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Surgical Management of High Energy Dorsolumbar Fractures

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ABSTRACT

Background: The management of dorsolumbar fractures has been the subject of much controversy. There are different criteria for the choice of management based on the severity of the kyphotic deformity, canal compromise, vertebral height loss, and neurologic status.

Objective: To evaluate the results of surgical management of high energy dorsolumbar fractures in the Trauma Unit at Assiut, and at Al-Azhar University Hospitals.

Patients and Methods: From October 2017 to October 2019, 40 patients with thoracolumbar spine (TLS) fractures, all of them were treated by posterior instrumentation with pedicle screws and rod system. 23 petients (57.5%) underwent long-segment fixation and 17 patients (42.5%) underwent short-segment fixation. They were operated upon at the Trauma Unit of Assiut University Hospital and Al-Azhar University Hospital.

Results: The clinical outcome according to modified Macnab criteria; in long segment group it was excellent in 8 patients (34.7%), good in 11 patients (47.8%), fair in 3 patients (13%) and poor in 1 patient (4.3%), while in short segment group; it was excellent in 3 (17.6%), good in 10 (58.8%), fair in 3 (17.6%) and poor in 1 (5.9%). The kyphosis correction (%), in long segment group was ≥70 in 16 patients (70%), <70 in 7 patients (30%), while in short segment group, it was ≥70 in 10 patients (59%) and <70 in 7 patients (41%).

Conclusion: Short segment fixation using pedicle screw at the level of fracture, in high energy thoracolumbar fractures; provides comparable correction to long segment fixation and the amount of correction loss can be minimized by proper selection of cases suitable for short segment fixation.

Keywords: Dorsolumbar, Fractures, High energy, Kyphotic.

INTRODUCTION

Dorsolumbar segment of the spine is an unstable zone between the fixed dorsal and mobile lumbar spine and has a higher risk for fracture, but it has also important anatomic characteristics that allow for a greater recovery from neurologic injury than more cephaloid cord injuries. More than 50% of thoracic and lumbar injuries occur between T11 and L1[(1)], and the majority of these fractures are unstable. Overall, 20 to 40% of these fractures are associated with neurological deficits[(2)]. The primary goal of treatment of the thoracolumbar fracture is keeping patients alive, protecting them from further neural damage, obtaining stability by reconstructing the anatomical alignment of spinal columns and returning patients to the workplace through early mobilization and rehabilitation. Surgery is the treatment of choice in the management of high energy dorsolumbar fractures and the accepted methods of treatment of these fractures include posterior reduction (with or without decompression) and instrumentation, and anterior decompression and instrumentation[(3-5)].

PATIENTS AND METHODS

A total of 40 patients (23 males and 17 females) and their average age was 28.03±10.95 ranged from 16 to 60 years were included in this study with high energy dorsolumar fractures, 8 patients (20%) at the thoracic region, 24 patients (60%) at the thoracolumbar junction, 8 patients (20%) at the lumbar region. We classified them by using the AO classification system into 16 patients (40%) had type A fractures, 20 patients (50 %) had type B fractures and 4 patients (10 %) had type C fractures.

Study design: Prospective consecutive study.

Inclusion criteria:

1) Adults between 16-60 years old.
2) Patients with high energy dorsolumbar fractures.

Exclusion criteria:

1) Patients less than 16 years or more than 60 years.
2) Neglected fractures more than one month duration.

Method of intervention: They were operated upon at the Trauma Unit of Assiut University Hospital and Al-Azhar University Hospital by posterior instrumentation with pedicle screws and rod system. 23 petients (57.5%) underwent long segment fixation and 17 patients (42.5%) underwent short segment fixation. Decompression was done in 3 cases (17.6%) of short segment fixation group and in 6 cases (26%) of long segment fixation group.

Postoperative regimen: The mean follow-up period was 6.0±0.85; ranging from 6 months to 1 year. All patients were followed up and evaluated both clinically via ASIA score and modified Macnab criteria and

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radiologically by follow up plain x-rays every month for at least 6 months.

Clinical and radiological evaluations: All patients were assessed clinically as regard the neurological status by using ASIA scoring system into: ASIA E 31 patients (77.5 %), ASIA D one patient (2.5 %), ASIA C two patients (5 %), ASIA B (four patients: 10 %) and ASIA A (one patient: 2.5 %). Also, all patients were radiologicaly evaluated by measuring the preoperative kyphotic angle.

Ethical approval: An approval of the study was obtained from Al- Azhar University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation.

