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Sameh M. Saleh
Matarya Teaching Hospital, sameh.matareia2004@gmail.com

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Original Article

Effectiveness of posterior long-segment fixation and decompression in comparison with short-segment fixation and decompression in management of traumatic burst thoracolumbar fractures

Sameh M. Saleh
Neurosurgery Department, Matarya Teaching Hospital, Cairo, Egypt

Abstract

Background
The optimal management of thoracolumbar spine fractures remains a matter of controversy. The literature implies that the use of short-segment (SS) pedicle screw fixation may be inappropriate because of its high reported failure rate. To overcome this, currently long-segment (LS) pedicle instrumentation for thoracolumbar (T-L) fractures is gaining popularity.

Aim
The aim was to assess and compare the efficacy and safety of LS versus SS fixation with posterior decompression for the treatment of traumatic thoracolumbar burst fractures.

Patients and methods
This prospective study was carried out at the Department of Neurosurgery, Matarya Teaching Hospital. A total of 70 patients in whom the unstable burst thoracolumbar fractures were confirmed were included, where 35 patients (15 male and 20 female) had LS fixation and decompression, whereas 35 (16 male and 19 female) patients had SS fixation and decompression. LS fixation includes two levels above and two levels below, whereas short fixation involves vertebra above and vertebra below the fractured one. Ethics committee approval was taken.

Results
Clinical outcome was assessed according to Modified-Macnab Criteria. Overall, 34.3 and 57.1% showed excellent and good results, respectively, among LS group and 11.4 and 51.4% showed excellent and good results, respectively, among SS group. Cobb's angle evaluation was used to assess radiological outcome.

Conclusion
LS fixation with posterior decompression is significantly effective in treating patients of unstable traumatic burst thoracolumbar fractures than SS fixation and decompression.

Keywords: Burst fractures, decompression, long-segment fixation, short-segment fixation, thoracolumbar spine, Transpedicular instrumentation

Introduction

Management of unstable thoracolumbar fractures remains controversial in spite of an improved knowledge of the morphometric, anatomic, and biomechanical features of thoracolumbar vertebrae [1]. The restoration of the vertebral

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Correspondence to: Dr. Sameh Mahmoud Saleh, MD.
Ibn el Hakm Street, Cairo, Egypt,
Tel: 01005619786-02 22506090, Fax: 02 22506090.
E-mail: sameh.matareia2004@gmail.com

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column stability and the decompression of the spinal canal are the goals of treatment of thoracolumbar fractures. Earlier mobilization of the patient is the advantage when they are achieved [2].

It has been demonstrated that short-segment (SS) instrumentation is associated with an unacceptable rate of failure [3]. The highest rate of the instrumentation failure resulting in re-kyphosis of the entire segment is associated with SS posterior reduction and stabilization of burst fractures, showing the inadequacy of the SS transpedicular instrumentation used for the treatment of thoracolumbar and lumbar fractures [4].

An alternative is to use longer segmental instrumentation to reduce the load on each screw. Hence, performing posterior fixation with two or more segments above and below the fractured vertebra appears to be associated with less rate of failure, yet significant increased vertebral immobility and dorsalgia were also detected in long-segment (LS) fixation [5].

The aim of this work was to evaluate the efficacy of posterior laminectomy and LS pedicle fixation in management of unstable thoracolumbar burst fractures in comparison with SS fixation and posterior laminectomy.

Patients and methods

A total of 70 patients operated for unstable thoracolumbar burst fractures between June 2015 and May 2018 were reviewed as part of a prospective randomized study. LS posterior transpedicular fixation with decompression was performed in 35 cases (group 1) and SS fixation with decompression in 35 cases (group 2).

The inclusion criteria were single-level fracture between T11 and L2, kyphotic deformity exceeding 15°, spinal canal compromise of 50% or more, and loss of 50% of anterior body height. Patients with pathological fractures or multilevel injuries were excluded from the study. In addition, patients who were managed with a delay of 3 weeks or more were also excluded from this study to facilitate dealing with retroplused bone fragments or disc materials before excess adhesions get formed.

The first assessment of a patient included the history of injury, the mode of injury, a thorough clinical and neurological examination, and status of the stability. Then, priorities included resuscitation of patient and treatment of life-threatening injuries before stabilization of the spinal injuries.

Anteroposterior and lateral plain radiographies, computerized tomography scans, and MRI were taken to identify all injuries and to assess the severity and nature of the injury. Neural canal and pedicle were identified in computerized tomography scan. Soft tissue injuries and cord changes were identified in MRI. The level and type of fractures were classified according to thoracolumbar injury classification score. The indications for surgical intervention were thoracolumbar injury classification score greater than 4.

