies; (h) has a minimal complication rate compared with other treatment options; and (i) has results that compare favourably with all previous published reviews of management of thoracolumbar fractures.

Combined Anterior and Posterior Methods

With the advent of improved spinal instrumentation, the need for combined procedures is becoming less frequent. Currently, combined techniques are used in three situations: (1) when the canal is compromised circumferentially and requires anterior and posterior decompression, (2) when realignment or rebalancing is required to correct severe coronal or sagittal plane deformity (>40 degrees), and (3) when structural augmentation is deemed necessary (multiple contiguous levels of injury or poor bone quality or osteoporosis).

CONCLUSION

The present study provides a retrospective analysis of our results. Young adult males had thoracolumbar spine injury predominantly affected by road traffic accidents. Extremity bony injury was a common association. Lumbar vertebra L1 was the most common site affected by thoraco lumbar spine injury.

Anterolateral approaches to thoracolumbar spine fractures can be an effective means of treating these injuries. The development of safe and effective anterior fixation devices allows both decompressive and stabilisation measures to be achieved via this approach. In our series the results have shown that the titanium cage and Z-Plate system is both safe and effective in the treatment of unstable injuries of the thoracolumbar spine. In addition we offer

details on the use of a titanium cage for vertebral reconstruction. This technique (a) allows better safe and decompression of neural structures to promote maximal neurological recovery; (b) provides immediate stability and allows for early mobilisation that should reduce perioperative complications; (c) involves a minimum number of motion segments, possibly minimizing current and subsequent back pain; (d) corrects deformity and restores sagittal alignment, which may also reduce the incidence of low-back pain; (e) allows compression across the construct to promote arthrodesis; (f) uses the patient's own bone to promote arthrodesis; (g) allows interpretable postoperative imaging studies; (h) has a minimal complication rate compared with other treatment options; and (i) has results that compare favourably with all previous published reviews of management of thoracolumbar fractures.

Patient with incomplete spinal cord injury showed good to excellent recovery and could be mobilised early with external support after anterior spinal stabilisation and patients with complete spinal cord injury with Frankel's Grade A & B die not show any recovery in this study.

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