ORIGINAL STUDY

The Role of Transpedicular Approach in Thoracolumbar Junction Burst Fracture with Significant Canal Compromise

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Abstract

Background data: **The thoracolumbar junction TLJ (T11-L2) is one of the most commonly injured spinal zones, representing more than 50% of all thoracic and lumbar spine fractures. Of all fractures in the TLJ, 40% are burst fractures. The ventral cord decompression at the TLJ after significant canal compromise is technically demanding. The midline laminectomy corridor does not allow adequate access to the vertebral body without significant neurological morbidity.**

Purpose: **This study aims to evaluate the safety and efficacy of transpedicular (TP) decompression in the management of complete TLJ burst fracture with significant canal compromise.**

Study design: **A retrospective clinical case series.**

Patients and methods: **This study was conducted on 20 patients with a TLJ complete burst fracture with significant canal compromise (≥35%) and a Thoracolumbar Injury Classification System (TLICS) > 4. All patients underwent the TP approach for decompression after simultaneous transpedicular screw fixation, including fractured vertebra, via a posterior midline skin incision. The patient's neurological status was assessed pre- and postoperatively according to the American Spinal Injury Association (ASIA) impairment scale, and back pain was documented using the visual analog scale (VAS). An axial CT scan was used to assess the pre- and postoperative extent of canal compromise, while the kyphosis was calculated by Cobb's angle.**

Results: **11/15 (73.3%) patients improved neurologically by one grade on the ASIA scale, and five patients remained neurologically intact (grade E) preoperatively, and no patient deteriorated or developed iatrogenic nerve root injury. The average VAS dropped from 6.5 preoperatively to 2.15 postoperatively. A unilateral TP decompression was performed in 17 patients; short-segment fixation with an intermediate screw was preferred in nine patients, while long-segment fixation and an intermediate screw were selected in eight patients according to surgeon discretion. Bilateral pediculectomy, performed in three patients due to severe canal compromise (≥50%), had a statistically significant higher duration and more blood loss compared to other patients with unilateral TP decompression. The mean preoperative kyphotic deformity was 12° which improved to 2.2° postoperatively (mean kyphosis correction 9.8°). The mean Cobb's angle during follow-up (minimum 1 year) was 3.7°, thus resulting in a loss of 1.5°. The average canal compromise decreased from 43% preoperatively to 15% postoperatively (+28%). There was no perioperative mortality or hardware failure. One patient had a wound infection, and debridement was done.**

Conclusion: **TP decompression is a safe, effective, and less invasive option for treating TLJ burst fractures with significant canal compromise. However, it is technically demanding and requires special instrumentation and preparation.**

Keywords: Burst fracture, Posterolateral approaches, Thoracolumbar junction, Transpedicular decompression, Ventral cord decompression

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Introduction

The thoracolumbar junction TLJ (T11-L2) is one of the most commonly injured spinal zones, representing about 6.9% of patients presenting to referral trauma centers after blunt trauma [1] and more than 50% of all thoracic and lumbar spine fractures [2]. This may be explained by the fact that this area is under great biomechanical stress due to the transition from the stiff kyphotic thoracic spine splinted with ribs attached to the sternum to the flexible lordotic lumbar spine. Moreover, the change from the coronal orientation of thoracic facet joints to the sagittal orientation of the lumbar spine permits more mobility [3].

Of all fractures that occur in the TLJ, 40% are burst fractures [1]. According to the AO spine thoracolumbar fracture classification, a complete burst fracture is A4, which involves both endplates along with the posterior vertebral wall [4]. This classification is primarily descriptive rather than determinant for management [5]. On the other hand, the three-tier TLICS with scores of 1–10, the burst fracture (2/4) with either mechanical instability (due to an associated posterior ligamentous complex injury) (2–3) or neurological injury (2–3) will need surgical intervention (score >4). While scores <4 are managed conservatively with an orthosis. Score 4 is a gray zone managed according to surgeon preference [6].

There are multiple therapeutic options for surgical management of burst fracture of TLJ [7]. Firstly, the posterior approaches are performed for stabilization via transpedicular screw fixation [8,9]) and indirect reduction of the retropulsed fracture fragments is achieved via the ligamentotaxis technique. If there is a significant ventral cord compression, direct cord decompression is feasible via the technically demanding posterolateral routes, including the transpedicular (TP) approach [10–13] (and endoscopic-assisted technique), the more extensive approaches (costotransversectomy CTV, and lateral extracavitary LEC). Secondly, the anterolateral approaches, including the extensive thoracoabdominal and less invasive thoracoscopic approaches [11,14]. Ultimately, the combined approaches for 360° fixation and decompression.

The TP approach enables the surgeon to access, decompress and reconstruct the ventral thoracolumbar spine. Moreover, segmental transpedicular screw fixation is achieved in the same setting with fewer complications compared to the extensive other posterolateral or anterior approaches. On the other hand, the TP approach holds a higher risk of incomplete decompression leading to nonimprovement due to inadequate visualization of the ventral epidural space and potential spinal cord injury.

This work aims to assess the efficacy and safety of the TP approach for surgical decompression of TLJ complete burst fractures with significant canal compromise (≥35%).