The patient and his/her relatives were explained in detail about the nature of injury, severity of injury, the possible outcomes of nonsurgical/surgical management, and the importance of rehabilitation. All study participants provided informed consent.

All patients underwent posterior pedicle screw fixation (in the usual conventional way regardless of the number of the vertebrae fixed) and reduction under C-arm monitoring. LS fixation includes two levels above and two levels below, whereas fixation involving vertebra above and vertebra below the fracture one represents SS fixation. Posterolateral synostosis was performed with bone fragments with autologous bone with no interbody spacers.

Participants were allocated by simple unblinded randomization to one of two treatment groups without selective radiological or neurological criteria other than that of inclusion criteria to avoid clinical bias.

The surgical procedure was tailored in an attempt to reach the retropulsed bone fragments or prolapsed disc materials through performing both laminectomy and minimal facetectomy. In prone position, a midline skin incision to expose the laminae 1 or 2 levels above and below the injured levels is performed followed by dissection until the facet joints on both sides were seen. After routine laminectomy, facet joints are removed minimally to expose nerve root of both sides. The manipulations were performed with great care to avoid damage to the neural structures.

All patients with thoracolumbar fractures included in our study were evaluated with biomechanical criteria and clinical outcome. The immediate postoperative radiographs were compared with radiographs of each follow-up (at interval of 3, 6, and 12 months postoperatively), evaluating any loss of correction by measuring kyphotic angle using Cobb's method. Progressive deformity was considered as the change of the sagittal alignment of the spine comparing the initial postoperative weight-bearing radiograph with the most recent radiograph of the follow-up. This progression was considered to be absent, minor, or major. Overall, 5–10° increase of the kyphosis was defined as minor progression; an increase of more than 10° was defined as major progression. Moreover, at each follow-up, clinical outcome was measured using modified-Macnab criteria.

Successful instrumentation was considered when solid fusion without progressive deformity or failure of the implant was achieved. Failure or bending of the implant or development of major kyphosis before fusion occurred was considered as failure of the fixation regardless of the duration of the follow-up (Fig.1 and 2).

Results

A total of 70 patients were included in this study, comprising 35 patients (15 males and 20 females) in group one and 35 patients (16 males and 19 females) in group two. The mean age in the first group was 23.2 years (16–45 years) in

comparison with 25.3 years in the second group (15–38 years). The demographic data of the two study groups are presented in Table 1.

The leading cause of the fracture was falling from height followed by occupational injuries and then road traffic accidents in both groups. L1 fractures were the commonest in both groups. A total of 22 patients had other associated injuries, with bilateral fracture of the calcaneus being the commonest. Neurological deficits were detected in 26 patients [5 major (Frankel A, B, and C), 9 moderate (Frankel D), and 12 minor deficits (Frankel E)] (Table 2).

The minimum duration of follow-up in both groups was 14 months, and the maximum duration of follow-up was 32 months, with a mean duration of 22.57 months. The follow-up period among patients of LS fixation group was in the range of 14–32 months, with a mean of 22.63 months, and the follow up-period among patients of SS fixation group was in the range of 16–30 months, with a mean 21.33 months.

The mean preoperative kyphotic angle as measured by Cobb's method was 30.04° (range: 19–40°) for the first group, whereas for the second group it was 30.11° (range: 20–40°), and mean immediate postoperative kyphotic angle was 6.31° (range: 5.00–10.00°) and 10.47° (range: 5.00–15.00°) for the first group and the second group, respectively. During the follow-up period, mean kyphotic angle was 7.64 and 13.67°, in LS group and SS group, respectively, at 6-month follow-up, and was 9.29 and 16.18°, respectively, at 12-month follow-up visits, with significant change between the two groups at LS follow-up ($P = 0.01$) (Table 3).

Patients in both groups achieved satisfactory clinical outcomes according to the modified-Macnab criteria. In the LS group, 12 (34.3%), 20 (57.1%), three (8.6%), and 0 (0.0%) cases were considered to have excellent, good, fair, and poor outcome, respectively. In the SS group, four (11.4%), 18 (51.4%), and eight (22.9%), five (14.3%) cases were considered to have excellent, good, fair, and poor outcome, respectively, with significant improvement in the LS group than the SS group, with P value less than 0.05.

