Surgical Treatment of Thoracolumbar Fractures: Anterior Versus Posterior Approach

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Abstract

Background Data: Treatment of thoracolumbar vertebral fractures is highly controversial. The most important factor determining treatment strategy is whether the patient has a neurological injury.

Purpose: This work studied the results of the surgical treatment of thoracolumbar fractures admitted at the Neurosurgery Department of Benha University Hospital between January 2006 and June 2014 and tried to outline the indications of either the anterior or the posterior approach based on this experience.

Study Design: Descriptive retrospective clinical case study.

Patients and Methods: This is a retrospective study of the medical records of 72 patients who were hospitalized with the diagnosis of traumatic thoracolumbar spinal fracture and operated upon at the neurosurgical department of Banha University between January 2006 and June 2014. Sixty patients operated through the anterior approach, where 12 operated through the posterior approach.

Results: Clinical outcome: Posterior group: no patient experienced neurological deterioration postoperatively. Preoperative low back/leg pain improved greatly in most patients (54 out of 60) and remained the same in 6 patients based on the VAS for pain. Anterior group: According to ASIA; patients grade A (N=6) and D (N=1), remained the same post-operatively, whereas, of the other patients with incomplete cord lesion (N=5), three improved one grade and two did not improve at the last follow-up. Radiological outcome: Posterior group: Preoperatively, most patients experienced loss of more than 40% of the vertebra body's height and compromise of more than 40% in canal. Its overall mean values were 42.5±11.5% and 50.6±10.2%, respectively. No statistically significant correlation appeared between the canal compromise and loss of vertebral body height (P>0.05). However, the mean kyphotic deformities measured preoperatively and at within 12 months follow-up, were 19.2±5.5 degrees and 8.0±3.6 degrees. The mean mid-sagittal diameter improved from 9.2±3.1 mm before surgery to 15.1±0.8 mm at the 12 months follow-up visit, with a significant difference between preoperative and postoperative values (P<0.01). The mean vertebral body height before surgery was 42.5±11.5%. At the 12-month follow-up visit, this score showed a statistically significant increase, to 69.0±11.4% (P<0.01). Anterior group: The preoperative segmental kyphosis improved postoperatively (at the three month follow up visit) from a mean of 26.5° (range 16- 35°) to a mean of 11° (range 5- 17°). This correction was maintained in all but
three patients who lost correction of a mean 30° (at the end of the follow up visits- at 12 months). None of the patients had implant failure. All patients had bone fusion on final follow up plain radiography. **Conclusion:** Posterior surgery is performed primarily in the treatment of burst fractures without neurological deficit. Anterior decompression is indicated in an incomplete neurologic deficit with marked canal compromise and intact posterior ligamentous complex. Both approaches are safe and efficient in retaining the stability of the spine. (2014ESJ071)

**Keywords:** Thoracolumbar fractures, anterior approach, posterior approach

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**Introduction**

The thoracolumbar region is generally accepted as that part of the spine formed by vertebrae from the 11th thoracic to the 2nd lumbar. Spine fractures, especially fractures accompanied with the spinal cord injury, pose a difficult surgical, social and economic problem. The three major trauma mechanisms for thoracolumbar spine fractures are rotation/translation, distraction, and compression.

Most thoracolumbar burst fractures are stable injuries that can be treated nonsurgically. Regardless of neurologic deficits, unstable burst fracture that have retropulsed bone fragments compromising the canal requires surgical interventions such as decompression of neural structures, correction of spinal deformities and stabilization. The success of the treatment depends on the initial medical treatment, x-ray diagnostics, anatomical reduction, surgical decompression of the spinal canal (if needed) and surgical stabilization as final immobilization. In cases of neurological damage, it is necessary to determine the exact grade of motor impairment and of sensory functions. The classification and gradation of neurological damage in patients with the fractures of thoracolumbar spine are determined according to the ASIA (American Spinal Injury Association) score.

This work studied the results of the surgical treatment of thoracolumbar fractures admitted at the Neurosurgery Department of Benha University Hospital between January 2006 and June 2014 and tried to outline the indications of either the anterior or the posterior approach based on this experience.

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**Patients and Methods**

This is a retrospective study of the medical records of 72 patients who were hospitalized with the diagnosis of traumatic thoracolumbar spinal fracture and operated upon at the neurosurgical department of Banha University between January 2006 and June 2014.