Patients and methods

Study design

This is a retrospective study of patients with burst fractures of TLJ conducted at Cairo University Hospitals, Beni Suef University Hospital, and King Salman Armed Forces Hospital from January 2018 to December 2020 with a one-year follow-up. Ethical committee approval (FMBSUREC/06112022) and informed consent were obtained.

Inclusion Criteria: Patients with burst fracture (AO A4 of both endplates or A3 one end plate) of TLJ (T11-L2) with significant spinal canal compression by retropulsed bony fragments (canal encroachment ≥35%); TLICS >4.

Notably, cases with severe canal compromise (≥50%) underwent a bilateral TP approach to decompress the spinal canal bilaterally, and long-segment fixation was adopted.

Exclusion Criteria: Patients younger than 18 years, hemodynamically unstable patients, paraplegic patients with imaging-confirmed complete cord transection (ASIA A), and cases operated via anterolateral or combined approaches.

Outcome measures

The following parameters were used for the analysis of our surgical results:

Clinical parameters: pre-and postoperative neurological status according to American Spinal Injury Association (ASIA) impairment scale [15] and visual analog scale VAS for back pain.

Radiological parameters: pre- and postoperative extent of canal compromise via axial CT scan (the ratio of the largest cross-sectional area of the retropulsed bony fragment or postoperative residual fragment) at the level of fracture to the preoperative estimated normal canal dimensions at that level. If the original cross-sectional area cannot be estimated at the largest section of the retropulsed bony fragment, the average of the adjacent upper and lower slices was used [16]. This was calculated precisely using the picture archiving and communication system (PACS) software. Additionally, the kyphosis angle was the assessment by Cobb's angle (the angle

formed between a line parallel to the superior end plate of one vertebra above the fracture and a line parallel to the inferior end plate of the vertebra one level below the fracture) as described by Keynan et al. [17]. It is noteworthy that Magnetic Resonance Imaging (MRI) was requested to assess the cord and posterior ligamentous complex.

Intraoperative: the estimated blood loss and operative duration.

The primary outcome measures included the ASIA impairment scale and canal compromise percentage. In contrast, the secondary outcome measures involved the VAS for back pain, kyphosis angle, intraoperative blood loss, operation time, and complications.

Surgical technique

The patient was under general anesthesia in a prone position on a frame at a radiolucent table for easy AP fluoroscopy. The standard posterior midline incision was centered at the level of the transpedicular approach and extended from one (short-segment fixation) or two vertebral levels (long-segment fixation) above and below that level according to the planned fixation levels. The subperiosteal paraspinal muscle dissection was performed to the outer margins of the transverse processes.

The transpedicular decompression is preferably a unilateral approach from the maximum dural compression side unless the canal compromise is $\geq$ 50%, which requires a bilateral technique for decompression and long-segment fixation (Fig. 1). If the spinal canal is compromised equally, without an associated unilateral pedicular fracture, the transpedicular decompression side depends on the surgeon's preference.

The upper and lower levels were fixed using transpedicular screws. At the index level, the pedicle contralateral to the transpedicular decompression was also included in the fixation in unilateral cases. The transpedicular tunnel was made by passing the appropriate size awl, tape, and short (35 mm) screw; the screw was removed, and about 5–6 mm, a transpedicular tunnel was performed, reaching the vertebral body. After complete laminectomy at that level with the table tilted 20°–30° contralaterally, the medial wall of the transpedicular tunnel was removed with a Kerrison rongeur and then a drill while protecting the dural sac with a dissector under microscopic magnification.

After adequate ipsilateral drilling of the posterior 1/3 of the vertebral body, the midline area was reached. The anterior half of the vertebral body should not be violated to avoid great vessel injury and anterior column collapse, especially if spacer insertion is not planned. The posterior longitudinal ligament was preserved to protect the dura and cord. The epidural bleeding was stopped via bipolar cautery, gel foam, and oxidized regenerated cellulose. Punches were used to remove free bony pieces, while reverse-angled curettes and the Woodson elevator were helpful to push the retropulsed bony fragments anteriorly away from the thecal sac.

Evidently, the midline area is a blind zone, so lateral fluoroscopy was mandatory during excising or disimpacting midline bone fragments. A curved-tip dissector should move freely under lateral fluoroscopy at the posterior vertebral line to ensure adequate midline dural decompression. Once adequate decompression was achieved, rods were placed on the pedicle screws, and a reduction maneuver (with mild distraction) was performed to restore vertebral body height and sagittal alignment of the spine.

In the end, facets and transverse processes between the fixation area were decorticated, and bone graft was distributed generously, especially at the pediculectomy site, to enhance fusion.