Statistical Analysis

An Excel spreadsheet was established for the entry of data. The analyses were carried with SPSS software (Statistical Package for the Social Sciences, version 24, SSPS Inc, Chicago, IL, USA). Numerical data were described as mean ±SD. Frequency tables with percentages were used for categorical variables. Chi-square test was used to analyze categorical variables. A p-value < 0.05 was considered statistically significant.

RESULTS

Table (1): The AO classification of fractures of our patients (N=40)

AO classification of fracture	No. (n=40)	%
Type A3	7	17.5
Type A4	9	22.5
Type B1	3	7.5
Type B2	8	20.0
Type B3	9	22.5
Type C	4	10.0

Table (2): AO Classification of neurological status of our patients

AO Classification of neurological status	No. (n=40)	%
Neurologically Free (NF)	31	77.5
Incomplete paraplegia	1	2.5
Complete cauda	1	2.5
Complete paraplegia	5	12.5
Conus	2	5.0

9 patients out of 40 had neurological deficit at the time of presentation; one patient (2.5%) had ASIA C, two patients (5 %) had ASIA B, and six patients (15 %) had a complete injury (ASIA A). Five patients out of 9 (55.6 %) showed neurological improvement at the last follow up.

Assessment of clinical outcome according to modified Macnab criteria are shown in table (3).

Table (3): Clinical outcome according to modified Macnab criteria

	Long-segment group No. 23	Short-segment group No. 17
Excellent	8 (34.7%)	3(17.6%)
Good	11 (47.8%)	10 (58.8%)
Fair	3 (13%)	3 (17.6%)
Poor	1 (4.3%)	1 (5.9%)

The pre and postoperative kyphotic angle was measured as shown in table 4.

Table (4): The pre- and postoperative kyphotic angle

Parameters	Long Segment No. 23	Short Segment No. 17
Preoperative kyphotic angle	15-35° (Mean=22.4°)	15-28° (Mean=20°)
Postoperative kyphotic angle (Immediate)	4-9° (Mean=5.5°)	5-7° (Mean=5.8°)
Postoperative kyphotic angle (Last Follow up)	5-12° (Mean=7.7°)	7-12° (Mean=8.4°)
Postoperative angle change (Immediate)	7-30° (Mean=16.9°)	9-22° Mean=14.2°)
Postoperative angle change (Last follow up)	1-29° (Mean=14.5°)	6-19° Mean=11.6°)
Loss of Correction	0-9° (2.4°)	1-7° (2.6°)

Table (5): The degree of kyphosis correction in relation to the type of fixation

Fixation Method	Total	Kyphosis Correction (%)		P. value
		≥70	<70	
Short Segment	17	10 (59%)	7 (41%)	0.712
Long Segment	23	16 (70%)	7 (30%)	
Total	40	26	14	

Also the vertebral body height loss in % was assessed: The average preoperative vertebral body height loss was 36.8%, which improved to 17.6% at the final follow-up.

As regard the complications in our study:

3 cases had implant failure as shown in table (**6**), two of them had short segment fixation and failure occurred after bony fusion and the correction loss did not exceed 50% (max. loss was 7°); so only implant

removal was performed with no clinical consequence. The third case of implant failure had long segment fixation with 90% correction loss but with no clinical consequence; so the implant was removed without any other interference. One case had superfacial wound infection, she was a female, diabetic and fatty. The infection noticed one week postoperatively and pa9rentral antibiotics were given and infection was completely cured.

Table (6): showing implant failure in relation to the type of fixation

Patient No.	Fixation Type	Failure Type	Reported fusion at failure time
1	Short segment	Caps loosening, rod slippage	yes
1	Short segment	Screw breakage	Yes
1	Long segment	Screw pullout	Yes

Metal removal: 30 patients (75%) underwent metal removal after one year, 10 patients refused.

Case presentation:

Patient No. 1: A 25 year's old male, manual worker. The mechanism of injury was fall from height. With fracture-dislocation at dorsal 12-L1 (Type **C** fracture according to AO classification). Neurological examination on admission was complete paraplegia (ASIA A), the patient underwent a long segment fixation.

Fig. (1): Preoperative plain x-ray.

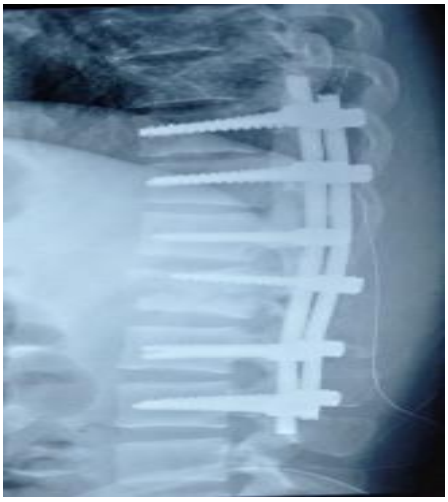

Fig. (2): Immediate postoperative x-rays.

