

The Feasibility of the Posterior Approach as a Surgical Technique for the Management of Severe Thoracolumbar Fracture Dislocation

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Abstract

Background: Vertebral fracture dislocation results from failure of the three columns under compression, rotation, and tension. This failure is the main differentiating feature of these types of spinal fractures. Most of these fractures result in severe spinal cord injury and complete neurological impairment.

Aim of Study: The purpose of this study is to report our short-term experience with the posterior surgical approach to managing severe traumatic thoracolumbar fracture dislocation.

Patients and Methods: This retrospective study involved the enrollment of 25 patients who received single-stage posterior surgery for fracture dislocation of the thoracolumbar spine between January 2019 and January 2021. A comprehensive review was conducted on demographic data, medical records, and radiographic images retrieved from the PACS workstation, which stands for picture archiving and communication system.

Results: Twelve patients were found to have a thoracolumbar fracture, with 10 of them located in the thoracic region and 3 in the lumbar region. Fifteen patients had an ASIA grade of A, three patients had an ASIA grade of B, three patients had an ASIA grade of C, two patients had an ASIA grade of D, and two patients had an ASIA grade of E prior to surgery. Fifteen patients had an ASIA grade of A, two patients had an ASIA grade of C, three patients had an ASIA grade of D, and five patients had an ASIA grade of E postoperatively. The patients' mean age was 34.76. The mean duration of hospital stay was 4.52 days. The mean duration of the surgical procedure was 235.20 minutes. The average preoperative kyphosis was 14.28, while the average postoperative kyphosis was -0.980. A significant statistical difference was observed between the preoperative and postoperative kyphosis, as indicated by a *p*-value of less than 0.05. A significant statistical difference was observed in the neurological improvement of patients with incomplete and complete spinal cord injuries, as indicated by a *p*-value of less than 0.05.

Conclusion: According to our research, the utilization of the posterior surgical technique is both safe and effective in treating severe traumatic thoracolumbar dislocation. The

intervention resulted in substantial improvements in the sagittal plane and overall quality of life.

Key Words: Posterior – Fractures – Kyphosis – ASIA – Dislocation.

Introduction

VERTEBRAL fracture dislocation occurs due to the inability of the three columns to withstand compression, rotation, and tension. The primary distinguishing characteristic of these particular spinal fractures is the failure of the three columns [1]. As per the AO classification for thoracic and lumbar fractures, fracture dislocation fractures may fall under the categories of B 1.2, B2.3, B3.3, or C types [2]. This particular type of fracture represents a major category of spinal injuries resulting from high-energy trauma, albeit being a relatively small percentage of spinal fractures. Typically, it is associated with neurological impairments and canal narrowing. According to Denis, there were a total of 412 thoracolumbar spinal fractures, out of which 16% were represented by fracture dislocations [1]. This corresponds to the identical percentage reported in another multicenter study that included 1019 consecutive patients [3].

Transitional instability in the spinal column (AO Type C injuries) occurs as a result of simultaneous, multidirectional, compressive, and distractive forces acting on various spinal elements. The majority of these fractures often lead to significant spinal cord injury and complete neurological impairment. Dural tears and cerebrospinal fluid leaks are observed in over 50% of the fractures. There is a common association between intraabdominal and intrathoracic organs [4-8].

Initially, the treatment regimen encompasses resuscitation as an integral component of the advanced trauma life support (ATLS) protocol, along-

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side the management of critical, potentially life-threatening injuries. Next, spinal stabilization and rehabilitation procedures are conducted. Kyphosis and chronic pain are late neurological consequences observed in patients without any neurological deficit, which can have a negative impact on their overall quality of life [9]. It is imperative to reduce and fix these injuries promptly and effectively [10,11]. The primary objective of surgical intervention is to attain optimal coronal and sagittal alignment while ensuring reduction, particularly in patients presenting with complete spinal cord injuries. It is imperative, even in patients with a low likelihood of neurological recovery, to allow for spinal biomechanical stability, as it promotes effective rehabilitation [2]. Numerous reduction techniques for thoracolumbar fracture dislocations have been documented in the literature, with the objective of establishing standardized surgical approaches for this specific fracture type.

In this study, our experience was demonstrated in the surgical treatment of twenty-five patients who had suffered severe traumatic thoracolumbar fracture dislocations. Decompression, reduction, stabilization, and fusion are the components of the treatment that are performed through a posterior approach. In this article, we will talk about the issues that arise during the treatment of this uncommon injury.

