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Original Article

Single-Center Experience with Independent Anterior Retroperitoneal Decompression and Reconstruction of Burst Lumbar Fractures

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BACKGROUND: Lumbar burst fracture is a common spinal injury that causes instability, kyphotic deformities, and intra-canal bone pieces that cause neurological deficits and necessitate surgical decompression and reconstruction. The ideal surgical technique is still debatable.

OBJECTIVE: This stretrospective study assessed our center's experience with surgical treatment for some kinds of unstable three-column lumbar fractures which was achieved via a single-stage, independent anterior surgery with anterior fixation.

METHODS: Twenty patients with traumatic lumbar burst fracture with spinal canal compromise were included between July 2021 and July 2023. All patients had surgical decompression and stabilization using stand-alone anterior approach.

RESULTS: The first lumbar (L1) vertebra was the site of 40% of the fractures. A minimum of six months were spent monitoring every patient. Patients had mean thoracolumbar injury classification and severity score (TLICS score) of 7.4. Oswestry disability index (ODI) ranged between 80–90 before surgery and 21–50 after surgery. Seventy-five percent of neurologically affected patients improved at least one grade according to the Frankel classification scale of neurological affection after surgery, except 3 cases with no improvement of the preoperative A-grade. The kyphotic angle showed improvement from mean angle 9.5˚ before surgery to mean angle 2.8˚ after surgery.

CONCLUSION: The direct anterior decompression of neural elements with contemporary anterior spinal instrumentation and reconstruction improves segmental angulation without violation of the posterior column and has a shorter fusion segment compared to the posterior fusion. It also has acceptable operation time and perioperative complications.

KEYWORDS: Anterior lumbar fixation, Burst lumbar fractures, Retroperitoneal decompression.

INTRODUCTION

A common form of spinal trauma is "unstable" thoracolumbar burst fracture. Many believe that because of the enormous energy delivered to the vertebral body during severe trauma, bone fragments from broken endplates retropell into the spinal canal, which increases the risk of kyphotic deformities and neurological complications. Neurologically compromised patients need to have surgical decompression and reconstruction.[1]

The range of the available surgical management options indicated the ongoing controversy around the best course of treatment. Direct anterior decompression (with or without instrumentation), direct posterolateral procedures (transpedicular approaches) with long- or short-segment fixation, indirect posterior decompression and reduction (ligamentotaxis), and combination of anterior and posterior approaches were some of these.[2]

There had been reports of using the transpedicular-transfacetal route or the posterior approach via laminectomy to get access to the spinal canal. Decompression was accomplished either indirectly through ligamentotaxis or directly through disimpaction. In most cases, posterior stabilization necessitated placing the instrumentation two levels above and below the fracture site.[3]

With the advancement of anterior thoracolumbar instrumentation design and biomechanical performance, thoracolumbar burst fractures, whether or not there was a neurologic deficit, had been successfully treated with a single-stage anterior operation, as reported by others in more recent times.[4]

From a theoretical standpoint, treating burst lumbar injuries with a single-stage anterior operation could have advantages like better direct canal decompression (which could lead to better neurologic recovery), anterior load sharing being restored, fewer levels needing arthrodesis, sagittal alignment being restored, and significantly reduced surgical morbidity (in contrast to an anterior and posterior two-stage technique).[2,3,5]

Anterior lumbar spine (ALS) surgery is a popular surgical approach for accessing the intervertebral space, but it carries a number of intraoperative and postoperative risks. The neurovascular systems adjacent to the lumbar spinal column exhibit significant anatomic differences. Numerous difficulties had been reported, including vascular, neurological, and visceral harms that occurred during surgery, as well as postoperative consequences

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such as infection, thrombosis, retrograde ejaculation (RE), and complications associated with implants.[6]

This study set out to retrospectively assess our center's experience with anterior instrumentation used in surgical treatment of some types of unstable three-column lumbar fractures using a single-stage, independent anterior technique.

PATIENTS AND METHODS

Twenty participants were included in this retrospective clinical study remove. Twelve males and 8 females were included between July 2021 and July 2023. The age distribution was 34.2 ± 7.84 years.

