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Transpedicular Corpectomy and Anterior Column Reconstruction for the Treatment of Traumatic Thoracolumbar Fractures

Mehmet Yigit AKGUN[1], Mustafa Onur ULU[2], Orkhan ALIZADA[3], Mahmut OZDEN[4], Murat HANCI[1]

[1]Koc University Hospital, Department of Neurosurgery, Istanbul, Turkey
[2]Istanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine, Department of Neurosurgery, Istanbul, Turkey
[3]Baskent University Hospital, Department of Neurosurgery, Istanbul, Turkey
[4]Bahcelievler Memorial Hospital, Department of Neurosurgery, Istanbul, Turkey

Corresponding author: Mehmet Yigit AKGUN ✉ myigitakgun@gmail.com

ABSTRACT

AIM: To retrospectively analyze the results obtained from the posterior-only approach in non-pathological traumatic thoracolumbar body fractures with spinal cord compression.

MATERIAL and METHODS: A total of 17 patients with traumatic non-pathological thoracolumbar fractures were included in the study. Demographic details include preoperative data such as neurological status, deformity, pain scores, and radiology; intraoperative data such as blood loss, duration of surgery, and complications, and postoperative data including the neurologic status; the duration of hospital stay, pain scores, and deformity correction were analyzed.

RESULTS: Among the 17 patients, 8 were in ASIA A, 9 had incomplete neurologic deficits (ASIA C - D), and none was neurologically intact (ASIA E) preoperatively. All patients had TLICS scores >4 and were treated surgically. The mean TLICS score was 7.31. Although no worsening was detected in the neurological images of the patients during the postoperative period, neurological improvement of at least one ASIA grade was detected in 13 patients. However, it was found that the neurological functions remained the same in the 4 patients. With significant improvement, the mean preoperative VAS score was 8.2, while the mean postoperative VAS score was 3.3. In addition, satisfactory outcomes were obtained in radiological examinations, both in terms of kyphotic deformity and vertebral body collapse.

CONCLUSION: Traumatic thoracolumbar fractures can be effectively fixed with the posterior-only approach and the transpedicular route. One of the most significant advantages of this procedure is that peripheral decompression, reduction, anterior column reconstruction, and instrumentation all can be performed simultaneously in the same session.

KEYWORDS: Corpectomy, Transpedicular, Fracture, Thoracolumbar, Posterior

INTRODUCTION

Burst fractures of the thoracolumbar region can occur due to several reasons. It is frequently noted after high-impact trauma. In such cases, anterior column reconstruction can be treated with an anterior or combined approach (3,9). Posterior-only approaches have also been described (36) that rely on distraction and ligamentotaxis reduction (21). However, the ideal surgical approach in this situation remains debatable.

Stability and sagittal balance may be impaired because of injury to the anterior and middle columns. Partial or complete removal of the vertebral body may be necessary to restore

Mehmet Yigit AKGUN : 0000-0003-1342-7663
Mustafa Onur ULU : 0000-0002-6256-0869
Orkhan ALIZADA : 0000-0003-0942-9906
Mahmut OZDEN : 0000-0003-2441-0015
Murat HANCI : 0000-0001-9261-6686

this balance. In addition, this system was strengthened through a combination of posterior stabilization and anterior decompression. Numerous surgical options are available, including the posterior, anterior, and lateral approach or their combinations (1,21).

The anterior route provides direct exposure to the vertebral body. Thus, decompression of the spinal canal and reconstruction of the anterior column can be easily performed. The described route has been widely discussed in the literature. However, it offers several disadvantages, including the need for access to surgeons, high risk of pulmonary and vascular complications, post-thoracotomy, or lumbotomy pain. Moreover, in most cases, they should be combined with posterior transpedicular fixation to re-establish segmental stability (7,11,20).