Patients and Methods

We obtained ethical approval from the Institutional Review Board of our institution. We conducted a comprehensive search within our hospital's (Beni-Suef University hospitals) digital medical record system utilizing the keywords "thoracic," "thoracolumbar," "lumbar," and "fracture-dislocation". The inclusion criteria for this study were as follows: Patients who experienced spine trauma as a result of violent force; patients with complete disruption of all three columns of the spine; patients with injuries located in the thoracic, thoracolumbar, or lumbar segments; patients with acute fractures and injuries occurring within a month of the study; and patients with a follow-up time of more than two years. This retrospective study enrolled a total of 25 patients who experienced fracture dislocation of the thoracolumbar spine and underwent single stage posterior surgery. The study period spanned from January 2019 to January 2021. A comprehensive review was conducted on demographic data, medical records, and radiographic images obtained from the PACS workstation (Picture archiving and communication system).

A preoperative radiographic assessment was conducted utilizing posterior, anterior, and lateral plain radiographs of the region, as well as three-dimensional computed tomography (CT) and magnetic resonance imaging (MRI). Anterior translation was observed in a total of 17 patients, while lateral displacement was observed in 7 patients. Additionally, a combination of both anterior translation and lateral displacement was observed in 6 patients, as shown in Fig. (2). In all patients, it was observed that the ruptured disc fragments at the injured segments were dispersed and displaced in both anterior and posterior directions. This resulted in their entry into the spinal canal and subsequent compression of the neural elements.

Operative procedure:

The patient was positioned in the prone position. A standard posterior midline approach was employed, involving subperiosteal dissection of the paraspinal muscles over the affected levels. This revealed the spinal column extending to the transverse processes. It is imperative to exercise caution when identifying anatomical structures at the fracture-dislocation site to avoid any unintended harm to potentially exposed dural elements. The exposure was performed both superiorly and inferiorly to the fractured and dislocated segment. After identifying the standard bony landmarks, pedicle screws were inserted at the superior level. The screws were intentionally inserted flush with the laminar element, while the inferior screws were slightly protruding. This offset would enable spinal reduction in the sagittal plane. The quantity of screws utilized was subject to variation based on the severity of the fracture dislocation and the number of segments involved. A total of three to five segments are stabilized using a range of 6 to 10 pedicle screws. Subsequently, the dislodged or affected facets were released through the surgical removal of the superior and/or inferior articular processes. Recontoured rods were appropriately positioned and securely attached to the distal pedicle screws. Distraction was applied utilizing the instrumentation setting prior to tightening the proximal screw nuts. This technique can effectively realign the dislocated spine in both the sagittal and coronal planes. In certain instances, achieving complete reduction initially posed challenges. Consequently, supplementary maneuvers were required, including modifying the depth of the pedicle screws, reshaping the rod contour to a more lordotic curve, and/or performing in situ contouring (Figs. 1,2).



Fig. (1): MRI dorso lumbar spine sagittal view T2 weighted image showing fracture dislocation in the thoracolumbar junction.



Fig. (2): Lateral fluoroscopic view showing complete reduction of the dislocation.

A decompression procedure was carried out on each patient due to the presence of protruding fracture fragments and the associated neurological deficit. A laminectomy procedure, along with a unilateral facetectomy, was conducted to provide access to the dura and lateral aspects of the disc while ensuring minimal or no traction on the neural structures. In cases where a dural tear is observed, it is common practice to surgically suture the tear to effectively manage any potential cerebrospinal fluid (CSF) leakage. The surgical procedure involved the removal of the ruptured disc and bone fragments from the spinal canal using the posterolateral approach, which is comparable to the transforaminal lumbar interbody fusion (TLIF) technique. Hemostasis was achieved using an absorbable gelatin sponge. Furthermore, the procedure of posterolateral fusion was consistently carried out prior to the deployment of drainage and subsequent closure of the wound.