Cases characteristics were retrospectively gathered from our university hospital records. Cases data, diagnoses, and treatment outcomes were privately kept and cases were marked by codes.

All patients have signed informed consents for operation and publication to be involved in this study. Approval was obtained from the research ethics committee in our university.

Patients with traumatic lumbar burst fracture with anterior canal compromise were included in this study. However; medically unfit, osteoporotic and pathologically fractured cases were excluded from this study.

All cases were assessed and exposed to clinical history, general and neurological examinations, and routine laboratory tests. Pre-operative clinical examinations were sensibly performed and muscles strength of the lower limbs of all patients was sensibly classified by the motor power classifying system from 0 to 5 and Frank grade classification.

All cases were pre-operatively exposed to radiological assessment via X-ray in both anteroposterior and lateral views. On lateral radiographs in the neutral position, the kyphotic angle was measured from the superior endplate of the vertebral body above the fractured level to the inferior endplate of the vertebral body below the damaged vertebra. Some patients; computerized tomography (CT), magnetic resonance imaging (MRI) and dual-energy X-ray absorptiometry (DEXA) scans were also performed. **(Fig. 1)**

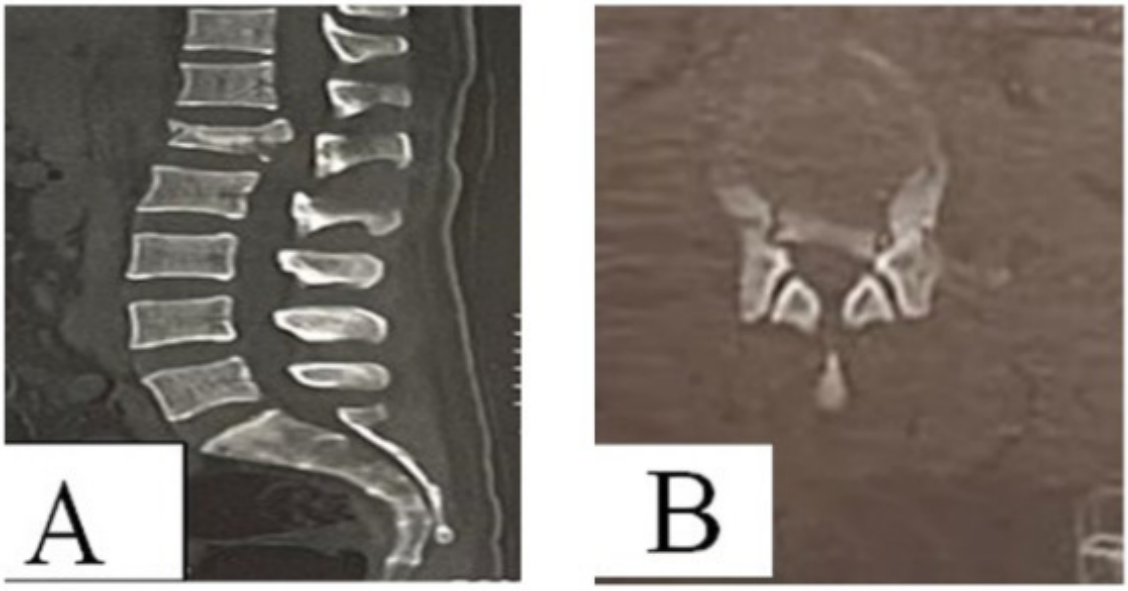

Fig 1: Pre-operative CT Lumbosacral spine showing L1 burst fracture. (A): Sagittal cut. (B): Axial cut.

