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Surgical options for traumatic fractures of the thoracic and lumbar spine. A series of 20 patients

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ABSTRACT

Background context. Thoracolumbar fractures represent a large number of spine injuries in adults. Such fractures are a result of traumatic accidents with high-energy impacts, such as falls from height or following motor vehicle accidents, often resulting in some degree of neurological deficit.

Purpose. To report a total of 20 cases of thoracolumbar fractures in young adults with various neurological manifestations. The majority had indications for transpedicular fixation.

Study Design. Series of 20 cases and review of the literature.

Patient Sample. A series of 20 patients with a history of falling from a height or after motor vehicle accidents (RTA) with complicated fractures at the level of the thoracolumbar vertebrae which present with neurological deficits.

Methods. We report here on a total of 20 patients with a history of falls from height or following RTA. Patients presented to the hospital complaining of back and abdominal pain. Fractures at the thoracolumbar vertebral level were confirmed with imaging studies revealing post-traumatic spinal deformities. All cases were initially considered for conservative medical treatment. However, unstable complicated cases with bone fragment migration as well as spinal canal compression were deemed candidates for surgical intervention via posterior spinal fusion with transpedicular screw fixation.

Written informed consent was gathered from all patients. Detailed history, clinical examination, as well as X-ray, computed tomography and magnetic resonance imaging of the dorsolumbar spine were obtained in all cases. Neurological status was assessed using the Frankel grading for spinal cord injury.

Results. The patients tolerated the operations without complications and remained in stable postoperative condition.

Conclusion. Surgical treatments via transpedicular fixation are extremely efficient for treating unstable and complicated thoracolumbar spinal fractures. Nevertheless, conservative medical treatment is still of high value and should be considered as the first treatment option, especially in stable cases. The patients who underwent surgery showed excellent outcomes and improvement of neurological deficits. The surgical procedure preferred in the present study was the posterior spinal fusion with pedicle screw fixation.

Keywords
spine,
fractures,
surgery,
fixation,
thoracic and lumbar,
screw,
tarnspedicular,
treatment

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Introduction

The biomechanical properties of the thoracic spine and thoracolumbar junction directly predispose this anatomically unique region to various types of traumatic injuries. High-energy trauma produced by road traffic accidents (RTA) is the primary cause of injury, followed by falls from a height and sports-related injuries (1). The thoracolumbar vertebrae are associated with a high risk of post-traumatic compression fractures due to the effects of axial loading, which under normal conditions contribute to the natural kyphotic curvature of the thoracic spine (2) (3).

The management of traumatic fractures of the thoracolumbar (T1-L5) spinal column remains controversial. There are a number of publications outlining various treatment strategies aimed at obtaining normal mobilization and stability of spinal fractures. Despite the variety of treatment options presented in medical literature, there has as yet been no definitive consensus with regards to a gold-standard management protocol (4)(5). Nor have there been any reported advantages with respect to patient outcome, despite several operative strategies being currently employed to achieve fracture reduction and fixation. Furthermore, there is a scarcity of supporting evidence in the available literature for choosing conservative versus surgical management or vice versa (6) (7).

While patients with limited vertebral body compression, for example, can benefit from non-operative treatment such as thoracolumbar orthosis, restriction of activities and administration of analgesics (8), surgical management is generally considered of utmost necessity in patients presenting with severe biomechanical spinal instability or acute or chronic neurologic deficit (9). Indications for surgical treatment include unstable injuries associated with neurological deficits, complicated fractures with dislocation or progressive deformations associated with compression of neural structures (10) (11) (12) (13). The primary objectives of surgical treatment of unstable thoracolumbar fractures are optimizing neural decompression, early stabilization, pain relief and adequate nursing care (6) (14).

A number of classification systems have been devised to categorize thoracolumbar fractures. One of the most commonly used classification systems in clinical practice today is the scheme proposed by Francis Denis in 1983, which has aided in the communication and description of thoracolumbar fractures and their respective treatment strategies among medical practitioners [Figure 1] (15). Denis maintained that complete rupture of the posterior ligamentous complex alone would be insufficient to create spinal instability in flexion, extension, rotation and shear, and that spinal instability at least in flexion would develop only in the presence of additional disruption of the posterior longitudinal ligament and posterior annulus fibrosis (15) (16).