Rehabilitation may be initiated with a TLSO orthotic within a timeframe of 5-10 days following surgery, taking into consideration the overall condition and comorbidity of the patients. Radiographic examinations were conducted at 3 and 6 months following the surgery, and subsequently on an annual basis, in order to evaluate the bone graft fusion, any potential loss of correction, and the occurrence of implant failure. There were no instances of patients being lost for follow-up visits. The measurement of sagittal kyphosis was taken from the superior endplate of the intact vertebra cephalically to the inferior endplate of the intact vertebra caudally. The fusion status was evaluated using the methods proposed by Lee et al. The confirmation of definitive fusion was established through the observation of bony trabecular bridging across the interface between the graft and host. A computed tomography (CT) scan was performed in response to the diagnostic uncertainty observed on an X-ray image. A comprehensive neurological assessment was also recorded during each subsequent assessment to evaluate the progress of recovery. The surgical procedure would be deemed unsuccessful under the following circumstances: if the implant exhibited signs of looseness or breakage prior to bony fusion; if there was a notable increase of 10° or more in sagittal kyphosis when compared with immediate postoperative imaging; if there was a recurrence of the dislocation or subluxation; or if there was persistent localized pain that did not respond to changes in body position.

Primary hypothesis:

In the treatment of severe thoracolumbar fracture dislocation, the posterior surgical approach has been shown to be both successful and safe.

Statistical analysis:

The data were analyzed using statistical measures such as mean \pm standard deviation (\pm SD), range, or frequencies (number of cases), and percentages were used when appropriate. A comparison was conducted between pre- and post-operative values of kyphosis using the Wilcoxon signed rank test for paired (matched) samples. A comparative analysis of ASIA before and after the surgical procedure was conducted utilizing the McNemar test. Statistical significance was determined by considering two-sided *p*-values that were less than 0.05. The statistical analyses were conducted using IBM SPSS (Statistical Package for the Social Sciences; IBM Corp., Armonk, NY, USA) release 22 for Microsoft Windows.

Outcome Measures:

ASIA impairment scale [22].

Class Description:

- A- Complete: No motor or sensory function preserved.
- B- Incomplete: Sensory but no motor function preserved below the neurologic level. (Includes sacral segments S4-5).
- C- Incomplete: Motor function preserved below the neurologic level (more than half of key muscles below the neurologic level have a muscle strength grade <3).
- D- Incomplete: Motor function preserved below the neurologic level (more than half of key muscles below the neurologic level have a muscle strength grade \geq 3).
- E- Normal: Sensory & motor function normal.

Results

The study was conducted on a cohort of 25 patients who had experienced fracture dislocation of the thoracolumbar spine and subsequently underwent single-stage posterior surgery. The number of males was 15, and the number of females was 10. The level of fracture was thoracolumbar in 12 patients: 10 in the thoracic region and 3 in the lumbar region. The mode of trauma was RTA in 14 patients and FFH in eleven patients. The surgery was done on the same day in 20 patients and on the second day in 5 patients. The preoperative ASIA grade was classified as follows: Grade A in 15 patients, Grade B in 3 patients, Grade C in 3 patients, Grade D in 2 patients, and Grade E in 2 patients, as shown in Table (1). The postoperative ASIA grade was classified as follows: Grade A in 15 patients, Grade C in 2 patients, Grade D in 3 patients, and Grade E in 5 patients, as shown in Table (2).

Table (1): Showing Pre-operative ASIA Score.

Preoperative ASIA	Frequency	Percent
A	15	60.0
B	3	12.0
C	3	12.0
D	2	8.0
E	2	8.0

Table (2): Showing Post-operative ASIA Score.

Postoperative ASIA	Frequency	Percent
A	15	60.0
C	2	8.0
D	3	12.0
E	5	20.0

The average age of the patients was 34.76. The average duration of hospitalization was 4.52 days. The mean duration of the surgical procedure was 235.20 minutes. The mean blood loss observed was 772.00ml. The mean preoperative kyphosis was 14.28, while the mean postoperative kyphosis was -0.980, as shown in Table (3). A statistically significant difference was observed between post-operative kyphosis and preoperative kyphosis, as indicated by a *p*-value of less than 0.05.

Table (3): Showing data of age, hospital stay, blood loss, and pre-, and post-operative Kyphosis.

	N	Minimum	Maximum	Mean	SD
Age	25	18	52	34.76	8.442
Hospital stay	25	3	6	4.52	0.918
Surgery time	25	180	300	235.20	38.957
Blood loss	25	300	1,200	772.00	242.418
Kyphosis Pre	25	13	16	14.28	0.891
Kyphosis Post	25	-1.5	-0.5	-0.980	0.3948

Values are expressed as mean ± SD.
N: Number. SD: Standard deviation.

Table (4): Showing ASIA Impairment Scale.