Transpedicular corpectomy and expandable cage reconstruction via the posterior-only approach have recently been described as promising alternatives for the treatment of these patients to avoid the morbidity associated with the anterior approach. The development of microsurgical techniques and tools enable corpectomy and fixation through a more secure and familiar posterior route, and self-expandable cages have been proven to be effective in restoring the alignment with good biomechanical outcomes (12,13).

The concern that remain here is that posterior-only approaches may not provide effective stabilization and optimal reconstruction due to the involvement of the anterior column (6). In this study, we investigated our experience in cases of corpectomy performed by the transpedicular route. We performed a retrospective analysis of cases with spinal cord compression secondary to a traumatic thoracolumbar fracture.

MATERIAL and METHODS

Thirty-eight patients who underwent thoracolumbar transpedicular corpectomy for various pathologies between 2015 and 2019 in our clinic were retrospectively evaluated. Informed consent was obtained from all patients in accordance with the institutional policy. A total of 17 patients with traumatic non-pathological thoracolumbar fractures were included in the study. Demographic details including preoperative data such as neurological status, deformity, pain scores, and radiology; intraoperative data such as blood loss, duration of surgery, and complications; and postoperative data such as the neurological status; the duration of hospital stay, pain scores, and deformity correction were analyzed. The patients were followed up in 3-, 6-, and 12-month intervals.

The preoperative neurological images of the patients were presented using the American Spinal Injury Association (ASIA) impairment scale (16). Motor and sensory functions were determined through detailed physical examinations. In addition, the patients' pain scores were evaluated using the visual analog scale (VAS) (4). The pain was sub-classified as severe (VAS 7–10), moderate (VAS 5–6), or mild (VAS 0–4). A detailed postoperative neurological examination (sensory and motor) was conducted and recorded at each follow-up visit. The neurological status was categorized as improved, stable, or worsened based on the ASIA grade change after surgery.

The existing fracture was defined and classified by preoperative spinal computed tomography (CT) and magnetic resonance imaging (MRI). With imaging modalities, kyphotic angulation, the degree of cord contusion/compression, and the level of posterior ligamentous complex damage were evaluated. The parameters that should be considered while measuring the maximum canal compromise (MCC) are the first normal level below the injured segment, the first normal level above the injured segment, and the maximum canal compression measured on T1-weighted imaging in the midline sagittal section of the injured segment (8).

The indications for surgery were decided as per the Thoracolumbar Injury Classification and Severity (TLICS) scale (18). Postoperative CT was performed on all patients before their discharge and then during the follow-up period. The presence or absence of fusion, subsidence of the cage, implant failure, sagittal vertical axis, coronal balance, and the kyphotic angle was measured and evaluated based on postoperative and follow-up CT images.

Operative Procedure

All patients underwent a posterior-only approach for transpedicular corpectomy with cage placement and instrumented fusion by the same surgeon (MOU). These patients were positioned prone on a radiolucent spine operating table and a standard posterior exposure was achieved above and below the fracture/dislocation level. Before decompression, pedicle screws were inserted above and below the involved vertebral segment under the C-arm/O-arm guidance. At the affected level, laminectomy was carefully performed to expose the dura widely. With the dura in direct view, the inferior and superior articular processes and pedicles of the affected level were drilled/rongeur out and then resected, thereby exposing the relevant disc spaces and nerve roots. Corpectomy and microdiscectomies were then performed using a combination of high-speed drills, curettes, and rongeurs through the transpedicular corridor so as to expose the below and above endplates. A fully compressed expandable titanium cage packed with autograft bone and demineralized bone matrix was placed through the space between the adjacent nerve roots, with particular attention paid to preserving the nerve roots wherever possible. After the placement of the bilateral rods, the compression was performed on the segment where the corpectomy was performed, and it was aimed to correct the kyphotic deformity. Transverse connections were placed in necessary cases. To increase fusion, autologous bone grafts obtained during laminectomy and corpectomy were placed in the posterolateral region following the decortication stage. Artificial bone grafts were used in patients who could not obtain sufficient autologous grafts.