In the Denis classification system, the spine is subdivided into three columns as follows: anterior column (anterior longitudinal ligament [ALL] and anterior two-thirds of the vertebral body and annulus), middle column (posterior one-third of the vertebral body and annulus, posterior vertebral wall and posterior longitudinal ligament [PLL]), and posterior column (all posterior structures of the PLL which include: posterior bony arch and posterior ligamentous complex (supraspinous and interspinous ligaments, capsule, and ligamentum flavum).

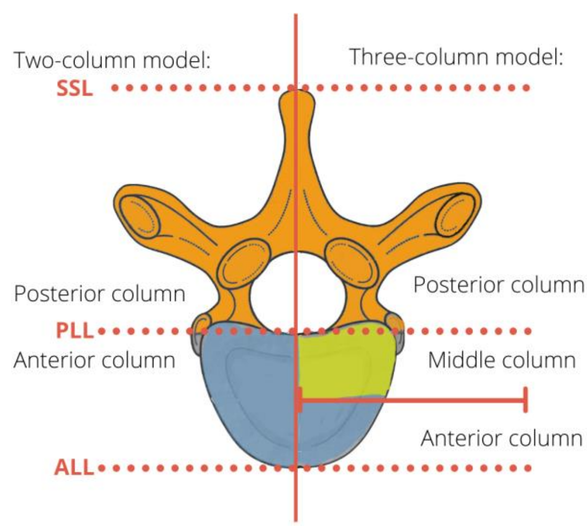


Figure 1. Two-column model compared with three-column model (Denis). In addition to the positions of SSL, PLL and ALL.

The Denis "3-column model" relied on anatomic divisions to guide surgical planning, whereas more modern classification systems such as the Thoracolumbar Injury Classification System (TLICS) emphasize the initial neurologic status and structural integrity of the posterior ligamentous complex as a guide for surgical decision-making and have demonstrated a high intra- and inter-observer reliability. Other systems, such as the Load-Sharing Classification, also aid as useful tools in planning the extent of instrumentation and fusion (15) (17) (18) (12) (19).

This case study is aimed at presenting our experiences in adult traumatic spinal injury. Radiological findings, treatment strategies, and clinical outcomes were evaluated retrospectively and compared with the available literature.

CASES AND METHODS

Study design

This is a retrospective study conducted at Benha University Hospital, Benha, Egypt, between 2016 and 2020.

We report here a total of 20 patients with thoracolumbar injuries sustained by falling from a height or following RTA, of which 16 had presented with indications for surgical management via transpedicular fixation, i.e., with unstable and complicated fractures associated with neurological deficits. Four cases had no indication for surgical treatment and were treated conservatively.

As per standard procedure for all patients admitted to our clinic, detailed patient histories were gathered, comprehensive physical examinations were performed, and all relevant laboratory investigations were completed for each case. Pre- and postoperative neurological status was assessed using the Frankel Grade classification for spinal cord injury, a functional grading of impairment in activities of daily living, and analysis of gait disturbances (20) (21).

After performing an initial clinical and neurological examination, the diagnosis was confirmed radiologically, i.e., bony structure injury of the thoracolumbar spine was confirmed with computerized tomography (CT), while neural and ligamentous involvement was confirmed with additional magnetic resonance imaging (MRI).

The length of time, from the day of patient admission to the operation, ranged from 3-7 days, depending on the clinical and neurological status of the patient, as well as on trauma severity.

All patients were fully informed with regard to treatment options to manage their injuries, including the aim and scope of the treatment, possible operative and perioperative risks, as well as potential short- and long-term complications. Informed written consent forms were signed and submitted by all patients upon hospital admission.