Surgical technique: Right side down, the patient was placed in left lateral decubitus. Since the aorta was easier to work with and mobilize than the inferior vena cava (IVC), the approach was made from the left side to avoid the liver and IVC. On the level of exposure, an oblique skin incision was necessary. Based on the fluoroscopy image, the incision was focused on the level that was approached. The skin and subcutaneous tissue were opened then the lateral fibers of the abdominal muscles (external oblique, internal oblique and abdominal transverse) could be carefully opened. The 10th or 11th ribs were resectioned after subperiosteal separation to reach L1-L2 and in cases of L1 fractures, the diaphragm was released to insert screws in dorsal (D)12 vertebra. The extraperitoneal fat served as our guide, and the peritoneum, which includes the ureter and aorta, was retracted anteriorly and medially while being covered with wet gauze. The retroperitoneal area was reached without entering the pleural cavity. We employed a self-retaining retractor, ligated the segmental vessels, and exposed the periosteum after removing the psoas muscle from its attachments to the L1 and L2 vertebrae using the vertebral column as a guide. With the anterior dural sac exposed, the level was identified by C-arm, and then partial corpectomy was done attempting to preserve its anterior portion to prevent damage to soft structures using a high-speed drill. Following that, short segment instrumentation and bone fusion were completed by inserting screws (one vertebral body above and one below the fractured level) to the fractured level, applying mesh loaded by bone graft with rods above it, tightening the set screws, and closing with the insertion of a drain. **(Figs. 2,3).**

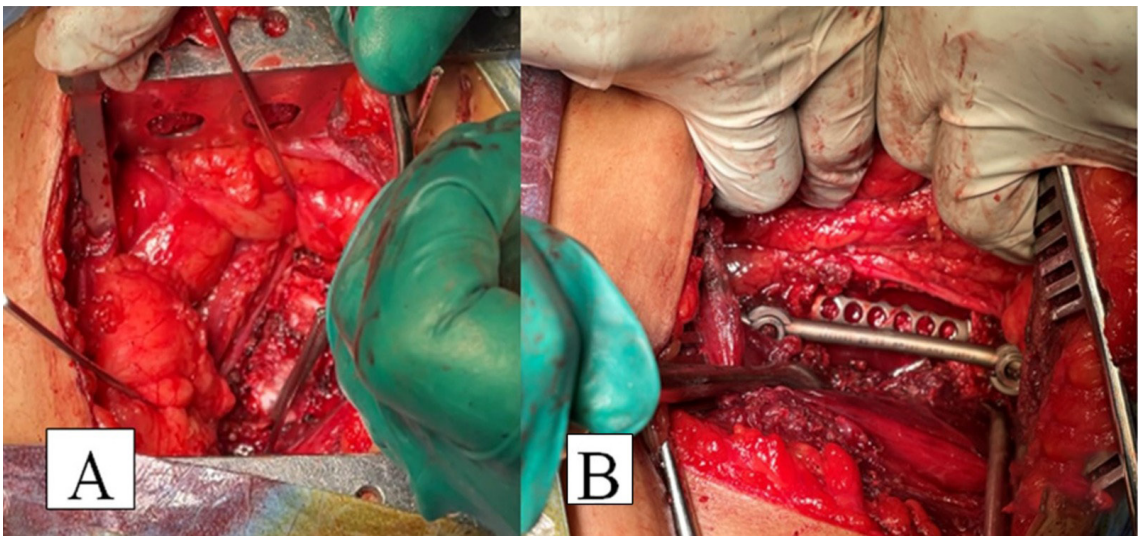

Fig 2: Intra operative images; A: Showing corpectomy of L1. B: Mesh loaded with bone graft and final reconstruction.

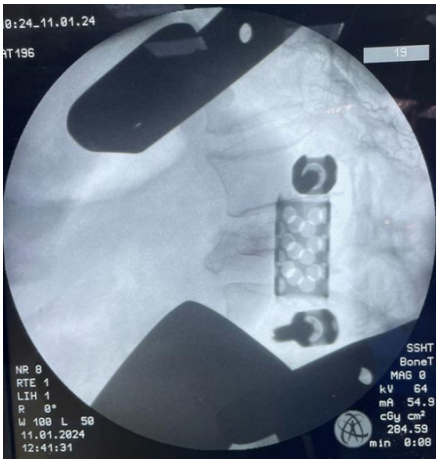

Fig 3: Intraoperative X- ray showing the construct and instrumentation.