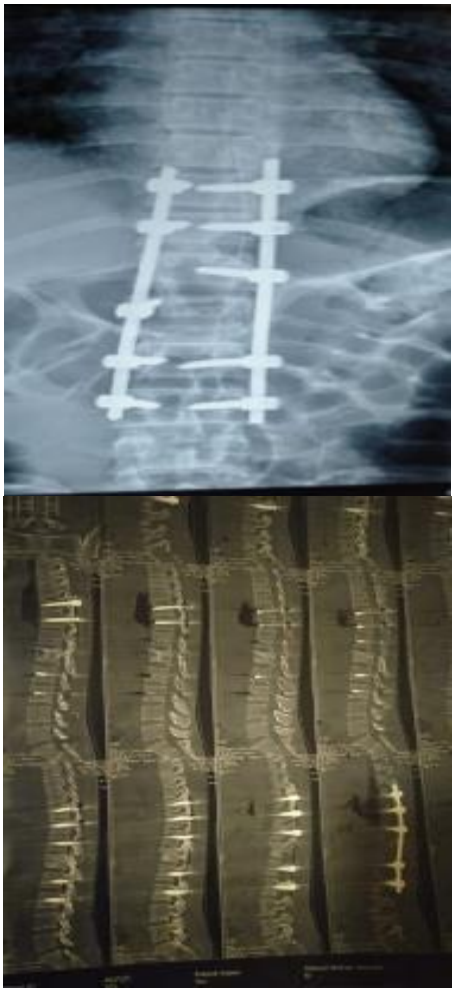

Fig. (3): C-T after 6 months.

Patient No. 2:

A 20 year's old female, housewife with fracture D12 (type **A**4 fracture according to AO classification). The mechanism of injury was fall from height and the patient wass neurologically free on admission. The patient underwent a short segment fixation.

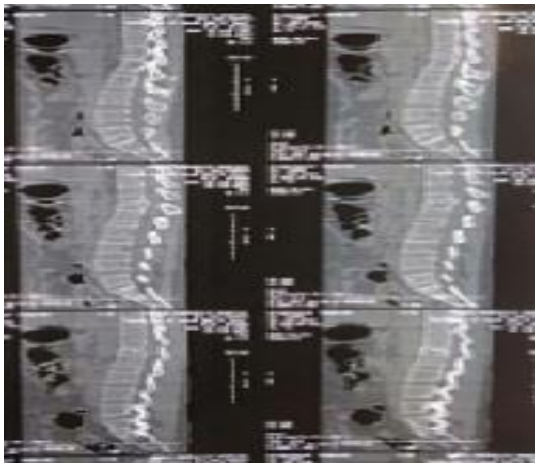

Fig. (4): Preoperative C-T.

Fig. (5): Immediate postoperative x-ray.

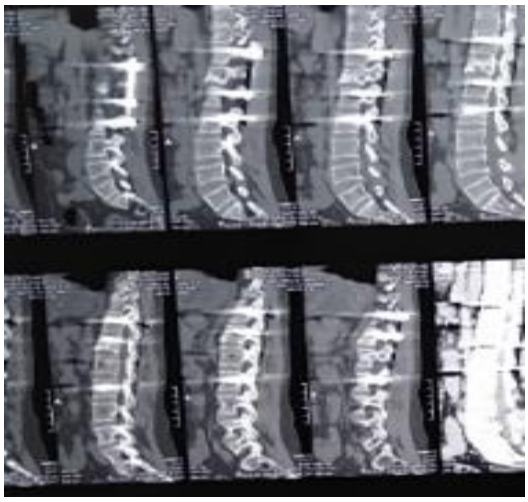

Fig. (6): C-T after 6 months.

DISCUSSION

Thoracolumbar fractures are commonly seen at the thoracolumbar junction, more than 50% of thoracic and lumbar injuries occur between T11 and L1 because it is a transition zone from a relatively rigid thoracic kyphosis to a more mobile lumbar lordosis and the facet joints of the thoracic region are oriented in the coronal (frontal) plane [6]. In our study, 8 patients (20%) had the fractuture at the thoracic region, 24 patients (60%) at the thoracolumbar junction, 8 patients (20%) at the lumbar region.