CASE REPORTS

Surgical procedures

All patients in the present study with surgical indications were treated with pedicle screw fixation, which is generally considered a safe procedure through which adequate reduction and stability can be achieved, and provides patients with early pain relief and mobility (22). Although either anterior or posterior approaches can be used in spinal fusion surgery, posterior approaches are associated with lower postoperative morbidity rates. Less aggressive than the anterior approach, posterior fixation is associated with several advantages, including less intraoperative bleeding and fewer postoperative complications, while still achieving excellent spinal stabilization (23) (24). Preoperative intravenous antibiotic prophylaxis was administered to each patient.

The posterior approach was utilized for each case in the present study. Each patient was placed in a prone position. A midline posterior incision centered over the affected area was performed with the aid of preoperative X-Ray imaging planning. An initial laminotomy was performed on each patient. Using anatomical landmarks such as the facet joints and transverse processes, it was possible to establish insertion points on the pedicles [Figure 2]. For example, an entry point can be identified by drawing a horizontal line through the middle of the transverse processes, or from the intersection of the upper one-third of the transverse process and a vertical line drawn through the prominent ridge on the superior articular facet.

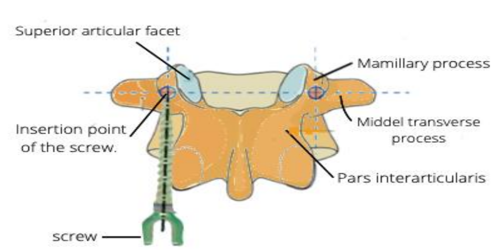


Figure 2. The transpedicular insertion; insertion point of the screw.

Cortical bone was nibbled off at the point of the intersection of these two lines, pilot holes were created using a burr, and a ball handle probe was passed through the cancellous channel in the pedicle and into the vertebral body. Screw angulation and placement were performed using C-arm-guided fluoroscopy.

A transpedicular screw fixation and fusion approach was then employed, with bilateral, two-level pedicle screw placement, followed by bilateral rod placement situated on the fracture level and on at least one adjacent level superiorly or inferiorly, based on the location of the intact endplate. For example, in cases where the inferior endplate was intact and the superior endplate was fractured, screws were inserted caudally to the inferior endplate at an angle of approximately 5°. Transpedicular screw fixation was complemented by placement of adjoining rods with cross-connecting rod reinforcement. Distraction was performed and locking nuts were tightened. The surgical wound was thoroughly irrigated and closed over a suction drain.

Postoperative monitoring and follow-up

Postoperative imaging studies were performed in order to ensure the efficacy of the surgical procedure. Following surgery, patients were transferred to the post-anesthesia care unit for 24 hours. Postoperative patient mobilization was initiated on the first day. The average time for suture removal was approximately 12 days. Patients wore a Taylor brace until the 10th–12th postoperative day, or longer in cases with injuries involving all three columns. Regular physiotherapy and assisted mobilization were continued until the patient was discharged from the hospital. A detailed neurological examination was repeated on the day of patient discharge.

All patients with unstable injuries were monitored with regular follow-up visits: at 4–6 weeks post-operation, and bi-monthly afterwards, for an average total period of 24-36 months. Follow-up visits included clinical, neurological and radiological examinations, as well as documentation of any postoperative complications.