All cases were assessed immediately postoperative then in the outpatient clinic at a steady period after 2 weeks from the operation then after 3 and 6 months. ODI had been utilized for preoperative and postoperative disability evaluation in all patients, pain before and after surgery was compared with visual analogue scale (VAS) score. Also Frank grade classification was assessed to compare neurological state before and after operation.

Approximately one day after surgery, a CT scan and x-ray was done to ensure that instrumentation was in a good position and efficacy of decompression and fixation. The drain was typically removed 48 hours after surgery.At 3 and 6 months after surgery plain x-rays were done to assess fusion. **(Fig. 4).**

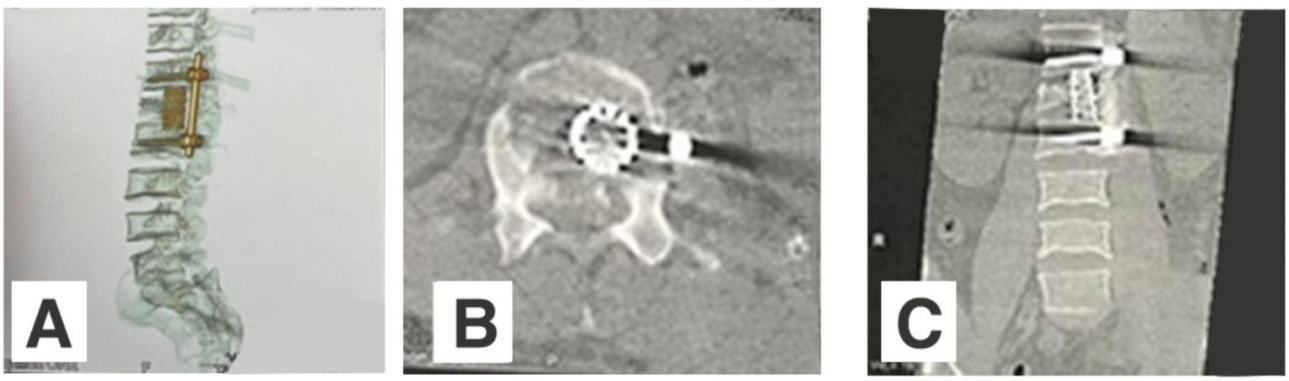

Fig 4: Post-operative CT Lumbosacral spine showing the construct and instrumentation; A: 3D reconstruction image, B: axial and (C): Coronal image.

Lumbar brace was often retained for one month following surgery, and patients were instructed to begin movement while wearing it. The duration of follow-up ranged from 6 to 12 months.

RESULTS

Current work comprised 12-males and 8-females. The ages of the patients at presentation ranged between 25-50 years with a mean value of 34.2 ± 7.84 years. L1 was the most frequent level among all patients (40%) **(Table 1).**

Patients had TLICS that ranged from 4 to 8 with mean of 7.4 (Table 2). ODI ranged between 80-90 with a mean of 85.6±4.03 before surgery and 21-50 after surgery with a mean of 36 ± 12.82. The pain was evaluated using a 10-point VAS. It has ranged from 7-9 pre-operatively with a mean value of 8.2 ± 1.8 and from 1-3 post-operatively with a mean value of 2.3 ± 1.6. Regarding Frankel scale, 75% of neurologically affected patients improved at least one grade aafter surgery according to Frankel classification scale of neurological affection surgery; however three cases with a preoperative grade of A did not get better **(Table 3).**

After and final follow-up, the kyphotic angle improved from a mean of 9.5˚ (range of 0˚ to 20˚) prior to surgery to 2.8˚ (range of 0˚ to 8˚). In every patient, there was a substantial difference between the kyphotic angle before surgery and at the end of the follow-up (p =<0.001). Six months following the anterior approach, one patient required additional posterior instrumentation and fusion because the kyphotic angle worsened following the failure of bone fusion.

