Intermediate pedicle screws for unstable thoracolumbar junction injuries

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Background
To evaluate the use of an additional pedicle screw for unstable thoracolumbar spine injuries.

Patients and methods
Thirty patients with unstable thoracolumbar spine injuries were included in the study. All patients underwent open reduction and internal fixation using a posterior approach. Pedicles were localized using anatomical landmarks and intraoperative imaging. Patients were followed up for 1 year.

Results
There were 30 patients with unstable thoracolumbar junction injuries who were managed with pedicle screws and rods with the addition of intermediate screws. Men were more affected (the male : female ratio was about 2 : 1). Wedge compression and burst were the most common. About 28 patients were neurologically free, one with Frankel B, and another one with Frankel C. The two patients with neurological impairment showed improved neurology by at least one Frankel grading.
No postoperative neurological deterioration was observed; metal failure occurred in two patients after 1 year of follow-up.

Conclusion
Pedicle screw fixation is a good choice for thoracolumbar junction injuries to achieve reduction and stability; additional fixation (intermediate screw at the fractured level) provides significant correction of vertebral body height and local kyphosis, and maintains the correction.

Keywords:
intermediate screws, pedicle screws, thoracolumbar junction injuries

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Introduction

Traumatic injuries are mostly responsible for spinal fractures, which affect the thoracolumbar junction in more than half of the cases. Compression fractures are the most common type of fractures. Burst fractures account for a significant percentage of traumatic compression-type fractures (up to 80% in an actual multicenter study). Burst fractures cause a retropulsion of a posterior wall fragment into the spinal canal, which is associated with a higher incidence of neurological deficits. Therefore, they represent the transient area between stable and unstable fractures. The treatment of unstable fractures and fracture dislocations of thoracolumbar spine remains controversial. Either anterior, posterior, or both approaches can be used. However, the posterior approach is less extensive. Pedicle screw devices allow immediate stable fixation as the screw traverses all three columns [1].

The majority of thoracolumbar spine fractures and fracture dislocations may be considered acute sagittal plane deformities. Unstable thoracolumbar spine injuries require stabilization (a) to allow mobilization of the patient to prevent pulmonary and venous complications; (b) to relieve pain; (c) to realign the spine and spinal canal; and (d) to decompress the neural elements directly or indirectly [2].

Harrington instrumentation and similar methods were the most commonly used fixation methods for thoracolumbar fractures. However, fracture treatment with the Harrington device fixates five to seven vertebrae, resulting in negative effects on mobility. This negative effect is greater the further down in the lumbar spine the fracture. Furthermore, in the postoperative period, a brace is required for mobilization of the patient during healing to avoid instrumentation failure. Moreover, the patient is not allowed to set for 6 months. Instability, instrument failures, and correction losses have been reported. Some loss of correction may occur after the removal of the distraction devices, so that the end result is often roughly similar to the original deformation [3].

Boos and Webb [4] suggest that pedicular fixation is a relatively safe procedure and is not associated with a significantly higher risk of complications than non-pedicular instrumentation. Pedicle screw fixation provides short, rigid segmental stabilization that allows

preservation of motion segments and stabilization of the spine in the absence of intact posterior elements, which is not possible with nonpedicular instrumentation. For the correction of spinal deformity, pedicular fixation provides the theoretical benefit of rigid segmental fixation and of facilitated deformity correction by a posterior approach.

Short-segment surgical treatments on the basis of the use of pedicle screws for the treatment of traumatic conditions have been proved to be practical, safe, and effective [5].

Inclusion of the fracture level in the construct has offered a better kyphosis correction, in addition to fewer instrument failures [6].

The aim of this work is to evaluate the use of an additional intermediate screw for unstable thoracolumbar spine injuries.