Statistical Analysis

The data were analyzed using the paired t-test and nonparametric Wilcoxon test with the IBM SPSS 20.0 software (SPSS Inc, Chicago, IL, USA). The significance level was set at $p<0.05$ for all analyses.

RESULTS

The characteristic data for these patients and their pathologies are detailed in Tables I and II. A total of 17 patients who underwent transpedicular corpectomy and arthrodesis by the posterior-only approach during the study period were included in this study. There were a total of 7 male and 10 female patients of ages ranging from 16 to 75 years in this study.

The mode of injuries were motor vehicle accidents in 8 patients and falls from height in 9. All patients underwent surgery as soon as their vital signs had stabilized. The median duration of the interval between injury and surgery was 3 days. The average operating time was 293 min, and the mean blood loss was 1789 mL (range: 757–3252). The mean clinical follow-up was 32.8 months, whereas the mean radiographic follow-up was 15.8 months.

L_1 was the most common vertebral level involved in 6 patients. In the remaining cases, L_5, L_3, L_2, T_{12}, and T_7 fractures were recorded. Posterior transpedicular fixation was performed in all patients. The decision of the number of levels fused was based on the patient's characteristics, CT findings, and the surgeon's preference. Intraoperatively, the nerve root was sacrificed on the ipsilateral side where the cage was being placed in 1 patient, and an iatrogenic nerve injury was recorded in two patients; all of these were noted in the thoracic region. Dural

Table I: Summarized Data of Patients

Variables	Patients (n=17)
Age,Years	49.25 ± 24.26
Male/Female	7/10
Clinical Manifestation (%)	
Complete injury	8 (47.1)
Incomplete injury	9 (52.9)
Mode of Injury (%)	
Motor Vehicle Accident	8 (47.1)
Fall from height	9 (52.9)
Pathological Level (%)	
Thoracal	5 (29.4)
Lumbar	12 (70.5)
Mean blood loss (mL).	1789 (757-3252)
Mean op. time (min.)	165.3 (123-205)
Sacrifice of the nerve root (%)	1 (5.88)
Mean TLICS score	7.25
Mean VAS score (Pre/Post)	8.8/3.1
Mean Cobb angle degree (Pre/Post)	21.75/14.5
Thoracic kyphosis angle (Pre/Post)	47.8°/40.1°
Sagittal vertical axis mm (Pre/Post)	19.7 / 2.2
Coronal Balance mm (Pre/Post)	2.6 /0.57

Table II: Detailed View of Individual Cases

	Age/ Sex	Mode of Injury	Level	Post. Fixation Levels	Canal Compromise	TLICS	VAS (Pre)	VAS (Post)	Cobb (Pre)	Cobb (Post)
Case # 1	26/M	MVA	T_{12}	T_{10}-L_2	60%	7	9	5	25	20
Case # 2	67/F	Fall	L_2	T_{11}-L_4	25%	6	7	3	26	12
Case # 3	64/F	Fall	L_1	T_{10}-L_4	35%	7	8	3	34	29
Case # 4	62/F	Fall	T_{12}	T_9-L_4	80%	8	8	3	11	9
Case # 5	63/F	Fall	L_3	T_{12}-S_1	60%	7	7	2	11	9
Case # 6	20/M	MVA	L_5	L_3-S_1	80%	8	6	2	35	25
Case # 7	16/F	Fall	L_1	T_{11}-L_3	74%	8	9	4	17	5
Case # 8	75/M	MVA	L_1	T_{11}-L_2	66%	7	8	3	15	7
Case # 9	25/M	MVA	T_7	T_5- T_9	73%	7	8	4	25	20
Case # 10	68/F	Fall	L_5	L_3-S_1	59%	6	9	5	27	19
Case # 11	66/F	MVA	L_1	T_{10}-L_4	27%	7	7	3	29	14
Case # 12	61/F	Fall	T_{12}	T_9-L_4	38%	8	8	3	30	27
Case # 13	62/F	MVA	L_3	T_{12}-S_1	77%	7	8	3	12	10
Case # 14	21/M	MVA	L_1	T_{11}-L_2	62%	8	7	2	13	10
Case # 15	18/F	MVA	L_2	T_{11}-L_4	83%	8	6	2	31	26
Case # 16	76/M	Fall	T_{12}	T_9-L_4	70%	7	9	4	19	6
Case # 17	63/M	Fall	L_1	T_{10}-L_4	62%	6	8	3	17	8

tears secondary to trauma were identified intraoperatively in 1 patient.