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**Preoperative Assessment:**

Patients were clinically evaluated for type of injury, extent of Neurological deficit (ASIA grading score) Anterior-posterior (AP) and lateral Plain Radiographs, Magnetic Resonance Imaging (MRI) and 3D-Computerized Tomography (3D-CT) scan was carried out in all patients. The segmental kyphosis angle was measured on lateral radiographs as the angle between the superior endplate of the first uninvolved vertebra proximal to the affected segment and the first uninvolved vertebra distal to the affected segment. Based on computerized tomography and magnetic resonance images of the patients, we evaluated intracanal fragments, the presence of pedicle and laminar fractures, posterior ligamentous complex status and the presence of medullary edema.

**Operative Technique:**

**Posterior approach (N=60):** The surgical procedure attempted to reach the retropulsed bone fragments through performing both laminectomy and minimal facetectomy. In prone position, we made a midline skin incision to expose the laminae 1 or 2 levels above and below the injured levels. We performed blunt dissection until the facet joints on both sides were seen. After routine laminectomy, we removed facet joints minimally to expose nerve root of both sides. Then, beneath the dural sac, we could push the retropulsed bone fragments down into the fractures vertebral body to their rightful position in the burst vertebral body. The manipulation was ought to be performed with great care to avoid damage to the neural structures. This was a crucial procedure to decompress the neural canal without removal of the retropulsed bone fragments. After the posterior decompression and bone fragment repositioning, the transverse processes, laminae of above and below level, and other posterior bony surfaces were decorticated for posterolateral fusion. Then, we carried out the classical short-segment pedicle screw instrumentation (transpedicular screw and rod instruments). Finally, we embedded sufficient
amount of harvested bone fragments and artificial bone chips in the posterolateral sides of the column. (Figure 3,4)

**Anterior approach (N=12):** The affected vertebra was exposed by a left sided transthoracic intrapleural, retroperitoneal approach. The patient is placed in the true lateral position, with sufficient axillary roll under the right armpit and the lesion level over the break of the table. The table is then flexed to open up the vertebral interspaces; left sided approach is preferred to avoid retraction of the liver and inferior vena cava. Exposure above and below the diaphragm is usually needed to obtain an adequate working area for decompression and placement of the instrumentation. In all cases an 11th 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 one vertebral level below the lesion. 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. The disc material is then removed.

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. Along with 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 visualized from pedicle to pedicle, and epidural venous bleeding is controlled. The Z-plate device is placed, and distractive forces are applied to 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 third generation cephalosporin solution and closed in layers with a thoracostomy tube postoperatively. Corpectomy, iliac crest bone grafting & Z-plate fixation were done in 6 patients; corpectomy, titanium cage placement & Z-plate fixation was carried out in 6 patients. (Figure 5)

All patients were fitted with a thoracolumbar orthosis for six months and were encouraged to ambulate within 7 days of surgery. Patients underwent physiotherapy postoperatively.

**Follow up:**

The outcome was evaluated with (ASIA) scale after three months, six months and one year following surgery. Plain x-Ray both anteroposterior and lateral views and 3D Computed Tomography were done postoperatively. The segmental kyphosis angle and the extent of collapse were measured on lateral radiographs of each visit. The presence of fusion was determined from two plain radiographs and was verified with CT scan.

**Results**

**Patient Criteria:**

**Posterior group:** Sixty (34 males and 26 females) with age ranging between 16-68 years (40.6±12.8) were operated upon by posterior transpedicular screw fixation. According to the ASIA scoring system all patients were grade E.

The distribution of fractures in both groups is shown in Figure 1, and 2.

The causes of these fractures were fall (36 patients), motor vehicle accidents (16 patients) and direct blunt trauma (8 patients).

**Anterior group:** Twelve patients including 8 males and 4 females, with age ranging between 17 and 70 years (mean 44.2, SD 12.1) were operated upon by anterior surgical approach. 9 patients had burst fractures and 3 patients had fracture dislocation (according to McAfee classification)

The indications for surgery were instability. The neurological status of patients is summarized in table 1.

**Clinical Outcome:**

**Postoperative hospitalization:** The average postoperative hospitalization was 9 days (5–14 days) in the posterior group and 14.5 days (10–21 days) in the anterior group.

**Follow up:** The average follow up period was 18.2 months (9–32 months) in the posterior group and 16.5 months (8–38 months) in the anterior group.