	ASIA Post				Total
	A	C	D	E	
ASIA Pre:					
A:					
Count	15	0	0	0	15
% within ASIA Pre	100.0%	0.0%	0.0%	0.0%	100.0%
% within ASIA Post	100.0%	0.0%	0.0%	0.0%	60.0%
% of Total	60.0%	0.0%	0.0%	0.0%	60.0%
B:					
Count	0	2	1	0	3
% within ASIA Pre	0.0%	66.7%	33.3%	0.0%	100.0%
% within ASIA Post	0.0%	100.0%	33.3%	0.0%	12.0%
% of Total	0.0%	8.0%	4.0%	0.0%	12.0%
C:					
Count	0	0	2	1	3
% within ASIA Pre	0.0%	0.0%	66.7%	33.3%	100.0%
% within ASIA Post	0.0%	0.0%	66.7%	20.0%	12.0%
% of Total	0.0%	0.0%	8.0%	4.0%	12.0%
D:					
Count	0	0	0	2	2
% within ASIA Pre	0.0%	0.0%	0.0%	100.0%	100.0%
% within ASIA Post	0.0%	0.0%	0.0%	40.0%	8.0%
% of Total	0.0%	0.0%	0.0%	8.0%	8.0%
E:					
Count	0	0	0	2	2
% within ASIA Pre	0.0%	0.0%	0.0%	100.0%	100.0%
% within ASIA Post	0.0%	0.0%	0.0%	40.0%	8.0%
% of Total	0.0%	0.0%	0.0%	8.0%	8.0%

The patients with incomplete spinal cord injuries exhibited the highest rate of neurological improvement. There were no observed improvements in patients with complete spinal cord injuries, as indicated in Table (1). A statistically significant distinction in neurological improvement was ob-

served between patients with incomplete and complete spinal cord injuries, as indicated by a *p*-value of less than 0.05.

Discussion

Spinal fracture dislocations from high-energy impacts, which result in the disruption of the entire spinal column, are considered to be one of the most unstable types of spinal injuries. Additionally, they have been found to have the highest incidence of complete neurological impairment [12]. The static and dynamic stabilization elements, including the vertebrae, disc, facets, ligaments, and muscles, undergo damage due to a combination of shear rotation and flexion/extension [13]. In cases of such injuries, it is imperative to promptly stabilize the spine in order to ensure the protection of the neurologic and musculoskeletal systems. Surgical intervention is typically required, with treatment objectives primarily centered around four key aspects: Realignment of the dislocated spinal column, alleviation of pressure on neural structures, attainment of long-term spinal stability, and prompt initiation of mobilization and rehabilitation [13,14].

The feasibility of utilizing the anterior approach for treatment of fracture dislocation injury may be limited due to the challenging nature of reducing fractures solely through this approach, which may prove to be impossible in certain cases. The optimal method for achieving realignment and fixation involves utilizing the posterior approach for reduction techniques, multilevel instrumentation, and fusion procedures. In the early 1980s, Aebi et al. [15] employed the Harrington and Luque system for the management of thoracolumbar fractures and fracture dislocations. A significant proportion of patients, specifically one-third, necessitated reoperation due to inadequate or unsuccessful implantation. The development of the internal fixator system was driven by the presence of technically unsatisfactory results. In a subsequent study, Carl et al. [16] conducted research on the utilization of pedicle screw instrumentation for the treatment of thoracolumbar burst fractures and fracture dislocations. Out of their cohort of 38 patients, nine individuals experienced instances of bent or broken screws within a span of less than two years of post-operative follow-up. However, it is worth noting that the majority of these patients expressed satisfaction with the overall outcome of the surgical intervention. Certain authors have expressed a preference for utilizing long pedicle screw fixation, specifically involving two levels above and below the lesion. These authors hold the belief that additional anterior surgery, such as anterior decompres-

sion, is seldom necessary, especially in cases of incomplete spinal cord injuries [17,18]. In a recent study conducted by Wang and Zhu [19], posterior pedicle screw fixation was utilized for the treatment of complete fracture dislocation of the thoracolumbar spine. The study reported that 11 patients achieved satisfactory outcomes with a mean follow-up duration of 22.3 months. However, other authors have expressed the opinion that a singular posterior approach may not provide sufficient biomechanical stability for long-term follow-up. In their study, Ebelke et al. [20] employed survivorship analysis to examine thoracolumbar burst fractures. Their findings indicated an increase in the failure rate of posterior internal fixation during the follow-up period.