Among the 17 patients, 8 were in ASIA A, 9 had incomplete neurologic deficits (ASIA C - D), and none was neurologically intact (ASIA E) preoperatively (Figure 4). All patients had TLICS scores >4 and were treated surgically. The mean TLICS score was 7.31. While no worsening was noted in the neurological images of the patients in the postoperative period, neurological improvement of at least one ASIA grade was recorded in 13 patients. However, it was found that the neurological functions remained the same in 4 patients (Figure 1). There was a significant reduction in pain based on a mean preoperative VAS score of 8.2 to a postoperative VAS score of 3.3. No patient complained of local pain at the last follow-up evaluation ($p<0.05$). In the 3rd-6th and 12th-month routine controls of the patients, the VAS scores were 3.4, 3.5, and 3.4, respectively, and there was no statistically significant difference relative to those in the early postoperative period ($p>0.05$).

The observed complications included superficial wound infections in 2 patients (11.7%), cerebrospinal fluid leakage in 1 (5.88%), and pulmonary embolism in another 1 (5.88%). No deep-tissue infection or revision surgery was performed in the postoperative period. The mean time of discharge to rehabilitation or home was 5.5 days.

Canal compromise ranged from 34% to 80% (mean 66%), whereas the vertebral body height loss ranged from 19% to 68% (mean 37%). Statistically, significant improvement was recorded in the degree of kyphotic deformity and vertebral collapse in the segment where the traumatic fracture had occurred ($p<0.05$). In parallel, while the Cobb angle was 19.8 (5 to 35) in the preoperative period, it was found to be 13.1 (2 to 28) in the postoperative period, with a statistically significant difference ($p<0.05$). However, no difference was observed between the values postoperatively and at the last follow-up evaluation. Among other radiological parameters,

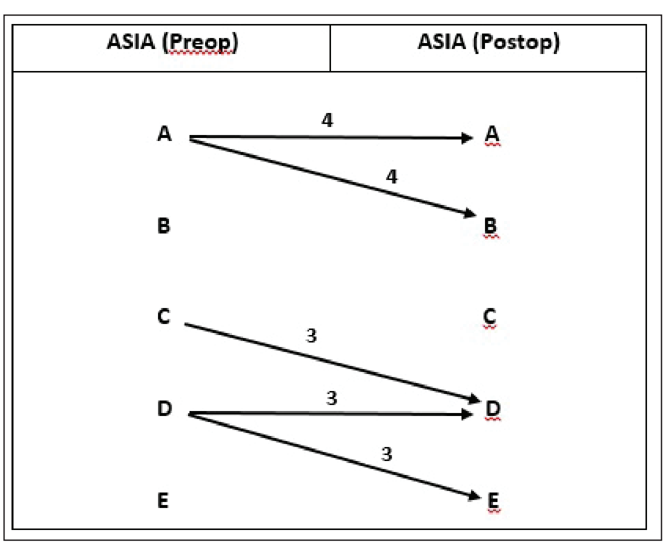

Figure 1: The number of preoperative and postoperative ASIA scales.

the coronal balance decreased from 2.6 mm (range -29 to 36 mm) to 0.57 mm (range -23 to 36 mm), but there was no statistically significant difference. In addition, the mean sagittal vertical axis (SVA) improved from 19.7 mm (range -79 to +184 mm) to 2.2 mm (range -33 to +71 mm), with a statistically significant difference. The mean thoracic kyphosis angle improved from 47.8° (range 17° to 117°) to 40.1° (range 23° to 67°). No statistically significant difference was found in the radiological parameters of the patients in the 3–6- and 12-month routine controls when compared with those in the early postoperative period ($p > 0.05$).