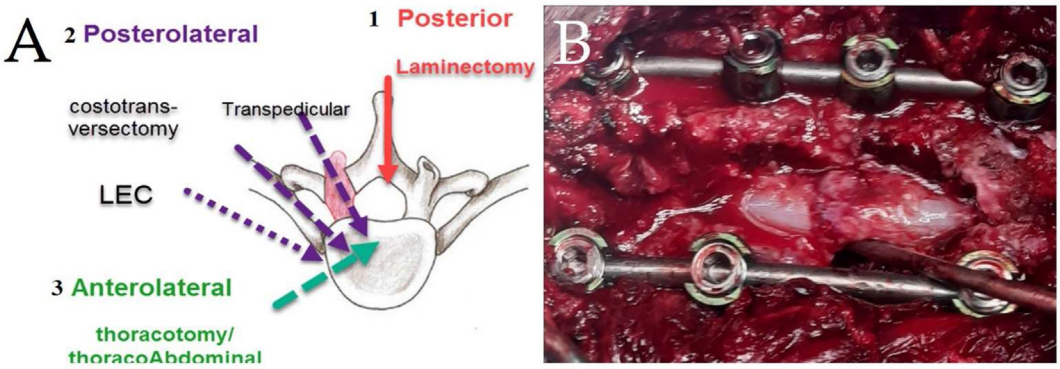

Fig. 1. (A) The different approaches for thoracolumbar fracture; (B) right transpedicular approach of L2 burst fracture.

Statistical analysis

The collected data were tabulated and analyzed using SPSS version 26 software. Categorical data were presented as numbers and percentages, while quantitative data were expressed as mean ± standard deviation. Paired *t*-test was used as a test of significance in two groups pre- and post-intervention, and analysis of variance (ANOVA) test was used as a test of significance in more than two groups. $P < 0.05$ was considered significant.

Results

Patient demographics

There were 13 males and seven females. The age range of patients was 19–61 years, with an average of 39.2 ± 12.3 years. The mode of injury was a motor vehicle accident in 13 patients, a fall from height in six cases, and assault by a heavy object in one patient. L1 was the most commonly fractured vertebra in 8 (40%) patients, followed by T12 (25%) and L2 (25%), in five cases at each level, while T11 was involved in only 2 (10%) patients (Table 1).

Primary outcomes

Among the 20 patients in this study, five patients were neurologically intact (grade E), while 11/15 (73.3%) patients improved neurologically by one grade on the ASIA scale, and no patient deteriorated or developed an iatrogenic nerve root injury. The average canal compromise decreased from 43% preoperatively to 15% postoperatively (Table 2).

Secondary outcomes

The average VAS of back pain dropped from 6.5 preoperatively to 2.15 postoperatively. The mean preoperative kyphotic deformity was 12°, which improved to 2.2° postoperatively (mean kyphosis correction of 9.8°). The mean Cobb's angle during follow-up (minimum of 1 year) was 3.7°, resulting in a loss of 1.5°.

The mean duration of surgery was 267.3 min (range: 220–350 minutes), and the mean blood loss was 810 mL (range: 500–2000 mL). The unilateral TP approach was performed in 17 patients; short-segment fixation with an intermediate screw was preferred in nine patients, while long-segment fixation and an intermediate screw were selected in eight patients according to surgeon discretion. The long-segment group had a statistically significant higher duration (not blood loss) compared to the

Table 1. The characteristics of 20 patients with TLJ burst fractures included in this study.

	Sex	Age	Level	TLICS	TP Approach	Fixation	Pre ASIA	Post ASIA	Pre VAS	Post VAS	PreOp canal compromise %	PostOp. canal compromise %	Pre K	Post K	FU K
1	M	27	T12	5	Rt side	Short	4	4	6	2	35	15	13	4	5
2	M	19	L2	7	Rt side	Long	4	5	7	2	45	10	14	7	8
3	M	49	L2	7	Lt side	Short	4	5	7	3	40	15	13	5	6
4	M	27	L1	5	Rt side	Short	3	4	5	2	35	15	12	2	3
5	F	32	T12	5	RT side	Short	5	5	7	1	40	10	13	−5	−2
6	M	33	L1	5	Lt side	Short	4	5	5	3	45	15	11	0	2
7	F	41	L1	5	Lt side	Short	4	5	7	2	45	15	12	5	6
8	F	50	T11	7	Lt side	Long	3	3	5	3	45	15	13	1	2
9	M	61	L1	6	Rt side	long	4	4	8	2	40	15	14	5	7
10	M	23	L2	5	Rt side	Long	4	5	6	3	35	10	13	−2	0
11	F	30	T12	7	bilateral	Long	2	3	7	2	55	20	10	2	3
12	M	49	T12	7	Bilateral	Long	2	2	8	2	65	20	9	3	5
13	M	34	L1	5	Lt side	Short	5	5	6	3	35	15	12	5	6
14	F	38	L1	5	Lt side	long	5	5	6	1	35	10	13	1	3
15	M	55	L2	7	Bilateral	Long	3	4	7	2	60	20	4	−3	0
16	M	40	L1	5	Rt side	Long	4	5	7	2	40	15	14	4	5
17	F	35	T12	6	Rt side	Long	3	4	8	3	45	20	13	2	3
18	M	30	T11	7	Lt side	Short	4	5	6	1	45	20	11	3	5
19	M	50	L2	6	Lt side	Short	5	5	6	2	35	10	14	2	3
20	F	60	L1	5	Lt side	Long	5	5	6	2	40	10	12	3	4

ASIA, American Spinal Injury Association; K, kyphosis; TLICS, Thoracolumbar Injury Classification System; TP, transpedicular; VAS, visual analog scale.

Table 2. Comparison between the preoperative and postoperative clinical and radiological parameters in 20 patients with the TP approach included in this study.