**Posterior group:** no patient experienced neurological deterioration postoperatively. Preoperative low back/leg pain improved greatly in most patients
(54 out of 60) and remained the same in 6 patients based on the VAS for pain. **Anterior group:** According to ASIA; patients grade A (N=6) and D (N=1), remained the same postoperatively, whereas, of the other patients with incomplete cord lesion (N=5), three improved one grade and two did not improve at the last follow-up (Table 1).

**Radiological outcome:**

**Posterior group:** Preoperatively, most patients experienced loss of more than 40% of the vertebra body’s height and compromise of more than 40% in canal. Its overall mean values were 42.5±11.5% and 50.6±10.2%, respectively. No statistically significant correlation appeared between the canal compromise and loss of vertebral body height (P>0.05). However, the mean kyphotic deformities measured preoperatively and at within 12 months follow-up, were 19.2±5.5 degrees and 8.0±3.6 degrees. The mean mid-sagittal diameter improved from 9.2±3.1 mm) before surgery to 15.1±0.8 mm at the 12 months follow-up visit, with a significant difference between preoperative and postoperative values (p<0.01). The mean vertebral body height before surgery was 42.5±11.5%. At the 12-month follow-up visit, this score showed a statistically significant increase, to 69.0±11.4% (P<0.01).

**Anterior group:** The preoperative segmental kyphosis improved postoperatively (at the three month follow up visit) from a mean of 26.5° (16-35°) to a mean of 11° (5-17°). This correction was maintained in all but three patients who lost correction of a mean 6° (at the end of the follow up visits- at 12 months). They needed revision surgery in the form of posterior spinal fixation using rod-screw system in two patients and hook-rod system in one patient and were stable over the next 6 months. None of the patients had implant failure. All patients had bone fusion on final follow up plain radiography.

**Complications:**

**Posterior group:** Intraoperatively, dural tear occurred in two patients without no postoperative cerebrospinal fluid (CSF) leak. Superficial wound infection occurred in 3 patients and responded to antibiotic treatment (3rd generation Cephalosporins). No patient experienced neurological worsening. Screw fracture was observed in two patients on the 3-month follow up visit and required pedicle subtraction osteotomy operation later on.

**Anterior group:** Superficial wound infection occurred in two patients and improved later on with appropriate medical treatment (3rd generation Cephalosporins). Pleural effusion occurred in two patients and was treated conservatively and hemothorax occurred in one patient treated with closed tube drainage.

**Table 1.** Preoperative and Postoperative ASIA Grades

<table>
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<tr>
<th>Preoperative ASIA</th>
<th>No. of Cases</th>
<th>Postoperative ASIA</th>
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![Figure 1. Distribution of levels of fractures in posterior group](image1)

![Figure 2. Distribution of levels of fractures in anterior group](image2)
**Figure 3.**
Preoperative sagittal reformate CT scan (A) with 3D-CT reconstruction (B) of LV1 fracture and postoperative plain radiography (C) of the same patient treated with posterior short segment fixation.

**Figure 4.**
Preoperative sagittal reformate CT scan (A) with 3D-CT reconstruction (B) of LV1 fracture and postoperative plain radiography (C) of the same patient treated with posterior short segment fixation.

**Figure 5.**
Preoperative Ct sagittal reformat (A) and 3D CT (B) of D11 fracture-dislocation, and Postoperative plain X-ray of the AP (C) and lateral (D) views same patient.
Discussion

In general, the treatment of thoracolumbar vertebral fractures is highly controversial. The vertebral stability after fracture constitutes an important part of the conflict. From the literature review, it can be established that various treatment methods ranging from conservative treatment to early surgical treatment have been used. The most important factor determining the treatment strategy is whether the patient has a neurological injury, and if yes, whether it is progressive or not. Since the concepts and definitions have not yet been agreed upon, different treatment approaches have evolved and continue to evolve.

The aim of the treatment of spinal fractures is to achieve a painless, balanced and stable spine that has healthy neurological function and the highest degree of spinal motion and to enable the patient to move in a short period of time. Surgical treatment is superior to conservative treatment in certain respects. Surgery provides spinal alignment and allows a better reduction of the fracture fragments. Canal width is more efficiently preserved regarding preventing damage to neurological functions. It also prevents complications developing secondary to plaster cast or long-term bed rest. Due to its ability to provide a high degree of stability, patients can be mobilized earlier. Hence, rehabilitation can be initiated earlier.