The average intraoperative blood loss was 455 ml in the LS group and 350 ml in the SS group. The average length of surgery was 235.35 min in the first group and 185.18 min in the second group. The average length of postoperative hospital

Table 1: Demographic data, fracture level, and severity of deficits

	Long-segment group	Short-segment group
Sex		
Male	15	16
Female	20	19
Age (years)		
Range	16–45	5–38
Mean	23.2	25.3
Fractured vertebral level (cases)		
T12	12	11
L1	20	19
L2	3	5
Neurological deficit		
Major	3	2
Moderate	6	3
Minor	5	7

Table 2: Mean kyphotic angle measured using the Cobb's method

	Long-segment group	Short-segment group
Preoperative	30.04±5.04°	30.11±5.04°
Immediate postoperative time	6.31±1.58°	10.47±2.78°
3 months postoperatively	6.49±1.60°	12.00±2.65°
6 months postoperatively	7.64±1.67°	13.67±2.83°
12 months postoperatively	9.29±2.03°	16.18±3.03°

Table 3: Assessment of clinical outcome according to the modified-Macnab criteria

	Long-segment group [*n* (%)]	Short-segment group [*n* (%)]
Excellent	12 (34.3)	4 (11.4)
Good	20 (57.1)	18 (51.4)
Fair	3 (8.6)	8 (22.9)
Poor	0	5 (14.3)

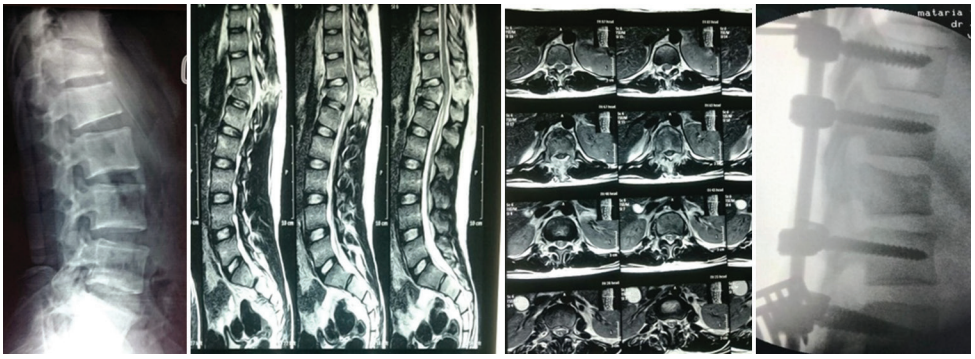

Figure 1: 23 years old female patient with fractured D12 vertebra treated by long segment fixation and posterior decompression.

Figure 2: 27 years old male patient with fractured L2 vertebra treated by short segment fixation and posterior decompression

stay was 4.75 days in the LS group and 3.65 days in the SS group. SS group showed significantly less intraoperative blood loss, as well as shorter operative time and hospital stay.

Postoperative complications noticed in both groups included the following: superficial wound infection in four cases, fixation system failure in one case in the form of one screw fracture among those used in the LS fixation above the fractured vertebra causing no progressive kyphosis and required no revision surgery after discussing the insult with the patient, and cerebrospinal fluid (CSF) leakage, which was managed conservatively in three cases in LS group, whereas superficial wound infection in three cases, deep wound infection that required revision surgery in one case, fixation system failure in six cases in the form of screw fracture in three cases managed surgically, progressive kyphosis and rod dislodgment in one case managed surgically, progressive kyphosis only in two cases that refused a redo surgery, and CSF leakage in four cases managed conservatively in the SS group.

Discussion

It is widely accepted that thoracolumbar burst fractures should be addressed surgically [6]. The goals of the treatment of thoracolumbar fractures, regardless of the selected method, are the restoration of the stability of the vertebral column and the decompression of the spinal canal, leading to earlier mobilization of the patient. However, the treatment of thoracolumbar burst fractures remains a controversial issue [2].

SS pedicle fixation is a popular option. However, there is a controversy as far as the results of this instrumentation are concerned. There are studies that report high rate of failure because of proximal screw pullout, screw breakage, and loss of correction even if material failure does not always affect the clinical outcome [7]. Nevertheless, some studies demonstrate that clinical long-term results are favorable in patients who underwent SS pedicle instrumentation [2].

Altay *et al*. [8] reported that the use of four pairs of screws (two above and two below) to lengthen the lever arm of the construct would probably not only enhance the stability but also allow effective reduction of kyphotic deformity.

In this study, 70 patients were operated for post-traumatic unstable burst dorsolumbar fracture after being evaluated clinically and radiologically. A total of 35 patients (15 males and 20 females), with a mean age of 23.2 years, had LS fixation with posterior decompression, and 35 patients (16 males and 19 females) with a mean age of 25.3 years had SS fixation with posterior decompression.