Results

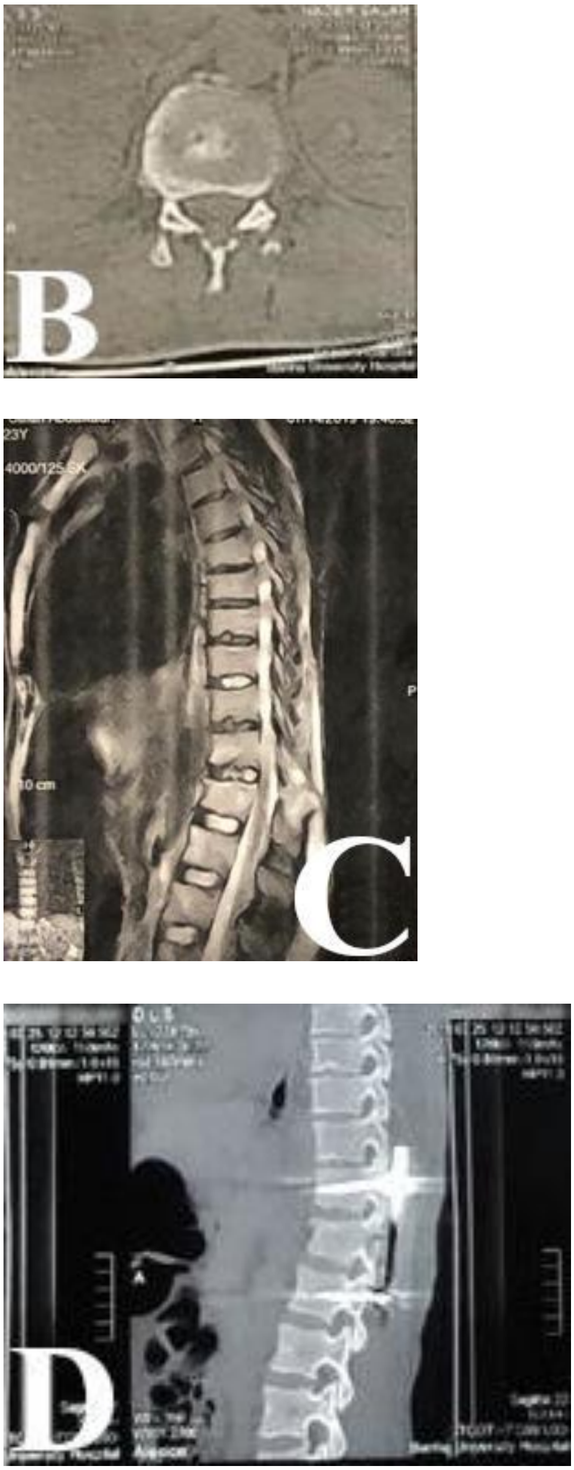
The posterior spinal fixation approach was used in the surgical treatment of 16 cases with unstable thoracolumbar burst fractures. Of the patients treated surgically, 12 had no neurological deficits at the time of hospital presentation. Transient leg numbness, tingling sensation and pain, immediately after the traumatic event, were reported by eight of these 12 patients, with symptoms subsiding by the time of admission into the emergency department. Persistent neurological deficit was reported by four cases in the study.

Six cases presented with a T12-level fracture, three cases with a T10-level fracture, one case with T9-level fracture and one case of T11-level fracture. Three cases presented with a fracture at the L3-level, and two cases presented with a fracture at the L2 level. There were no cases of dural tears in the present study.

Of the four patients with stable injuries who were managed conservatively, two cases presented with T10-level fractures, one case with a T11-level fracture and one case with a fracture at the L2-level. The mean duration of hospitalization was approximately four weeks.

Preoperatively, eight of the patients presented with normal motor function (Frankel grade E). Six patients presented with preserved, functionally useful voluntary motor function (Frankel grade D). Two cases presented with preserved, nonfunctional voluntary motor function (Frankel grade C).

In follow-up visits at 24-36 months postoperatively, the majority of patients had neurological recovery with either Frankel grade of E or D scores, while one patient had a persistent motor deficit, with a Frankel grade of C score.