Posterior surgery is performed primarily in the treatment of burst fractures without neurological deficit. With the effects of lordosis and posterior distraction force applied during posterior decompression, intracanal tissues are expected to be displaced anteriorly. Dunn concluded that short segment posterior instrumentation is a safe and effective option in the treatment of unstable thoracolumbar fractures as a standalone measure. McLain et al detected early failure of this technique.

In a retrospective study of 28 patients, Sanderson et al performed short segment posterior instrumentation without fusion in one level above and below the fractured vertebra and followed up the patients for two years. Implant failure was screw breakage in four patients (prevalence is 14%). In a prospective randomized study, Alanay et al evaluated the efficacy of transpedicular grafting and established that similar results were obtained with and without grafting. In a prospective clinical study, Wang et al compared the results of surgical treatment with and without fusion in thoracolumbar burst fractures. In that study, a total of 58 patients who were neurologically intact, with a kyphosis angle greater than 20° and a canal narrowing and collapse in vertebral height of greater than 50% were enrolled. As a result of that study, no marked difference was observed in kyposis angles between the two groups. Radiographic parameters were found to be statistically better in the non-fusion group. Implant failure was screw breakage in eight patients (prevalence 13.7%), five of whom were in the fusion group whereas 3 were in the nonfusion group. The authors suggested that the short term outcomes of short segment pedicular fixation without fusion in the treatment of thoracolumbar fractures were satisfactory. Additionally, they suggested that the advantages of nonfusion surgery included the absence of donor site related problems, preservation of motion segments, decreased blood loss, and the shortened duration of the surgery.

Dai et al published the results of a 5 years prospective randomized clinical study of 73 patients who underwent posterior short segment fixation with and without fusion for thoracolumbar burst fractures. Among radiological results, local kyphosis angle and loss of kyphosis angle correction were taken as the basis. As a result, no radiological or clinical differences were detected between the two groups. The duration of the operation and blood loss were found to be statistically significantly lower in the non-fusion group (p<0.05). Pain was observed but not considered to be a major problem. However, they emphasized that the presence of these findings are irrefutable. Consequently, they reported that posterolateral bone grafting was not necessary when posterior short segment fixation was performed in selected patients (Dennis type B patients with a load sharing score of <6). Posterolateral bone grafting was done in all of our patients. In a prospective study by Robertson and Wray, graft donor sites were examined in 106 patients who underwent posterior spinal fusion 3, 6 and 12 months after the surgery and it was demonstrated that the pain increased in the first 6 months and tended to decrease afterwards.

There are major disadvantages for the posterior approach surgery. The first one is the usually
insufficient indirect spinal canal clearance obtained by annulotaxis. The second is that partial or complete laminectomy can improve decompressions of the spinal canal but may destabilize the spine by increasing the spinal deformity. The third disadvantage is a frequent failure of pedicle screw fixation techniques, which happens even in cases in which a laminectomy has not been performed. The use of the anterior surgical approach to the thoracolumbar spine, whether as the sole approach or as a part of combined approach has been advocated by many authors during the past 50 years.

Initial reports of the anterior thoracotomy approach to the thoracic spine were related to Pott’s disease. Nevertheless, with the advent of anti-tuberculous antibiotic therapy, a decline in the number of cases led to less need for this procedure. Fracture is the most common pathological event at the thoracolumbar junction. These fractures often result in a significant instability of the spine and lead to acute or delayed neurological deficits. Most authors agree that unstable thoracolumbar fractures require surgical treatment, but which specific approach should be used for the treatment is still controversial. The anterior approach minimizes damage to the posterior ligamentous structures of the spine. The primary indication for an anterior decompression is an incomplete neurologic deficit with marked canal compromise and intact posterior ligamentous complex. 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 recommended the anterior technique after demonstrating an average recovery of 1.6 Frankel grades in his patient series. The low profile of this system is intended to prevent vascular complications and allow easy repair of the diaphragm. As a dynamic device, it allows distraction and reduction of kyphotic deformity as well as the ability to compress after bone grafting. The radius of curvature of the plate allows the plate to be closely applied to the curvature of the vertebral body. The titanium materials are CT-scan and MRI compatible. Although the Z-plate was approved by the US Food and Drug Administration in 1993, few clinical studies have been conducted to evaluate its advantages and disadvantages. 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.