Parameters	Preoperative	Postoperative	Last follow-up	*s* value
ASIA	3.85 ± 0.93	4.40 ± 0.88	–	0.001
VAS	6.50 ± 0.95	2.15 ± 0.67	–	<0.001
Canal compromise%	43 ± 8.49	15 ± 3.63	–	<0.001
Kyphosis deformity	12.02 ± 2.31	2.20 ± 2.97[a]	3.7 ± 2.52[b]	<0.001

Values are expressed in mean ± SD.
[a] Significant from preoperative results.
[b] Significant from postoperative results.

short-segment group (p value <0.001). Bilateral pediculectomy performed in three patients, due to severe canal compromise (≥50%), had a statistically significant (p value <0.001) higher duration and more blood loss compared to other patients with unilateral TP approach (Table 3).

Complications

Dural tears secondary to trauma were found in two patients (repaired with sutures and augmented with a muscle graft without postoperative CSF leak), and preoperative nerve root injury was encountered in one patient; none suffered iatrogenic dural or nerve root injury. Postoperatively, one patient had a superficial wound infection, requiring intravenous antibiotics according to culture, sensitivity, and debridement. There was no perioperative mortality or postoperative neurological deterioration. The mean postoperative hospital stay was 8.5 days (ranging from 5 to 19 days). No patient had hardware failure or delayed infection at the last follow-up (1 year).

Discussion

The optimal management of burst fracture at TLJ is still debatable. Stable burst fractures without neurologic compromise can typically be treated conservatively. Surprisingly, 50% spontaneous resorption of spinal canal compromise after conservative management of TL burst fracture was reported. The surgical management of thoracolumbar burst fracture is classified into two categories: the posterior approaches for fixation and indirect reduction via ligamentotaxis technique or direct decompression via posterolateral (TP) routes; the anterolateral approaches for direct vertebral body decompression and reconstruction and the combined approaches for 360° fixation and decompression [8–13,18–20] (Table 4).

Although anterolateral approaches have certain advantages, including direct access and decompression of the spinal canal, straightforward anterior column reconstruction, and correction of kyphotic deformity, they are more invasive routes that traverse body cavities with unavoidable handling of viscera and great vessels with access surgeon is usually needed. Another separate posterior incision is performed if combined anterior-posterior approaches are required for achieving 360° fusion [11].

Lubelsky et al. [14] reported a mean complication rate of 15%, 17%, and 39%, respectively, for CTV, LEC, and thoracotomy, which had the highest reoperation (3.5%) and mortality rates (1.5%).

According to Kshettry et al. [15], the ventral spinal canal exposure at T11-12 increased from 14.2% to 25.8% by laminectomy and 50% by medial facetectomy, respectively, to 43% via the TP approach. In contrast, the more extensive approaches (CTV and LEC) provided slight additional exposure at 47.7% and 52.7%, respectively.

Classically, indirect reduction of the retropulsed fracture fragments is achieved via ligamentotaxis technique when a strong distraction across the rods tenses the posterior longitudinal ligament (PLL), which is most efficient if performed within four days after trauma. However, it is not successful in patients with ruptured PLL or disruption in the annulus fibrosus originally attached to the extruded fragments [21,22]. Wang et al. [23] reported a 14.1%

Table 3. Comparison of the study groups regarding the blood loss and operative duration.

Group		Blood loss/ml			Duration/min		
	N	Mean	SD	*P* value	Mean	SD	*P* value
Gr 1: unilateral TP approach and short-segment fixation	9	616.67	86.60	<0.001	235.56	18.78	<0.001
Gr 2: unilateral TP approach and long-segment fixation	8	718.75	96.13		267.50[a]	10.35	
Gr 3: bilateral TP approach and long-segment fixation	3	1366.67[a,b]	550.76		330[a,b]	17.32	

[a] Significant from Gr 1.
[b] Significant from Gr 2.

Table 4. Classification and merits of the approaches for surgical management of burst thoracolumbar fracture [8–13,18–20].

The approach			Merits
Posterolateral approaches			Familiarity, fixation, and decompression simultaneously
Transpedicular fixation type	Number of motion segments	Levels of vertebra fixed	
Monosegmental fixation	1 motion segment	2 including the fractured vertebra	Compression and stable burst fracture, intact posterior ligaments, TLICS ≤4
Short-segment fixation	2 motion segments	3 vertebrae	a higher failure rate and loss of sagittal correction if not augmented
Two vertebral levels above + one vertebral below with intermediate screws at the fracture site	3motion-segments	4 vertebrae	
Long-segment fixation	≥4-motion segments	≥5 vertebrae	Less construct failure but loss of motion segments esp. in lumbar spine
Techniques for augmentation	-vertebroplasty		to decrease construct failure in severe fracture
	-screw insertion at the fracture site		
Techniques for decompression	A- Indirect: distraction and ligamentotaxis		Requires intact PLL and contraindicated in 'reverse cortical sign'
	B- Direct decompression: TP/-CTV/-LEC		If intracanalicular compromise ≥35%+fracture related neurological symptoms
Techniques of anterior column reconstruction	Insertion of the expandable cage after posterolateral decompression (-TP/-CTV/-LEC)		substantial kyphosis and severe vertebral body collapse
Anterolateral approaches	≥2 motion segments	≥3 vertebrae	Preserving motion segments, but higher morbidity ± access surgeon
Thoracoabdominal Thoracoscopic	Insertion of mesh, cage, or plate for anterior column reconstruction		If intracanalicular compromise ≥50%–65%
Combined Approaches for 360° fixation and decompression			Especially after anterolateral approaches

CTV, costotransversectomy; LEC, lateral extracavitary; PLL, posterior longitudinal ligament; TLICS, Thoracolumbar Injury Classification System; TP, transpedicular.

failure rate of the ligamentotaxis technique when the retropulsed bony fragments had 'double cortical surfaces' and were displaced more than 0.85 cm and rotated greater than 55°. Furthermore, the ligamentotaxis technique is contraindicated in patients with 180° inverted free bone fragments 'reverse cortical sign'. In this scenario, reduction may cause posterior fragment displacement and further dural compression [22].