In our conducted study, the mean preoperative kyphosis was determined to be 14.28, while the mean postoperative kyphosis was observed to be -0.980. A statistically significant difference was observed between postoperative kyphosis and preoperative kyphosis, as indicated by a p -value of less than 0.05. Over a period of approximately 24 months of follow-up, the correction was effectively maintained with a minimal loss of correction that did not show any statistically significant differences. The quantity of screws utilized was subject to variation based on the severity of the fracture dislocation and the number of segments involved. A total of three to five segments are stabilized using a range of 6 to 10 pedicle screws. Subsequently, the displaced or compressed facets were alleviated through the surgical procedure of resecting the superior and/or inferior articular processes.

While there may be differing view points on the necessity of surgical decompression for patients with complete neurological deficits and concerns about the potential destabilization caused by laminectomy, the authors firmly believe that fracture dislocation consistently coincides with laminae and facet fractures. Dural tears and cerebrospinal fluid (CSF) leaks frequently occur in cases of severe injuries of this nature. Additionally, the condition of dislocated and locked facets often presents a challenging obstacle to reduction of the fractured spinal segment [19]. Consequently, a laminectomy and facetectomy were performed on at least one side at the affected level. The objective of this procedure, in addition to neural decompression, was to remove the fractured laminae and facet fragments within the intracanal space, repair the dural sac to manage cerebrospinal fluid (CSF) leakage, facilitate proper alignment reduction, and assist in the execution of interbody fusion.

Our study findings indicate that patients with incomplete spinal cord injuries exhibited the highest rate of neurological improvement. There were no observed instances of improvement among patients with complete spinal cord injuries. A statistically significant distinction in neurological improvement was observed between patients with incomplete and complete spinal cord injuries, as indicated by a p -value of less than 0.05.

A notable concern associated with this procedure pertains to the constrained load-bearing capacity observed when employing small autografts for anterior column reconstruction [21]. Over the course of an average follow-up period of 24 months, the correction was effectively maintained. No graft-related issues were observed in our study.

Conclusions:

According to the findings of our research, the posterior surgical procedure is both an effective and safe method for treating severe traumatic thoracolumbar dislocation. It was associated with a significant improvement in the sagittal plane as well as an enhancement of the patients's quality of life.

Authors' statements:

There were no conflicts of interest, and all study procedures were conducted in strict adherence to established ethical guidelines. There is a complete absence of financial disclosure. The patients have given their informed consent. The aim and design of the study received approval from the medical and ethical committee of the neurosurgery department at our institute.

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جدوى النهج الخلفى كأسلوب جراحى لإصلاح الكسور الشديدة بالفقرات الصدرية والقطنية

الخلفية: ينتج كسر العمود الفقري عن فشل الأعمدة الثلاثة تحت الضغط والدوران والتوتر. هذا الفشل هو السمة المميزة الرئيسية لهذه الأنواع من كسور العمود الفقري، تؤدي معظم هذه الكسور إلى إصابة شديدة في النخاع الشوكي وضعف عصبي كامل.

الهدف من الدراسة: الغرض من هذه الدراسة هو تقديم تقرير عن تجربتنا قصيرة المدى مع النهج الجراحى الخلفى لعلاج الكسور الشديدة بالفقرات الصدرية والقطنية.

المرضى والطرق: تضمنت هذه الدراسة بأثر رجعى تسجيل ٢٥ مريضاً خضعوا لعملية جراحية خلفية أحادية المرحلة لكسر خلعى فى العمود الفقري الصدرى القطنى بين يناير ٢٠١٩ ويناير ٢٠٢١ تم إجراء مراجعة شاملة للبيانات الديموغرافية والسجلات الطبية والصور الشعاعية المسترجعة من أرشيف الصور.

النتائج: لوحظ وجود فروق ذات دلالة إحصائية بين تحذب العمود الفقري قبل الجراحة وبعد العملية الجراحية، كما لوحظ وجود فروق ذات دلالة إحصائية فى التحسن العصبى للمرضى الذين يعانون من إصابات غير كاملة وكاملة فى النخاع الشوكى.

الخلاصة: وفقاً لبحثنا، فإن استخدام تقنية الجراحة الخلفية آمن وفعال فى علاج الصدمة الشديدة للخلع الصدرى القطنى. أدى التدخل إلى تحسينات كبيرة فى ثبات العمود الفقري ونوعية الحياة بشكل عام.