In a review of complications associated with the Kaneda device, McAfee has briefly reported on 10 patients with thoracolumbar burst fractures whose vertebrectomies were reconstituted using carbon fiber cages packed with autologus bone. Titanium cages packed with autologus bone graft for vertebral reconstruction was used in 9 patients in this series. Titanium cage packed with autologus bone graft for vertebral reconstruction allows for safe and increased decompression of neural structures to promote maximal neurological recovery; provides immediate stability and allows for early mobilization that should reduce perioperative complications; involves a minimum number of motion segments, possibly minimizing current and subsequent back pain; corrects deformity and restores sagittal alignment, which may also reduce the incidence of low-back pain; has a minimal complication rate compared with other treatment options; and has

Anterior instrumentation is most effective when balanced by an intact posterior ligamentous tension bands. In recent years, several anterior fixation devices have been developed: anterior thoracolumbar locking plate (ATLP), Armstrong plate, ASIF T-plate, Dewald-LDI system, Dunn device, Kaneda device, Kostuik-Harrington device, Olerud plate, Slot-Zielke device, Synthes plate, Texas Scottish Rite Hospital device, University anterior plating system, and Yuan plate. The array of devices indicates the difficulty in designing an anterior fixation device that features low risk for vascular injuries, high neurologic recovery, low rates of hardware failures, high fusion rates, compatibility with computed tomography (CT) and magnetic resonance imaging (MRI), high rigidity, ease of insertion, and the option to perform a reduction of kyphotic deformity. The Z-plate has demonstrated adequate stability for most loading situations. The low profile of this system is intended to prevent vascular complications and allow easy repair of the diaphragm. As a dynamic device, it allows distraction and reduction of kyphotic deformity as well as the ability to compress after bone grafting. The radius of curvature of the plate allows the plate to be closely applied to the curvature of the vertebral body. The titanium materials are CT-scan and MRI compatible. Although the Z-plate was approved by the US Food and Drug Administration in 1993, few clinical studies have been conducted to evaluate its advantages and disadvantages. 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.

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results that compare favorably with all previous published reviews of management of thoracolumbar fractures.40,41

However the use of anterior approach for the treatment of thoracolumbar spine disease has several limitations a) the incidence rate of transient intercostal neuralgia and pulmonary complications, such as postoperative atelectasis, pneumothorax, pleural effusion, and hemothorax has been reported to be (14.1–29.4%).13, 17, 43 However in this study the incidence was 13.3% for pneumothorax and 6.7 % for hemothorax.

**Conclusion**

Posterior surgery is performed primarily in the treatment of burst fractures without neurological deficit. Anterior decompression is indicated in an incomplete neurologic deficit with marked canal compromise and intact posterior ligamentous complex. Both approaches are safe and efficient in retaining the stability of the spine.

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العلاج الجراحي لكسور المنطقة الصدر– قطنية: التدخل الامامي مقابل التدخل الخلفي

الخلاصة العلمية: يوجد خلاف بينٍ على العلاج الأفضل لكسور المنطقة الصدر– قطنية، ولكن يبدو أن وجود دليل اصابة عصبية هو العامل الأكثر أهمية.

الهدف من الدراسة: تهدف هذه الدراسة إلى محاولة تحديد دواعي التدخل الجراحي لكسور المنطقة الصدر– قطنية بنوعية الأمامي والخلفي ودراسة فعالية وامان صلا التدخلين.

البحث: دراسة مرجعية للملفات الطبية الخاصة بـ 72 مريضا بكسور المنطقة الصدر– قطنية للعمود الفقاري والذين أجري لهم تدخل جراحي. تم تقسيم المرضى إلى مجموعتين حسب نوع التدخل الجراحي وتمت دراسة كل تدخل على حدة من حيث دواعي التدخل ومضاعفات الجراحية وتاثيرها على الحالة السريرية والتصويري للمرضي وقد تبين أن صلا التدخلين أمن وفعال بِالأصول بالعمود الفقاري للثبات والتنزان الميكانيكي الحيوي لللثاث.

الخلاصة: يجري التدخل الجراحي الخلفي لكسور المنطقة الصدر– قطنية للعمود الفقاري في حالة وجود كسر متتجه بدون اصابة عصبية بينما يجري التدخل الجراحي الأمامي لكسور المنطقة الصدر– قطنية للعمود الفقاري في حالة وجود اصابة عصبية غير شاملة وصلا التدخلين أمن وفعال بِالأصول بالعمود الفقاري للثبات والتنزان الميكانيكي الحيوي لللثاث.


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