Patients and methods

This was a prospective study that included 30 patients with unstable thoracolumbar spine injuries (T10–L2) who were surgically managed at the Traumatology Unit; they were also followed up in the outpatient clinic of the Orthopaedic and Traumatology Department at Assiut University Hospital for 1 year. Patients with pre-existing systemic illness or associated extraspinal injuries significant enough to result in increased morbidity or mortality were excluded from the study. Patients with Frankel A were also excluded from this study because of the difficulty in follow-up. A detailed assessment of history and examination were carried out focusing especially on the mode of trauma, Frankel grading [7], sensory level, and any spinal deformity.

Plain radiographs, in anteroposterior and lateral views, were obtained. An MRI or a computed tomography scan was carried out to further evaluate the important relationships and instability of the spine when required. The most frequent etiology of the injury was a fall from a height in 15 patients, followed by motor vehicle accidents (regional kyphosis angle) in 10, and a motorcycle accident in five other. Six patients had T-12 fractures, 17 had L-1 fractures, and seven had L-2 fractures.

Those patients with unstable spine were then informed about the pros and cons of the surgical treatment. All patients underwent open reduction using a posterior approach. Pedicles were identified by anatomical landmarks and intraoperative imaging. Cases associated with neurology and or laminar fractures were decompressed; laminectomy and exploration of the neural canal were carried out. Pedicular screws were then inserted above and below and also through the fractured level. A rod was then coupled to the screws. The wound was then closed in layers after maintaining a drain. The patients were hospitalized for 2 days after surgery. They were administered broad-spectrum antibiotics and analgesics for 1 week. The drain was removed the day after the surgery. The second postoperative day follow-up radiographs were obtained. Thoracolumbar support was provided to the patients for 3 months.

All analyses were carried out using the SPSS, version 17.00, software using one-way analysis of variance. The results of the vertebral kyphosis angle (wedge angle) and the local kyphosis angle were compared preoperatively and at 1 year of follow-up.

We measured the vertebral kyphosis angle (the angle formed between the line parallel to the superior end plate and the line parallel to the inferior end plate of injured vertebrae on the lateral film) and the local kyphosis angle (the angle between perpendiculars to a line parallel to the superior end plate of the vertebra above the injured level and a line parallel to the inferior end plate of the vertebra below the injured level on the lateral radiograph) (Fig. 1) [8].

Ethical aspects: Informed consent was obtained from all patients.

Results

Thirty patients were managed with pedicle screws for thoracolumbar junction injuries. There were 19 men and 11 women (around 2 : 1 ratio). The mean age of the patients was ~36.7 years (range 15–62 years).

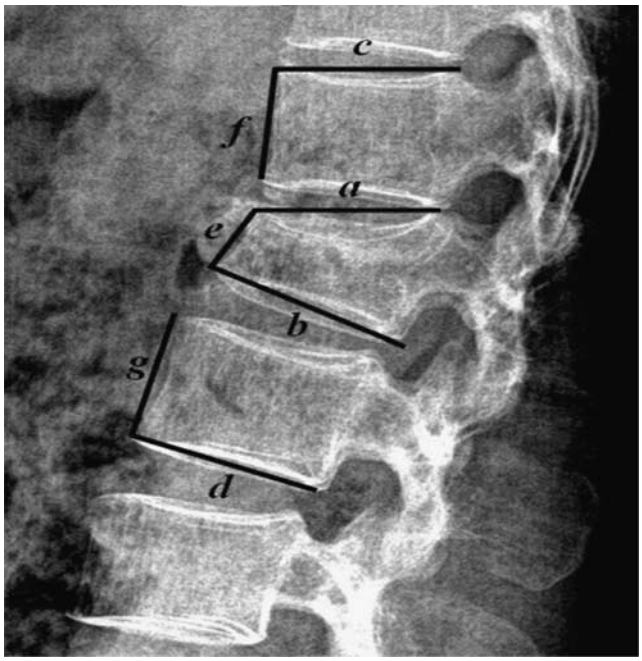
The AO thoracolumbar classification system described by Magerl and colleagues was used in our study (Fig. 2) [9]. This system is based on the AO classification that has been used previously for orthopedic extremity injuries. The AO/Magerl classification defines three major mechanisms of spinal injury: (a) compression injuries: A1, impaction; A2, split; A3, burst. (b) Distraction injuries: B1, posterior, predominantly ligamentous; B2, posterior, predominantly osseous; B3, anterior, through the disk. (c) Torsion injuries: C1, type A with torsion; C2, type B with torsion; C3, torsional shear injuries. The severity of injury is indicated by increasing values of injury classification.