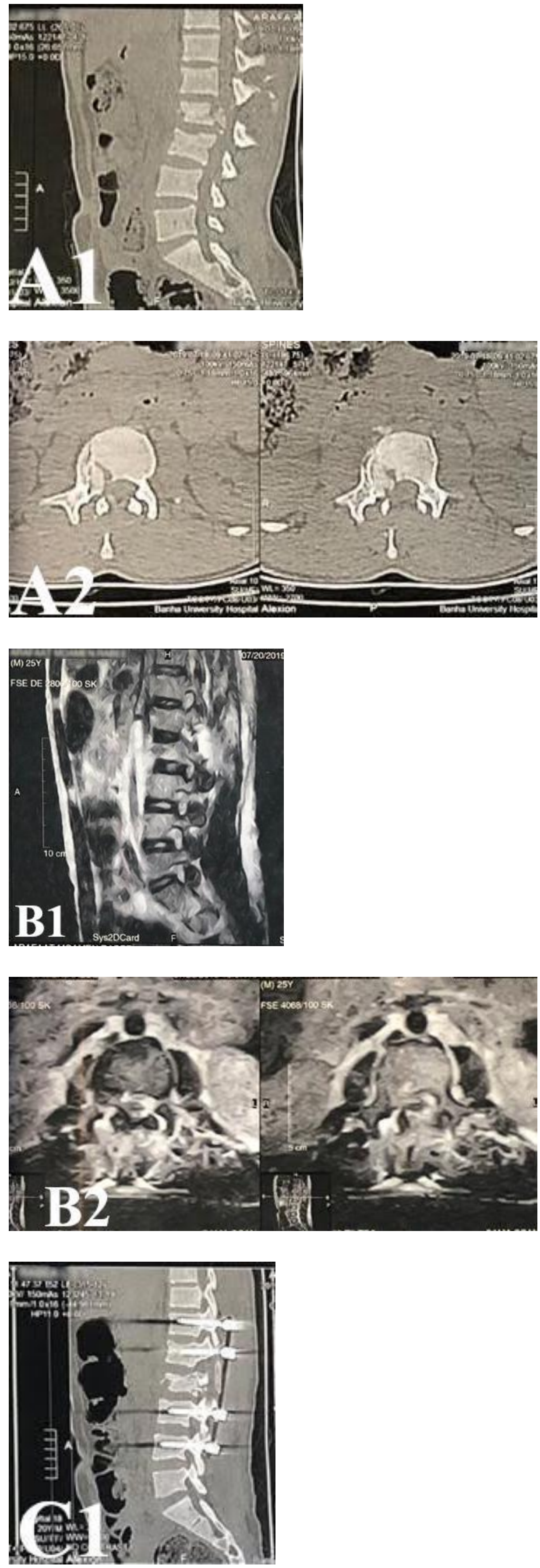


Figure 3. Case 1: A, preoperative sagittal CT of a 26-year-old male patient who sustained a T10 burst fracture without neurological deficit at time of admission (Frankel grade E). B, preoperative axial CT scan image confirming the presence of a fracture at the T10 vertebral level. C, preoperative MRI demonstrating T10-level fracture. D, postoperative sagittal CT imaging taken 24h after the patient underwent a transpedicular fixation procedure. The CT scan demonstrated correct screw placement at two levels (T9 and T11).

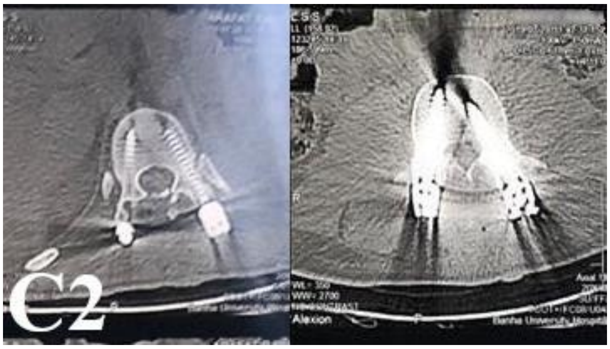
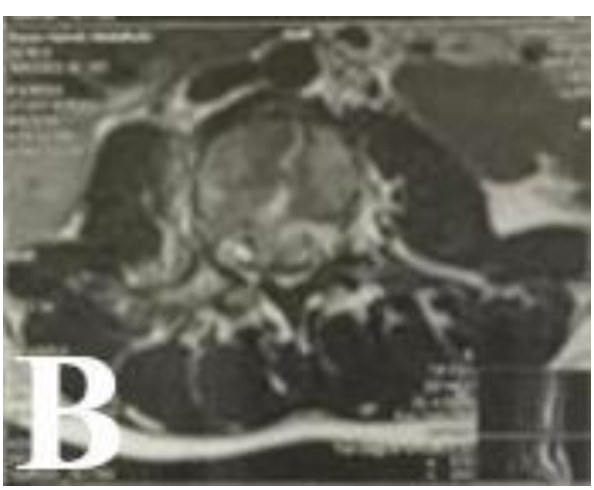