Zou et al. [24] reported that the distraction maneuver alone is responsible for restoring vertebral body height and that vertebral canal decompression using ligamentotaxis shows better results when combined with lordosis maneuvers. Castro et al. [25] showed that the addition of a lordosis maneuver, either before or after the distraction maneuver, contributed to further decompression of the vertebral canal. When lordosis is provided first, canal decompression tends to be enhanced, although no statistical difference was observed. Decompression of the vertebral canal during ligamentotaxis is not solely dependent on the PLL. The influence of the tension of all soft parts inserted on the vertebra, including the anterior longitudinal ligament and the fibrous ring, also contributes to repositioning the fragments [26].

Kose et al. [27] advocated indirect cantilevered hyperlordotic reduction without distraction after short-segment fixation with intermediate screws at the fractured vertebra to treat compression and burst fractures. The preoperative canal compromise decreased from 34.5% to 10% (+24.5%).

The technically demanding posterolateral routes are required for the removal of retropulsed bone fragments to restore the normal canal dimensions in significant canal compromise (≥35%), which may be associated with the improvement of neurological function in patients with partial deficits (Figs. 2 and 3). The TP decompression is less invasive and has lower complications than the more invasive CTV, and LEC approaches. The TP approach avoids spinal cord

manipulation compared with a midline posterior laminectomy approach [10–13]. Anterior column reconstruction via the TP approach is indicated in substantial kyphosis and severe vertebral body collapse, though it is challenging while saving the lumbar roots, contrary to the thoracic roots, which may be sacrificed [10]. The TP approach has versatile indications dealing with ventrally located pathologies at the thoracolumbar spine. It was first described for vertebral body biopsy in 1949 [28]. Later, it was used for thoracic disc herniation [29], spondylodiscitis [11], vertebral body tumors [30], and intradural extramedullary tumors [31].

Nevertheless, the transpedicular approach has several shortcomings, such as extended surgical time and higher blood loss, which may result in cord hypoperfusion and influence neurological results. It may involve an additional risk of neurological deterioration with less competent surgeons. The reported complications include pseudarthrosis, epidural hematoma, and inadequate decompression [13].

The current study observed neurological improvement in 11/15 (73.3%) patients, while none deteriorated after surgery. There was an average improvement in the ASIA score from 3.85 to 4.4 over a period of 12 months. The mean kyphosis angle decreased from 12° to 2.2° postoperatively (mean kyphosis correction 9.8°). The mean Cobb's angle during follow-up (minimum of 1 year) was 3.7°, thus resulting in a loss of 1.5°. The average canal compromise decreased from 43% preoperatively to 15% postoperatively (+28%).

These results are consistent with other published studies using TP decompression in significant TL burst fractures. Mavrogenis et al. [32] reported their results of bilateral TP decompression in 25 patients with TL burst fractures. Neurological improvement was achieved in 84% of patients. Spinal canal compromise improved from 51.7% preoperatively to 15.3% postoperatively (+35.4%), and the mean kyphosis angle improved slightly from 7.8° preoperatively to 1.2° postoperatively (correction 6.6°) with the loss of kyphosis correction of 2.3° at 14 months follow-up. The mean surgical time was 122 min (range 108–122 minutes), and the mean blood loss was 528 ± 123 mL. Similarly, Kaya et al. [13] reported neurological improvement in 23 of the 28 (82%) patients with TL burst fracture (average 59.5% canal compromise) treated by bilateral transpedicular decompression. The mean kyphotic deformities improved from 18.25° preoperatively to 7.8° postoperatively, with a 4° loss of correction at the final follow-up.

Regarding TP decompression and anterior column reconstruction, Wang et al. [33] reported ASIA score improvement in 13/20 (65%) patients with traumatic TLJ fractures operated via posterolateral approaches with cage insertion. The mean kyphosis angle improved from 25.2° preoperatively to 12.4° postoperatively (mean kyphosis correction 12.8°)