All 15 cases were performed under general anesthesia using a standard posterior midline incision in a prone position.

The mean operative time was about 88 min (range 75–135 min). In our first cases, the operative time was prolonged, and later operative time decreased as experience was gained. None of these patients showed deterioration after surgery. The neurological status of the patients (Frankel grading) and the subsequent improvement are shown in Table 1. Two patients (about 6.6%) had implant failure at 12 months of follow-up and these were removed; the fractures healed (Fig. 1).

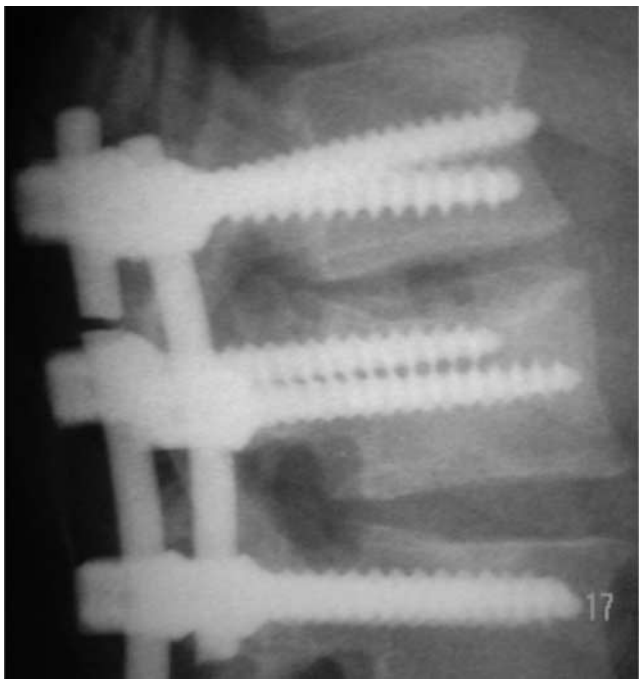
Statistical analysis showed a significant difference (P = 0.000 and 0.000, respectively) for vertebral kyphosis and regional kyphosis angles (Table 2) of a higher degree of correction when we included the intermediate screw (fractured level) in thoracolumbar fractures. The

Figure 1



Kyphosis angle (KA), angle between a and b; regional kyphosis angle (RA), angle between c and d.

Figure 2



Rod breakage.

Table 1 Frankel grading of the patients

	A	B	C	D	E
At presentation	0	1	1	0	28
At follow-up	0	0	1	0	29

Table 2 Descriptive statistics

	Mean	Minimum	Maximum	*P*-value
Preoperative vertebral kyphosis angle	21.30	6.00	37.00	0.000
Postoperative vertebral kyphosis angle	3.46	0.00	10.00	
Follow-up vertebral kyphosis angle	7.53	0.00	20.00	
Preoperative regional kyphosis angle	13.63	1.00	28.00	0.000
Postoperative regional kyphosis angle	2.70	0.00	7.00	
Follow-up regional kyphosis angle	6.86	0.00	17.00	

vertebral correction loss was 4.07, whereas the local kyphosis angle correction loss was 4.16.

Discussion

Although the treatment of patients with thoracolumbar fractures has changed considerably over the past two decades, the goals have remained constant. These include restoration of stability, correction of deformity, and decompression of the neural elements, when indicated. Improvements in technique have focused on providing the greatest stability with the least morbidity while optimizing functional outcome [10].