During routine controls, fusion was evaluated by CT and dynamic radiographs in all patients at the 6th-month follow-up. In addition, stability was subjectively confirmed by the absence of axial pain. The reconstruction was stable in all patients. No implant-related complications requiring revision or loss of correction were recorded at the last follow-up visit. Some of the cases in this series are illustrated in Figures 2–4.

DISCUSSION

Traumatic fractures and dislocations are usually noted after high-energy trauma. In addition, 80% of the patients with

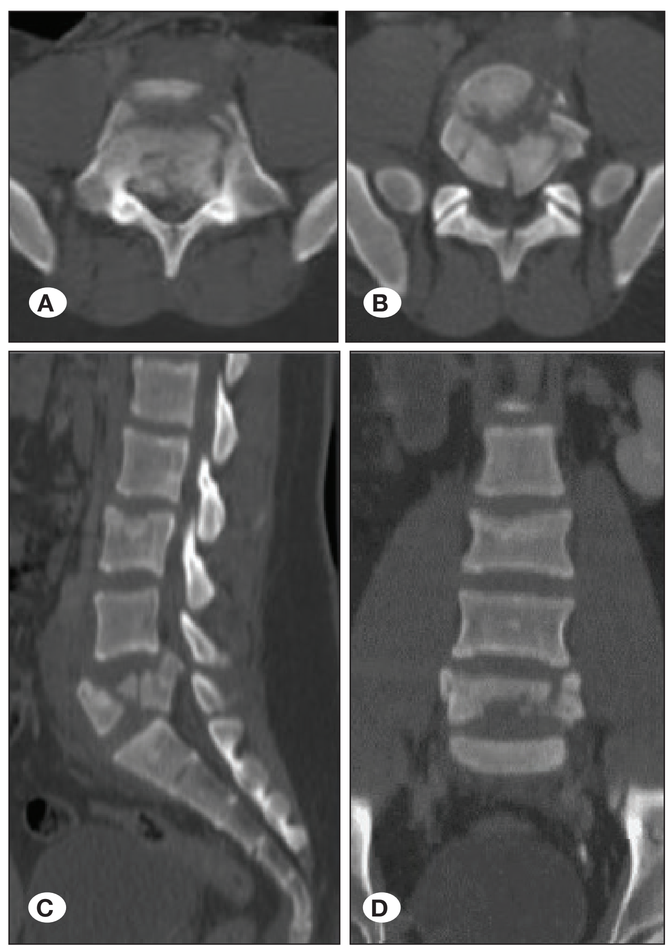

Figure 2: Case #6. A 20-year-old man with severe L_5 burst fracture after falling from a height. Preoperative axial **(A)**, coronal **(B)**, and sagittal **(C)** CT sections are shown.