Three cases (15%) suffered intraoperative problems during the procedure; two patients experienced peritoneal injury, which was treated directly by suturing the peritoneum with non-absorbable sutures. An intercostal chest tube was inserted and sutures were used to treat a pleural injury in the third patient. Three more cases (15%) had postoperative problems; the first two had superficial wound infections treated with systemic antibiotics and the third had worsening of the kyphotic angle following failure of bone fusion. Six months following the anterior approach, supplemental posterior instrumentation and fusion were performed two levels above and two levels below the fracture level **(Table 4).**

Table 1: Level of fracture in studied patients

		(n=20)
Level of fracture	Lumbar 1	8 (40%)
	Lumbar 2	7 (35%)
	Lumbar 3	5 (25%)

Table 2: TLICS and LSS of the studied patients

		(n=20)
TLICS	Median	6
	IQR	4 - 8
LSS	Median	7
	IQR	6 - 8

TLICS: Thoracolumbar injury classification and severity score, LSS: Load sharing scores, IQR: Interquartile range..

Table 3: ODI, VAS and Segmental Kyphotic Angle of the studied patients

	Preoperative	Postoperative	P value
ODI (%)			
Mean ± SD	85.6 ± 4.03	36.8 ± 12.82	<0.001*
Range	80 - 90	21 - 50	
Visual Analogue Scale			
Median	8	1	<0.001*
IQR	7 - 9	1 - 2	
Segmental Kyphotic Angle			
Mean ± SD	9.5 ± 6.35	2.8 ± 1.89	<0.001*
Range	0 - 20	0 - 8	

*: Significant as P value ≤0.05. ODI: Oswestry disability index, SD: Standard deviation, VAS: Visual analogue scale, IQR: Interquartile range.

Table 4: Complications of approach in studied patients

Complication	N(20)	Percentage
Wound infection	2	10%
Kyphosis	1	5%
Intraoperative vascular injury	0	0%
New deficit	0	0%
Retrograde ejaculation	0	0%
Peritoneal injury	2	10%
Pleural injury	1	5%
Sympathetic dysfunction	0	0%

DISCUSSION

When compared to posterior indirect (ligamentotaxis) and posterolateral decompression procedures, the anterolateral approach provided superior canal clearance by enabling direct decompression of ventral osseous and soft tissue pathologies.[4]

While some claimed that better anterior decompression leads to better neurologic recovery when compared to posterior therapy of thoracolumbar fractures,[7] other researchers did not find any discernible difference.[8]

Simple anterior strut grafting combined with early uninstrumented reconstruction techniques produced unacceptable high rates of pseudoarthrosis, ranging from 10% to 100% .Recently, there had been a major evolution in anterior thoracolumbar instrumentation, which had dramatically increased its usefulness in treating thoracolumbar trauma. Both distraction and compression were possible with current devices, which also had better load-sharing capabilities and more deformity correction.[2,8]

At this research, twenty patients had been admitted to and operated upon in department of neurosurgery, Tanta University Hospitals from July 2021 to July 2023. All patients came with traumatic lumber burst fracture. Patients were operated by anterior reconstruction and fixation by anterolateral retroperitoneal approach alone. In this study, patients were aged 25–50 years with a mean value of 34.2±7.84 years. High-energy trauma was accused for the incidence of traumatic spine injuries. Younger age groups were known to experience these kinds of incidents more frequently. In our study, there were 12 (60%) male patients and 72.5% males and 27.5% females in their study. 8 (40%) female patients. Sasso et al2 reported 72.5% males and 27.5% females in their study. Because of their occupations or activities, men are more likely to get injuries. Men's propensity for taking risks is widely known. According to Jansson et al's national longitudinal data on Thoracolumbar Fractures in Sweden, male gender is a risk factor for traumatic spine fractures.[9] Roche et al. also demonstrated comparable outcomes in undeveloped nations.[10]

In this research, three patients were hypertensive (15%) and one patient was diabetic (5%). There were 16 (80%) comorbidity-free patients.

Back pain was found in all patients (100%). Neurological examination was affected in 12 (60%) patients and intact in 8 (40%) patients. Half of neurologically affected patients (6 from 12 affected patients) had visceral affection. Sasso et al. reported 37 (92.5%) patients were neurologically affected pre-operative and 3 (7.5%) patients were intact.[2]

Traumatic fracture is common in thoracolumbar junction, especially L1 and L2, as being a transitional zone.[11] With respect to level of fracture in this research; the level of fracture was lumbar 1 in 8 (40%) patients, lumbar 2 in 7 (35%) patients and lumbar 3 in 5 (25%) patients.