The causes of thoracolumbar fracture are different depending on the patient's age, with a fall from a height being the most common cause. In younger patients, the fracture is more likely to occur due to high-energy trauma, such as motor vehicle accidents, motorcycle accidents, and falling injury [7-10]. In our study 25 patients (62.5%) had an injury due to fall from a height, 9 patients (22.5%) due to motor car accident, and 6 patients (15%) due to heavy object trauma.

Multiple classification systems are used to describe thoracolumbar spine fractures, each with its strengths and weaknesses. In our study, we used the AO classification system because it is the most comprehensive and most logical classification available up to date. In our study about 16 patients (40%) had type A fractures, 40 patients (50 %) had type B fractures and 4 patients (10 %) had type C fractures.

Management should begin as per the protocol of advanced trauma life support [7]. All patients with neurological deficit (9 cases) received a high dose of methylprednisolone intravenously, beginning with a bolus of 30 mg/kg over one hour and continued at an infusion rate of 5.4 mg/kg/hr but we can't conclude if the improvement that had occurred (in 5 cases out of 9) is due to the use of methylprednisolone or due to the early surgical intervention. Although it seems intuitive that early surgical decompression, especially in incomplete neurological loss, would offer a better chance for recovery, this notion has been extensively debated in the literature. Some have suggested that surgical manipulation of the acutely injured and inflamed spinal cord might not be advisable due to the susceptibility of the cord to further injury. Both laboratory and clinical research in this area has led to these conflicting viewpoints[11].

In our study, 4 cases (10%) were operated upon in the 1st 12 hours , 33 cases (82.5%) in the 1st 72 hours , and 3 cases (7.5%) after 72 hours. Long segment fixation (instrumentation two or more levels above and below the fracture site) is stronger and stiffer than short segment fixation (instrumentation one level above and below the fractured vertebra); however, it sacrifices spinal motion. The location of the fracture can influence the surgeon's choice of fusion. A long fusion in the upper and middle thoracic spine does not reduce the patient's spinal mobility and function very much. However, thoracolumbar and lumbar spines are functionally important. Preservation of mobility in these segments of the spinal column is fundamental particularly in manual workers whose jobs require increased demands on the spine. The long construct may be more suitable in the setting of comminution and osteoporosis. Short-segment fixation may lead to higher rates of instrumentation failure and pseudoarthrosis when used for unstable injuries (e.g.,

extensive comminution, osteoporosis, and fractures of the thoracolumbar junction) [12].

Adding pedicle screws at the fractured vertebrae may theoretically stiffen the construct by splitting the length of the rod that spans from the upper screw to the lower screw into 2 half-length parts. A shorter rod between two points of fixation will create higher stiffness and the additional fixation point can theoretically decrease motion at the metal-bone interface[13,14]. Also, in cases in which the amount of kyphosis correction is insufficient with short-segment fixation, the fixation should be extended including the pedicle of the fractured level to minimize the residual kyphosis. In our study 23 petients (57.5%) underwent long-segment fixation and 17 patients (42.5%) underwent short-segment fixation.

Mahar *et al.* [15], concluded that an average of 15° of kyphosis correction could be obtained using limited posterior segmental fixation. This is likely better than traditional, non-segmental pedicle screw fixation. This is compared to our study in which the average amount of correction for short segment fixation was 14.2°. However, the amount of correction was slightly higher with long-segment fixation (16.9°) but no statistical significance was found, which is similar to the findings of **Guven *et al.*** [16] who found no statistically significant difference regarding correction between long segment fixation and short-segment fixation with pedicle screw at the fractured level. But still, more than 70% of cases of long-segment fixation had more than 70% kyphosis correction. On the other hand, short segment fixation and poor initial postoperative kyphosis correction were both significantly associated with correction loss. Our explanation may be that the insufficient initial kyphosis correction, which was more common among the short segment group, resulted in a greater chance of correction loss.

The greater residual kyphotic deformity provides higher anterior vertebral stress on pedicle screws. Thus, the overloading force on the instrument loosens the screw, causing it to break, dislodge, and disconnect, which are mostly seen in short-segment fixation [15-20].

Study limitations: The follow-up period was only one year after surgery, which was relatively short in terms of clinical evaluations. The sample size was small and there is a risk of accidental bias during the treatment allocation process and with the randomization method.

CONCLUSION

Short segment fixation using pedicle screw at the level of fracture in high energy thoracolumbar fractures provides comparable correction to long segment fixation but if correction of the kyphotic deformity can not be achieved with short segment construct we have to extend the level of fixation.

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