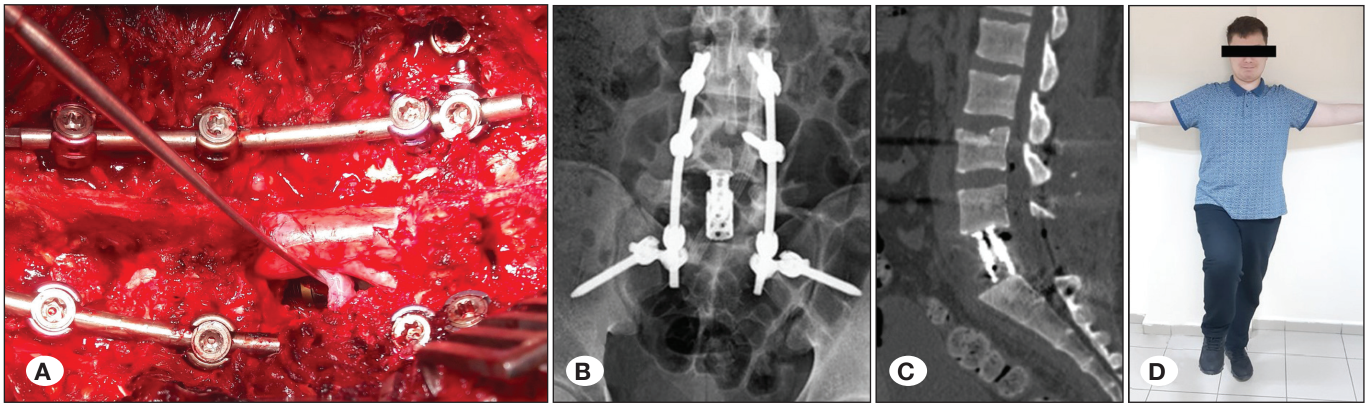

Figure 3: Case #6 (Cont.). **A)** An intraoperative photo showing the extent of decompression, cage replacement, and L_3-sacropelvic instrumentation. **B)** Postoperative lumbosacral AP X-ray , and **C)** sagittal CT sections d. The patient's final neurological condition at the last follow-up.