In our study, the operative time varied between 100 and 150 minutes, with a mean value (±SD) of 119.3 (±17.34) minutes. Xu et al.[12] reported that mean operation time in their research was 176.3 minutes . In comparison to posterior approach, Roblesgil et al,[13] found that compared to anterior approach procedures, posterior approach procedures were linked to a noticeably lower operative time. Regarding blood loss, intraoperative blood loss ranged from 200 to 400 mL with a mean value (± SD) of 317.5 (±66.48) ml. In comparison to posterior approach, Roblesgil et al.[13] found that the blood loss from both methods was comparable. This concurred with the results of Tang et al.[14] Furthermore, the mean operative time and blood loss in a research by Suzuki et al. that used a posterior approach alone for the reconstruction and decompression of lumbar burst fractures were 277 minutes and 471 milliliters, respectively.[15]

In the present research, pain was tested using VAS before and after the operation. The mean values were 8 before operation and 1 after operation. ODI ranged between 80–90 with a mean value of 85.6 ± 4.03 before operation and ranged between 21 – 50 with a mean value of 36.8±12.82 after surgery. Mean preoperative visual analogue scale in the Suzuki et al. study was 7.0, and it improved to 0.7 after surgery.[15]

Following surgery and the last follow-up, mean kyphotic angle improved from 9˚ (range from 0˚ to 20˚) prior to surgery to 2.8˚ (range from 0 to 8˚). In every patient, there was a substantial difference between the kyphotic angle before surgery and at the end of the follow-up (P=0.0001). One patient required additional posterior instrumentation and fusion six months after the anterior

approach because the kyphotic angle worsened after bone fusion failure.

Sasso et al.[2] examined the stand-alone, one-stage anterior surgical treatment of 39 patients' three-column thoracolumbar injuries. with a significant (p=0.0001) early postoperative correction to 7.4 (range 0–28, SD 7.4), whereas mean preoperative segmental kyphosis was 22.7 (Range 10–42, SD 8.3). Lin Bin et al 7 also reported improvement in kyphotic deformity from 24.2° before surgery to 5.2° after surgery.

Local kyphosis improved from 15.7° prior to surgery to -11.0° following surgery in Suzuki et al. study. Due to cage subsidence, local kyphosis increased by more than 10° in three cases involving mid- to lower-lumbar patients three months after surgery. One patient needed more surgery because of severe cage tilting and subsidence.[15]

Most of studies that managed burst fracture with anterior only decompression and fixation showed significant improvement between pre-operative and post-operative kyphotic angle and good ability to maintain that correction with follow up. The difference in numbers may be due to difference in measuring the kyphotic angle, some used local kyphotic angle and others used segmental kyphotic angle in addition to different instrumentation used in reconstruction of anterior and middle column.

Kaneda et al.[4] first published their preliminary findings regarding the anterior decompression and Kaneda device stabilization of 110 patients who had neurologic impairments and thoracolumbar burst fractures. In the biggest reported series to date, they included longer-term follow-up on 150 of these patients 13 years later (mean 8 years). These were all reported to be burst fractures based on the Denis classification, with a mean kyphotic deformity of 19˚ (corrected to 7˚ postoperatively, without considerable loss at latest follow-up) and a preoperative mean canal stenosis of 47% (improved to 2% postoperative mean canal stenosis). Ninety-five percent had at least one Frankel grade improvement in neurological function.14 superscript as mentioned before.

In our study, regarding neurological improvement, nine patients (75% of neurologically affected) improved at least one grade according to frank classification scale of neurological affection and 3 (15%) patients did not improved, two of them had a preoperative score of grade A. This was in line with what had been documented in the literature. Sasso et al.[2] reported that no patients' neurological condition worsened as a result of receiving surgery. At least one modified Frankel grade (ranging from one to three grades) has improved in thirty out of thirty-three patients (91%) who had incomplete injuries. Modified Frankel A patients showed some improvement in three out of four cases.2 superscript as mentioned earlier.