Intraoperative blood loss, length of surgery, and the average length of postoperative stay were significantly less in patients undergoing SS fixation with posterior decompression than in patients with LS fixation with posterior decompression ($P < 0.05$).

Sapkas *et al.* [2] in their prospective randomized study found that there is no significant difference between the two groups concerning age and sex. The average operative time was 170 min (range: 140–220 min), and the average blood loss was 1050 ml (range: 350–1800 ml) for the SS pedicle instrumentation, and 220 min (range: 190–300 min) and 1200 ml (range: 550–2100 ml), respectively, for the LS pedicle instrumentation. There is a statistically significant difference between the two groups as far as the duration of operation and the blood loss are concerned.

In this study, patients in both groups achieved satisfactory clinical outcomes. In the LS group, 91.4% of patients had excellent or good outcomes. In the SS group, 62.8% were considered to have excellent or good outcomes, with significant improvement in the LS group than the SS group, with *P* value less than 0.05.

On the contrary, in the study by Sapkas *et al.* [2], comparing the low back outcome score between the two groups, no significant difference is found. There is homogeneity between the SS pedicle instrumentation versus LS pedicle instrumentation of low back outcome score four categories: poor (5 vs 0%), fair (30 vs 30%), good (45 vs 53.3%), and excellent (20 vs 16.7%).

Alhemiary and Almayoof [9] in their prospective study found that clinically after operation and according to Macnab criteria, good results were obtained in approximately 53% in LS group, whereas 72% in SS group, and excellent results came next in both groups, accounting for 23 and 20%, respectively. Fair result was high in the first group, reaching up to 17%, whereas it was 4% for fair and poor outcomes in the second group.

Jin-Woo *et al.* [10] also reported high percentages of good score (50 and 62% for LS group and SS group, respectively), and they found excellent result in the first group (34%) in comparison with 18.8% in the second group, whereas fair outcomes of 11.4 and 18.8% in LS group and SS group, respectively. Poor outcome was 2% for first group and was nil in the other one.

In this study, radiologically, mean kyphotic angle in LS group preoperatively was 30.04°, which was reduced to 6.31° postoperatively, and mean kyphotic angle in SS group preoperatively was 30.11°, which was reduced to 10.47°. However, there was loss of kyphotic correction in SS group during long-term follow-up.

Li and Liu [5] in their meta-analysis study also suggested that the main outcomes of the radiographic indexes studied are better in the LS fixation group than that of SS fixation group.

Alhemiary and Almayoof [9] in their study observed that immediately after operation LS group had better correction of the local kyphosis angle, although associated with limitation of the motion segment, in comparison with the SS group. Moreover, SS achieved good correction of the lordotic angle postoperatively (Cobb's angle) in comparison with the preoperative angle.

Thanappan *et al.* [6] also reported that the mean kyphotic angle in the LS group preoperatively was 26.8°, which was reduced to 5.84° postoperatively, and mean kyphotic angle in SS with index vertebra fixation group preoperatively was 21.4°, which was reduced to 4.75°. However, there was loss of kyphotic correction in LS group during follow-up.

Complications noticed in this study included superficial wound infection in four cases, fixation system failure in one case owing to repeated lifting of heavy objects managed conservatively, and CSF leakage managed conservatively in three cases in LS group, whereas superficial wound infection in three cases, deep wound infection that required revision surgery in one case, fixation system failure in six cases where four of them were managed surgically, and CSF leakage in four cases managed conservatively in the SS group. The overall fusion rate failure is approximately 4.7%.

In the study by Sapkas *et al.* [2], in terms of the implant failure, three screws (three patients) were broken and four screws (four patients) were bent in the SS group. On the opposite, in the LS pedicle instrumentation group, no implant failure was observed. The vast majority of the patients refused to remove the implants. Six patients had their instrumentation removed after an average of 2 years (range: 9–35 months) after the accident. No other complications occurred.

For complication rate in the study b Li and Liu [5], no significant differences were detected between the two groups. The inducements for complication were similar among the studies, including superficial infection, pedicle screw dislodgement or implant breakage, and epidural hematoma.

Lee *et al.* [11] reported two cases of implant removal in **LS fixation group, as there was a risk of skin breakdown owing to the irritation by the rods, and one case of screw breakage in SS fixation group.

Conclusion

LS fixation with posterior decompression is significantly effective in treating patients of unstable burst thoracolumbar fractures than SS fixation and decompression, especially with long-term follow-up, as documented by clinical and radiological outcome.

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Conflicts of interest

There are no conflicts of interest.

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