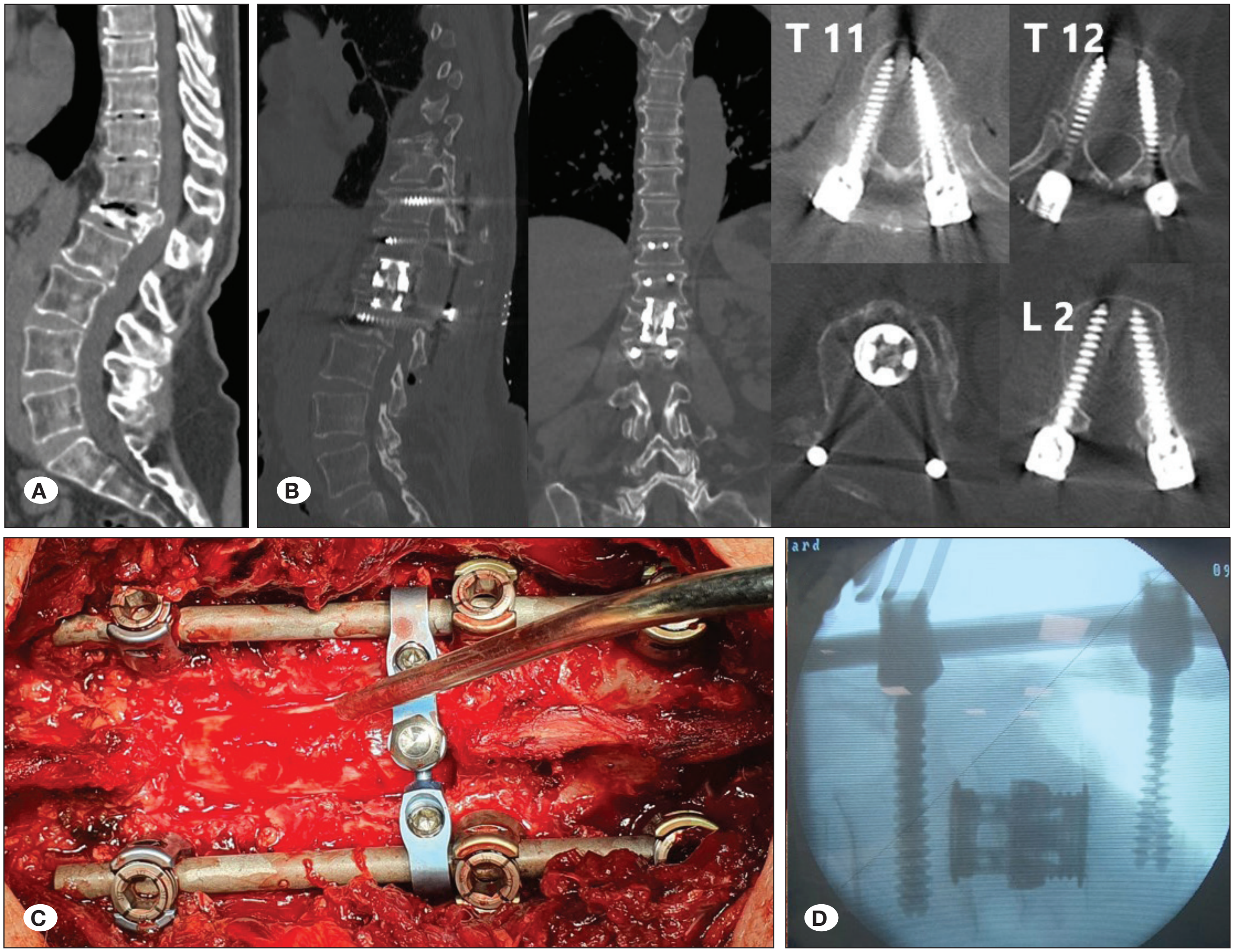

Figure 4: Case #8. A 75-year-old woman with severe L_1 compression fracture after MVA. **A)** Perioperative, and **B)** postoperative CT sections after L_1 posterior corpectomy and T_{11}-L_2 fusion. **C)** An intraoperative photo and **D)** fluoroscopy view showing the extent of posterior decompression and cage replacement.

thoracic fractures/dislocations develop complete paralysis (10, 38). As a result of several pathologies, the anterior column of the spine may lose its strength and become unstable, resulting in kyphotic deformity. For patients with spinal instability from a traumatic non-pathological vertebral body fracture with a neurological deficit from epidural spinal cord compression, a corpectomy is often necessary (27). Since thoracolumbar fractures/dislocations are usually noted after high-energy trauma, they are associated with thoracic and visceral injuries that require surgical treatment. Therefore, early intervention is extremely important. Unstable burst fractures with neurological deficits require surgery, albeit discussions on the ideal surgical approach are ongoing in the literature (15).

Circumferential reconstruction of the thoracolumbar spine can be performed with various surgical methods. For instance, it can be performed with a combined anterior and posterior approach or a combined lateral and posterior approach (15,33). Achieving high fusion rates in lumbar burst fractures and correcting sagittal deformities can be accomplished with the anterior approach alone or in combination with the posterior approach (15,33). Moreover, generally, unstable thoracic spine fractures have been treated either conservatively or surgically through an anterior approach (30,32). A double approach is often demanding and associated with significant risks. The need for a multidisciplinary team (thoracic and/or general surgeon), the need for patient repositioning, and long operation times are recorded among the disadvantages of extensive procedures such as conventional transthoracic and thoracoabdominal approaches. Although there are complications such as hemothorax, chylothorax, pleural effusion, atelectasis, and pulmonary contusion, there is the possibility of clear ventral visualization of the thoracic spine with open thoracotomy (17,35).

Lateral lumbar corpectomy has also been described in the literature; however, the retroperitoneal dissection stage with the lateral approach can be difficult due to adhesions and scar formation because of past surgeries (of the kidney). The risk of lumbar plexus injury and abnormal vascular anatomy also add a limitation to this procedure (26,31). On the other hand, some authors have advocated anterior surgery in their series because of the higher incidence of complications in posterior surgery. In addition, they suggest that kyphotic deformity can be corrected more safely in anterior surgery (14,24,28).

In our study, we demonstrated that extremely successful clinical and radiological results could be obtained in traumatic fractures with a single-stage posterior transpedicular corpectomy. It is known that anterior approaches have high morbidity rates and risks of injury to the visceral organs and large vessels. Thus, both avoiding these risks and performing instrumentation together with decompression in a single session are among the important advantages of our technique. In high-energy traumas and cases with neurological deficits, satisfactory outcomes with the current approach provide serious decreases in the overall morbidity rates of the patients.