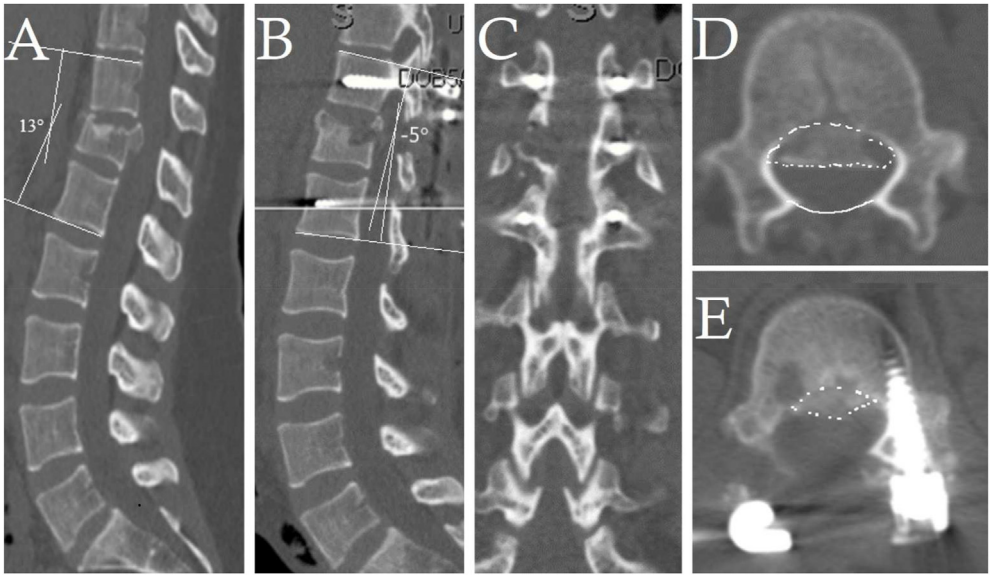

Fig. 2. Pre- and postoperative imaging of patient n. 5 (T12 burst fracture): (A) preoperative sagittal CT scan showing T12 burst fracture, kyphosis angle 13°; (B) parasagittal CT scan at the right side showing the pediculectomy and the above (T11), the lower (L1) screws, kyphosis angle (−5°) (lordotic); (C) postoperative coronal CT scan showing the Rt T12 pediculectomy and the short fixation (5 screws); (D) preoperative axial CT scan with 40% canal compromise (retropulsed bone fragment encircled by dotted line); (E) postoperative CT scan showing 15% canal compromise (residual bone fragment encircled by dotted line) and Left T12 screw.

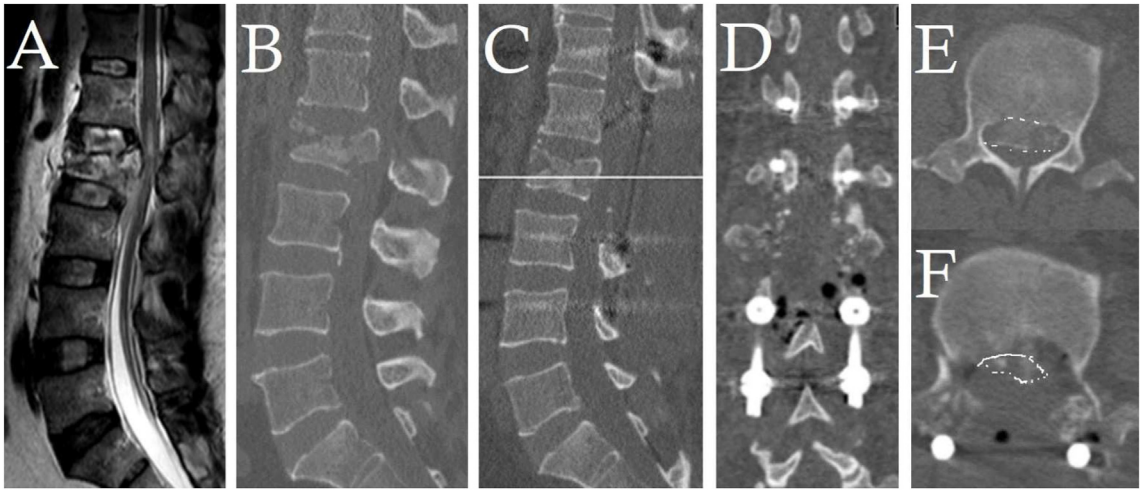

Fig. 3. Pre and postoperative imaging of patient n.15: (A) preoperative sagittal MRI T2 showing L2 severe burst fracture with conus compression and cord signal; (B) preoperative sagittal CT scan showing canal compression at L2; (C) postoperative sagittal CT scan showing the decompression of burst fracture and laminectomy and shadows of screws two levels above and below fracture level; (D) postoperative coronal CT scan showing the drilled pedicles bilaterally and the eight screws; (E) preoperative axial CT scan showing about 60% canal compromise (retropulsed bone fragment encircled by dotted line); (F) postoperative axial CT scan showing the bilateral transpedicular approach and decompression of the canal (20% canal compromise, residual bone fragment encircled by dotted line).

with slight loss of kyphosis correction of 0.9° at the 31-month follow-up. Likewise, Garg et al. [10] reported the results of 35 patients with complete burst lumbar fractures operated by transpedicular screw fixation and TP approach for decompression and spacer insertion. The mean kyphosis angle decreased from 13.97° to −3.57° postoperatively (mean kyphosis correction 17.54°). The kyphosis angle was 1.23° at follow-up (loss of kyphosis 4.2°).

Although the mean kyphosis correction in both studies (12.8° and 17.54°. respectively) was greater than our study (9.8°) due to anterior column reconstruction, Garg et al. [10] reported longer mean operative time (393.8 minutes) and greater estimated blood loss (1352 mL) than the results of the current study (267.3 min and 810 mL respectively). This difference is due to extra steps of anterior column reconstruction: discectomy and cartilaginous end plate removal cephalad and caudal to the fractured vertebra and insertion of expandable cages or mesh.