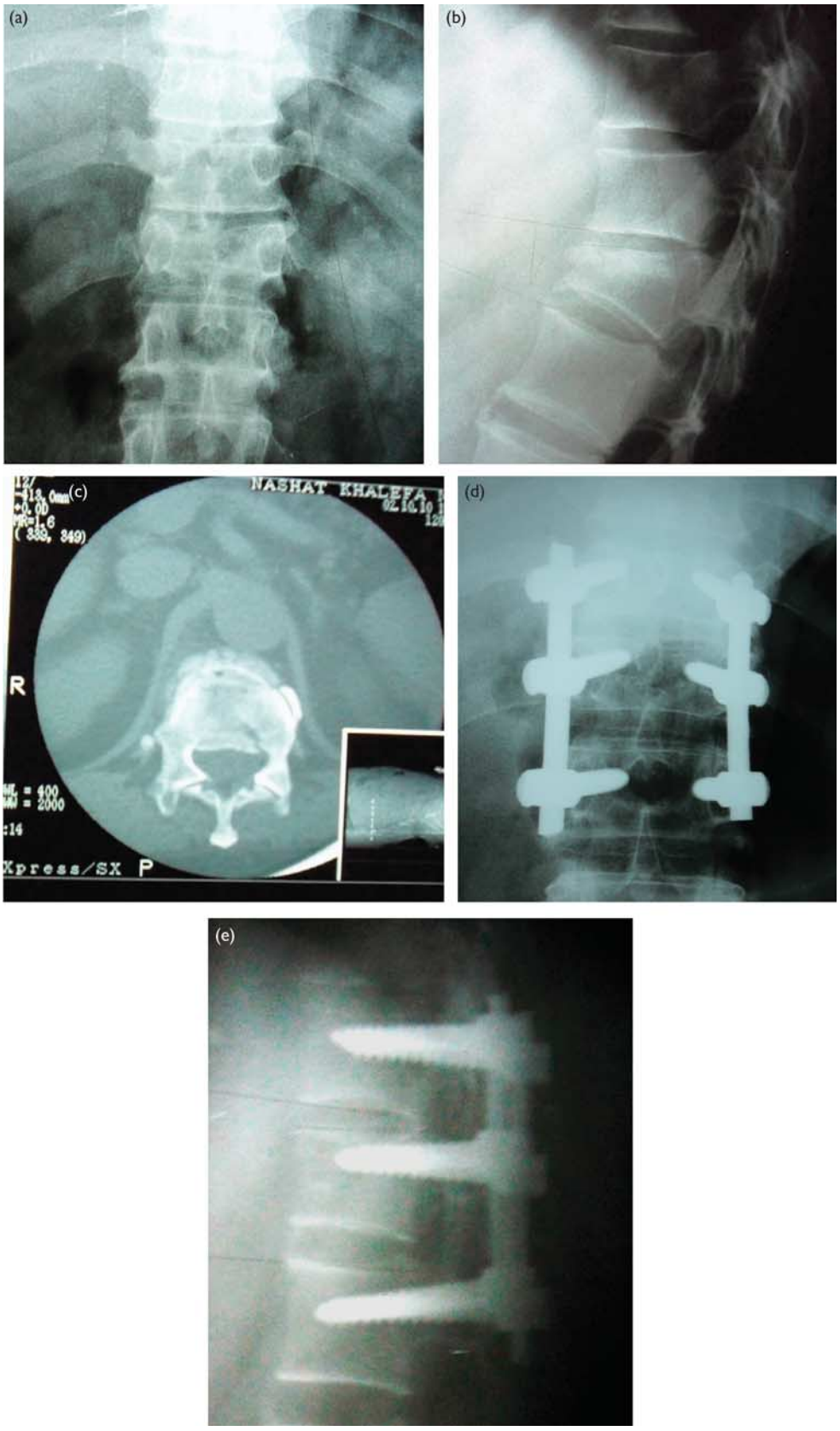
The disadvantages of conservative treatment include deterioration in neurological status [11], progressive kyphotic deformity [12], persistent backache [13], decubitus ulcer, and deep venous thrombosis [14]. Most of these complications can be avoided by early mobilization and decreased hospital stay by early surgery [15].