Figure 4. Case 2: A1, preoperative sagittal CT of a 20-year-old male patient who sustained an L2 burst fracture without neurological deficit at time of admission (Frankel grade E). A2, preoperative axial CT image confirming the presence of a fracture at the L2 vertebral level. B1, preoperative sagittal T1-weighted MRI revealing L2 fracture. B2, preoperative axial MRI showing the aspect of the fracture at L2. C1, postoperative sagittal CT scan obtained 24h after the patient underwent a transpedicular fixation procedure. The CT scan demonstrated correct screw placement at two levels superiorly (T12, L1) and two levels inferiorly (L3, L4). There is no significant correction of local post-traumatic kyphosis C2, postoperative axial T1-weighted MRI, 12 months after surgery, at which point the patient had a Frankel grade of E.

Figure 5. Case 3: A, preoperative sagittal CT of a 29-year-old female patient who suffered a T12 burst fracture without neurological deficit at time of admission (Frankel grade D). B, preoperative axial MRI confirming the presence of a fracture at the T12 vertebra level. C, preoperative coronal CT scan confirming the T12-level fracture. D, preoperative sagittal MRI demonstrating the fracture at T12. E1, postoperative sagittal CT scan acquired 24h after the patient underwent a transpedicular fixation procedure. The CT scan demonstrated correct screw placement at two levels superiorly (T10, T11) and one level inferiorly (L1). E1 and E2, postoperative sagittal and axial T1-weighted MRI revealing correct screw insertion. Serial follow-up CT scans were performed after surgery, with the patient having a Frankel grade of D.



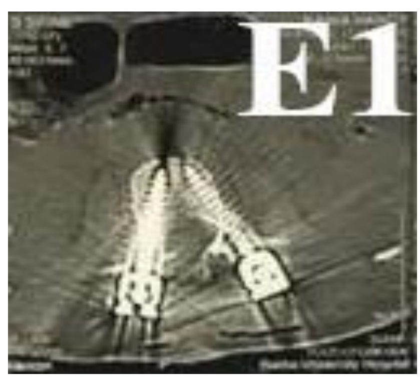


Figure 6. Case 4: A, preoperative sagittal CT of a 17-year-old female patient who was admitted with a burst fracture at the level of L3, with bilateral motor deficit (Frankel grade A). B, preoperative axial MRI confirming spinal cord compression at the L3-level due to the fracture. C, preoperative sagittal MRI demonstrating the presence of the fracture with evidence of spinal cord injury at the L3-level. D, postoperative sagittal CT scan revealing screw insertion at one level superiorly (L2) and at one level inferiorly (L4) relative to lesion. E, postoperative axial T1-weighted MRI revealing correct screw insertion (L2). Serial follow-up CT scans were performed after surgery, with the patient having a Frankel grade of C.

Discussion

The mechanism of injury in the present case series was via fall from a height or road traffic accidents (RTA) (20 cases), resulting in thoracolumbar fractures. Four patients presented with uncomplicated stable fractures, in which conservative management was indicated. The majority of the patients in the study (16 cases) had complicated unstable fractures. The patients were operated using the posterior approach with transpedicular screw fixation within 3-7 days from hospital admission. In our study, the most common site of fracture was located at the T12 vertebral level (6 cases). The surgical interventions proceeded uneventfully with no major intra- or postoperative complications.

All patients who underwent surgery were assessed neurologically pre- and post-operatively at regular intervals. The Frankel Grade classification was used to evaluate neurological function of the patients. Preoperatively, eight cases had Frankel grades of E, six cases had Frankel grades of D and two cases had Frankel grades of C. Following surgical intervention, only one patient had a persistent Frankel grade of C, while the majority of our cases had Frankel grades of D or E, which indicate acceptable results with posterior fixation for unstable thoracolumbar fractures.

Conclusion

The main objectives of surgical treatment of thoracolumbar fractures are to improve neurological deficits as classified by the Frankel scale, to prevent spinal cord injuries, and to achieve stability by screw fixation. Our case study demonstrates that posterior transpedicular screw fixation is an effective and safe surgical method to obtain stabilization of the spine. The approach is associated with good surgical outcomes and minimal complications.

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