The results of direct transpedicular decompression are superior to indirect ligamentotaxis techniques regarding spinal canal compromise reduction. The average improvement of canal compromise ranges from 10% to 24.5%. Benek et al. [34] reported the results of 56 patients diagnosed with TL fractures and significant fracture fragments retropulsed into the spinal canal who underwent only posterior instrumentation with distraction and ligamentotaxis; average canal compromise significantly decreased from 40.2% preoperatively to 26.8% postoperatively (+13.4%). Mueller et al. [21] observed a mean postoperative decline in canal compromise of (+10%) (from 29% preoperatively to 19% postoperatively) in 36 patients with distraction and ligamentotaxis for thoracolumbar fractures. Kuner et al. [35] found a reduction in canal compromise from 43% preoperatively to 25% postoperatively by approximately (+18%) in 56 patients. They found that large trapezoidal fragments were difficult to relocate.

In patients with neurologic symptoms related to burst fracture, ligamentotaxis alone does not appear to be sufficient for the desired spinal decompression [21]. However, the advantage of greater reduction of canal compromise achieved via transpedicular decompression is not necessarily translated into superior neurological outcomes.

Limitations of this study include the retrospective nature of the study, the relatively limited number of patients, and the lack of a control group are the limiting factors of our study.

In summary, the familiar and less invasive TP decompression combines the benefits of both anterior and posterior approaches for transpedicular fixation and ventral cord decompression in burst fracture with significant canal compromise (≥35%), especially in neurologically compromised patients.

Conclusion

TP decompression is a safe, effective, and less invasive option for decompression of TLJ burst

fracture with significant canal compromise. However, it is technically demanding and requires special instrumentation and preparation.

Ethics Information

The article does not contain information about medical device(s)/drug(s).

Author declaration of funding statement

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Conflict of Interest

The authors report no conflicts of interest.

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List of Abbreviations

CTV	Costotransversectomy
LEC	Lateral extracavitary
TLJ	Thoracolumbar junction
TLICS	Thoracolumbar Injury Classification System
PLL	Posterior longitudinal ligament
TP	Transpedicular