However, the number of levels to be fixed to gain maximum stability with minimal loss of mobility is still a matter of debate. Short-segment posterior fixation has been a popular method because of incorporation of fewer motion segments and relatively lesser morbidity [8].

Farrokhi *et al.* [6] studied two groups of patients with thoracolumbar fractures: one with exclusion of the fractured level fixation and another with inclusion of the fractured level. He found that inclusion of the fracture level in the construct did not prolong the operation or hospitalization, nor did it increase the amount of blood loss or postoperative infections. The patients in the 'including' group also showed insignificant kyphotic loss and limitation of motion, and a similar (and not worse) functional quality of life in comparison with the other group.

Pedicular disruption does not occur in the majority of the burst vertebral fractures, in contrast to flexion-distraction or fracture-dislocation injuries. Therefore, the pedicle at the fractured segment level can serve as an additional point of fixation. The intermediate segment fixation with an additional screw at the fracture level vertebra yields results that are comparable to or even better than long segment fixation, and has an advantage of preserving an extra mobile segment [10].

Figure 3



A case of a burst fracture of T-12 vertebrae. (a, b) Preoperative anteroposterior and lateral views; (c) computed tomography scan showing a retropulsed triangular fragment comprising the neural canal; (d, e) 1-year follow-up radiographs of anteroposterior and lateral views.

Figure 4

A case of a burst fracture of L1 vertebrae. (a, b) Preoperative anteroposterior and lateral views; (c) computed tomography scan showing a retropulsed triangular fragment comprising the neural canal; (d, e) 1-year follow-up radiographs of anteroposterior and lateral views.

Ekapichon [16] has reported that short-segment pedicular fixation with intermediate screws is safe and effective in the surgical treatment of thoracolumbar and lumbar burst fractures. It provides significant correction of vertebral body height and local kyphosis, and maintains the correction.

However, the number of levels to be fixed to gain maximum stability with minimal loss of mobility is still a matter of debate. Short-segment posterior fixation has been a popular method because of the incorporation of fewer motion segments and relatively lesser morbidity; however, because of a high incidence of implant failure and loss of correction reported in the literature, it has fallen into disrepute [17,18]. For these reasons, alternative techniques for stabilization of thoracolumbar fractures were developed. Augmentation of the anterior column using methods including transpedicular bone grafting and polymethylmethacrylate injection [19,20] has been reported. Nevertheless, many authors believe that transpedicular bone grafts do not prevent early implant failure and correction loss, and may lead to low anterior interbody fusion rates in the long term. The long-term results with the use of a polymethylmethacrylate injection are still not known, and it has its own complications such as epidural leakage [21,22].

The goal of the present study was to determine whether there was any significant difference in stability conferred by intermediate screws and maintenance of kyphosis correction. Pedicular disruption does not occur in the majority of the burst vertebral fractures, in contrast to flexion-distraction or fracture-dislocation injuries. Therefore, the pedicle at the fractured segment level can serve as an additional point of fixation, and a more stable spinal construct can be achieved.

Measurement of the vertebral kyphosis angle and regional kyphosis angle indicated that, there was good and maintained correction. The main vertebral kyphosis angle preoperatively was 21.3°, whereas the main degree at the last follow-up after1 year was 7.5°; also, the main regional kyphosis angle was 13.6° preoperatively, whereas at follow-up it was 6.8°.

In a similar study, Guven *et al.* [23] studied the inclusion of the fracture level in both short and long segment fixation. They observed that fracture level fixation yielded reduced rates of correction failure, which was most significant on short-segment constructs. They concluded that fracture level screw combination can achieve and maintain kyphosis correction.

In our study, there were two cases with metal failure, screw breakage, and rod breakage; no misplacement or infection had occurred.

Conclusion

In conclusion, inclusion of the fractured level in the construct yielded better kyphosis correction, in addition to fewer instrument failures, without additional complications, and with a comparable – if not better – clinical and functional outcome. We recommend the insertion of screws into pedicles of the fractured thoracolumbar vertebra when considering a short-segment posterior fixation, (Figs 3 and 4).

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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