There was no postoperative neurological decline in the Zhang et al. study. At the time of hospital discharge, 13 out of 27 patients (48%) had improved by at least one American spinal injury association (ASIA) grade. Neurological function improved in 22 patients (82%) at the last clinical follow-up.[16]

Six of our patients (30%) experienced perioperative complications, Three patients (15%) experienced intraoperative complications, non-absorbable sutures were used to stitch the peritoneum in two patients who suffered peritoneal spacing an intercostal chest tube was inserted and sutures were used to treat a pleural damage in one patient. The other three patients, which accounted for 15% of all cases, suffered postoperative problems. Systemic antibiotics were used to treat superficial wounds in the first two patients. Regarding the third patient, the bone fusion failed and the kyphotic angle deteriorated so the patient was managed six months following the anterior approach by posterior instrumentation and fusion two levels above and two levels below the fracture. Similar findings were reported by Zhang et al.[16] who found that 26% of patients experienced perioperative complications. None of those patients had any deaths or instances of worsening neurological impairments. There were no late vascular or intraoperative injuries reported. On radiographic imaging, two patients showed signs of little graft movement that did not worsen. There were two cases of dural tears. Three superficial wound infections treated with antibiotics, and one urinary tract infection.

Three out of 40 patients (8%) in Sasso et al. study needed additional posterior thoracolumbar arthrodesis with instrumentation either early or later. Anterior thoracolumbar implants did not need to be removed in any of the three patients who had radiographic indications of mild screw loosening that did not worsen. Two occurrences of pneumonia/atelectasis, one urinary tract infection, and one superficial wound infection were among the perioperative complications that were effectively managed with antibiotics.[2]

Compared to posterior instrumentation, the anterolateral approach provided better treatment of spinal kyphotic deformity and direct decompression of the spinal canal. The number of mobility segments that can be united was limited by the direct reconstruction and fusing of the spinal column made possible by the implantation of the allograft and anterior instrumentation. According to McBride study, posterior instrumentation typically needs pedicle screws two levels above and below the fracture with a fusion rate of about 90%.[17] The posterior instrumentation of short segments is still debatable. In a randomized controlled experiment, Tezeren and Kuru found that 5 out of 9 patients receiving short segment posterior instrumentation experienced a 55% failure rate and a corrective loss of 10 degrees.[18] The fusion rate in our study was 95% , with only 1 out of 20 patients failing to fuse at follow-up.

Neurological impairments in thoracolumbar fractures are typically brought on by compression to the ventral surface of the spinal cord and the effect of trauma. During surgical decompression, the ventral spinal cord can be

directly seen via anterolateral technique. There are not many researches that explicitly contrast anterior versus posterior methods. In a two-year clinical follow-up, Wood et al. conducted a randomized prospective comparison of these two methods in 38 patients. The anterior group experienced a greater amount of surgical blood loss. While radiographic analysis and patient outcomes were unclear in both groups, the anterior decompression and fixation group had fewer complications.[19]

According to certain research, the combined anterior–posterior technique improved vertebral height and increased postoperative kyphotic correction 20 However; the combined anterior-posterior procedure had numerous limitations, including increased operative time and blood loss, without improving function recovery, fusion rate, relief of pain, or ability to work.[8]

CONCLUSION

The direct anterior decompression of neural elements with contemporary anterior spinal instrumentation and reconstruction improves segmental angulation without violation of the posterior column and has a shorter fusion segment compared to posterior fusion. It also has acceptable rates of arthrodesis without the need for additional posterior instrumentation, with acceptable operation time and perioperative complications.

List of abbreviations

ALS: Anterior lumbar spine.
CT: Computed tomography.
D: Dorsal.
L: Lumbar.
LSS: Load sharing scores.
MRI: Magnetic resonance imaging.
ODI: Oswestry Disability Index.
RE: Retrograde ejaculation.
TLICS: Thoracolumbar Injury Classification and Severity Score.
VAS: Visual Analogue Scale.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this manuscript.

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