References

[1] Katsuura Y, Osborn JM, Cason GW. The epidemiology of thoracolumbar trauma: A meta-analysis. J Orthop 2016;13: 383–8.
[2] Gertzbein SD. Scoliosis research society. Multicenter spine fracture study. Spine (Phila Pa 1976) 1992;17:528–40.
[3] Wood KB, Li W, Lebl DS, Ploumis A. Management of thoracolumbar spine fractures. Spine J Off J North Am Spine Soc 2014;14:145–64.
[4] Reinhold M, Audigé L, Schnake KJ, Bellabarba C, Dai LY, Oner FC. AO spine injury classification system: a revision proposal for the thoracic and lumbar spine. Eur Spine J 2013; 22:2184–201.
[5] Vaccaro AR, Oner C, Kepler CK, Dvorak M, Schnake K, Bellabarba C, et al. AOSpine thoracolumbar spine injury classification system: fracture description, neurological status, and key modifiers. Spine 2013;38:2028–37.
[6] Vaccaro AR, Zeiller SC, Hulbert RJ, Anderson PA, Harris M, Hedlund R, et al. The thoracolumbar injury severity score: a proposed treatment algorithm. J Spinal Disord Tech 2005;18: 209–15.
[7] Aly TA. Short segment versus long segment pedicle screws fixation in management of thoracolumbar burst fractures: meta-analysis. Asian Spine J 2017;11:150–60.
[8] Wei FX, Liu SY, Liang CX, Li HM, Long HQ, Yu BS, et al. Transpedicular fixation in management of thoracolumbar burst fractures: monosegmental fixation versus short-segment instrumentation. Spine 2010;35:E714–20.
[9] Tezeren G, Kuru I. Posterior fixation of thoracolumbar burst fracture: short-segment pedicle fixation versus long-segment instrumentation. J Spinal Disord Tech 2005;18:485–8.
[10] Garg M, Kumar A, Singh PK, Mahalangikar R, Satyarthee GD, Agrawal D, et al. Transpedicular approach for corpectomy and circumferential arthrodesis in traumatic lumbar vertebral body burst fractures: a retrospective analysis of outcome in 35 patients. Neurol India 2021;69: 399–405.
[11] Lu DC, Lau D, Lee JG, Chou D. The transpedicular approach compared with the anterior approach: An analysis of 80 thoracolumbar corpectomies. J Neurosurg Spine 2010;12: 583–91.
[12] Varshney R, Datta P, Deb P, Ghosh S. A prospective study of posterior (transpedicular) approach versus anterior (transthoracic/ thoracoabdominal) approach for posttraumatic compression fracture of thoracolumbar vertebra in a tertiary care center: comparison of clinical and radiological outcomes. Indian J Neurotrauma 2021;18:111–8.
[13] Kaya RA, Aydin Y. Modified transpedicular approach for the surgical treatment of severe thoracolumbar or lumbar burst fractures. Spine J 2004;4:208–17.
[14] Lubelski D, Abdullah KG, Steinmetz MP, Masters F, Benzel EC, Mroz TE, et al. Lateral extracavitary, costotransversectomy, and transthoracic thoracotomy approaches to the thoracic spine: review of techniques and complications. J Spinal Disord Tech 2013;26:222–32.
[15] Rupp R, Biering-Sørensen F, Burns SP, Graves DE, Guest J, Jones L, et al. International standards for Neurological Classification of Spinal Cord injury: revised 2019. Top Spinal Cord Inj Rehabil 2021;27:1–22.
[16] Hashimoto T, Kaneda K, Abumi K. Relationship between traumatic spinal canal stenosis and neurologic deficits in thoracolumbar burst fractures. Spine 1988;13:1268–72.
[17] Keynan O, Fisher CG, Vaccaro A, Fehlings MG, Oner FC, Dietz J, et al. Radiographic measurement parameters in thoracolumbar fractures: a systematic review and consensus statement of the spine trauma study group. Spine 2006;31: E156–65.
[18] Uzumcugil O, Dogan A, Yetis M, Yalcinkaya M, Caniklioglu M. Results of 'two above: one below approach' with intermediate screws at the fracture site in the surgical treatment of thoracolumbar burst fractures. Kobe J Med Sci 2010;56:E67–78.
[19] Cho DY, Lee WY, Sheu PC. Treatment of thoracolumbar burst fractures with polymethyl methacrylate vertebroplasty and short segment pedicle screw fixation. Neurosurgery 2003;53:1354–60.
[20] Kshettry VR, Healy AT, Jones NG, Mroz TE, Benzel EC. A quantitative analysis of posterolateral approaches to the ventral thoracic spinal canal. Spine J 2015;15:2228–38.
[21] Mueller LA, Mueller LP, Schmidt R, Forst R, Rudig L. The phenomenon and efficiency of ligamentotaxis after dorsal stabilization of thoracolumbar burst fractures. Arch Orthop Trauma Surg 2006;126:364–8.
[22] Arlet V, Orndorff DG, Jagannathan J, Dumont A. Reverse and pseudoreverse cortical sign in thoracolumbar burst fracture: Radiologic description and distinction - a propose of three cases. Eur Spine J 2009;18:282–7.
[23] Wang XB, Lü GH, Li J, Wang B, Lu C, et al. Posterior distraction and instrumentation cannot always reduce displaced and rotated posterosuperior fracture fragments in thoracolumbar burst fracture. Clin Spine Surg 2017;30:E317–22.
[24] Zou D, Yoo JU, Edwards WT, Donovan DM, Chang KW, Bayley JC, et al. Mechanics of anatomic reduction of thoracolumbar burst fractures. Comparison of distraction versus distraction plus lordosis, in the anatomic reduction of the thoracolumbar burst fracture. Spine 1993;18:195–203.
[25] Castro IJC, Shimano AC, Bellucci AD, Defino HLA. Experimental study of ligamentotaxis maneuvers sequencing in vertebral canal decompression. Acta Ortopédica Bras 2008; 16:291–5.
[26] Fredrickson BE, Edwards WT, Rauschning W, Bayley JC, Yuan HA. Vertebral burst fractures: an experimental, morphologic, and radiographic study. Spine 1992;17:1012–21.
[27] Kose KC, Inanmaz ME, Isik C, Basar H, Caliskan I, Bal E. Short segment pedicle screw instrumentation with an index level screw and cantilevered hyperlordotic reduction in the

treatment of type-A fractures of the thoracolumbar spine. Bone Joint Lett J 2014;96-B:541–7.
[28] Michele AA, Krueger FJ. Surgical approach to the vertebral body. J Bone Joint Surg Am 1949;31:873–8.
[29] Patterson Jr RH, Arbit E. A surgical approach through the pedicle to protruded thoracic discs. J Neurosurg 1978;48:768–72.
[30] Weller SJ, Ejr Rossitch. Unilateral posterolateral decompression without stabilization for neurological palliation of symptomatic spinal metastasis in debilitated patients. J Neurosurg 1995;82:739–44.
[31] Visco ZR, Liu DD, Leary OP, Oyelese AA, Gokaslan ZL, Camara-Quintana JQ, et al. A transpedicular approach to complex ventrally situated thoracic intradural extramedullary tumors: technique, indications, and multiinstitutional case series. Neurosurg Focus 2021;50:E19.
[32] Mavrogenis A, Tsibidakis H, Papagelopoulos P, Antonopoulos D, Papathanasiou J, Korres D, et al. Posterior transpedicular decompression for thoracolumbar burst fractures. Folia Med 2010;52:39–47.
[33] Wang MY, Kim DH, Kim KA. Correction of late traumatic thoracic and thoracolumbar kyphotic spinal deformities using posteriorly placed intervertebral distraction cages. Neurosurgery 2008;62(3 Suppl):162–71.
[34] Benek HB, Akcay E, Yilmaz H, Yurt A. Efficiency of distraction and ligamentotaxis in posterior spinal instrumentation of thoracolumbar retropulsed fractures. Turk Neurosurg 2021;31:973–9.
[35] Kuner EH, Kuner A, Schlickewei W, Mullaji AB. Ligamentotaxis with an internal spinal fixator for thoracolumbar fractures. J Bone Joint Surg Br 1994;76:107–12.