Lu et al. compared the transpedicular approach with the anterior approach and found no significant difference between the two methods in terms of morbidity, albeit they reported that the neurological image was better in patients treated with the transpedicular approach (21). In their study, Xu et al. compared the two surgical methods and recorded longer operative time, blood loss, and increased cost rates in patients operated with the anterior approach. In addition, they found that the time to return to normal activity and the improvement of neurological findings were similar between both methods (39). In a recent metanalysis, both anterior and posterior surgery showed similar clinical and radiological results, albeit the anterior approach was associated with a longer operative time, greater blood loss, and higher cost than the posterior approach in the thoracolumbar burst fractures (37). In addition, when the intraoperative and postoperative complication rates were evaluated, when compared with similar series, it was striking that additional complication rates did not occur with the current surgical procedure.

Patients undergoing posterior transpedicular corpectomy experienced less blood loss, less operative time, and fewer complications when compared with the combined anterior/posterior corpectomy approach (37). Thus, serious decreases were observed in the morbidity rates. In accordance with the literature, we noted less blood loss, less operation time, and fewer complications in our cases. Thus, according to recent literature, the posterior transpedicular corpectomy approach is preferable in well-selected cases (22).

The patients were operated on within an average of 3 days after their admission to our clinic. The variability in surgical timing can be attributed to several factors including medical necessity (the use of anticoagulants or systemic pathologies), patient-based (refusal to undergo surgery), and technical difficulties. When the elapsed time and the healing process are considered, spinal cord decompression may become more difficult with the onset of fusion. However, we did not experience a compelling peroperative process in our cases.

The popularity of multisegment corpectomy applications, especially the posterior-only route, is in line with the advances made in the use of expandable cages. Its height is adjustable, which allows easy integration with any approach. However, the subsidence rates that develop after the use of these cages remain debatable. However, in a past study (2), surgery was performed with anterior-only fixation without any posterior support in half of the patients. Our low subsidence rates, on the other hand, can be attributed to our posterior thoracolumbar instrumentation application to all patients, as also confirmed by the literature (5,29,34). In addition, the high fusion rate in the control imaging of the patients is among the advantages offered by the current surgical method.

Stability ratios obtained as a result of different approaches were examined in detail in the literature. In a cadaver study, after total spondylectomy, circumferential instrumentation contributed more to stability than multi-level posterior instrumentation (25). On the contrary, some studies in the literature have reported that patients with short-segment instrumentation do not have a more reliable and effective treatment method that is independent of anterior support when compared to patients with long-segment stabilization (19,23). Our study, on the other hand, provides important data, including both long/short segment and circumferential instrumentation, as a combination of the views reported in the literature. We believe that the reduction of the need for long-segment posterior instrumentation is another advantage of the proposed operation technique. The results obtained in both clinical and radiological follow-up of our cases demonstrate that the current surgical approach is more than sufficient, especially in traumatic non-pathological thoracolumbar cases.

LIMITATIONS

Limitations of our study include the retrospective nature and the lack of a comparative or a control group (e.g., comparison with anterior-only approach).

CONCLUSION

It is feasible to obtain effective and satisfactory outcomes with a posterior-only approach and transpedicular route in thoracolumbar fractures occurring secondary to trauma without any underlying pathology. In addition, the reconstruction of both the anterior and posterior columns in a single session can provide rapid and serious improvement in the quality of life of the patients.

AUTHORSHIP CONTRIBUTION

Study conception and design: MOU, MH
Data collection: MYA, OA
Analysis and interpretation of results: MO, MYA
Draft manuscript preparation: MYA, MOU
Critical revision of the article: MH, MOU, MYA
Other (study supervision, fundings, materials, etc...): MOU, MH
All authors (MYA, MOU, OA, MO, MH) reviewed the results and approved the final version of the manuscript.

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