

Original Article

Early Experience with Percutaneous Transpedicular Screw Fixation for Thoracolumbar Fractures at a Tertiary Care Hospital in Pakistan

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ABSTRACT

Objective: To present our early experience with percutaneous transpedicular screw fixation for thoracolumbar fractures at a tertiary care hospital in Pakistan.

Material & Methods: A case series of 20 patients with thoracolumbar fractures, who met the inclusion and exclusion criteria were followed for up to six months to evaluate their functional status using the Oswestry Disability Index (ODI). Kendall's tau, Spearman's rho and Pearson correlations were conducted to draw useful conclusions.

Results: 85% patients' injury was reported from 'fall from height'. 55% of the fracture was the dorsal-lumbar junction (T12-L1). Burst type morphology was reported in maximum number of patients (65%). 55% of patients were reported to be neurologically intact. ODI score's mean percentage decreased from 40% to 23% during the first week to six months, indicates an improvement in the disabilities. A significant ($p < 0.050$) positive correlation was found between fracture morphology and ODI. All patients had an accurate screw trajectory postoperatively and no postoperative complications were documented. Neurology was stable for all patients at 1, 3 and 6 months.

Conclusion: Percutaneous transpedicular screw fixation can be a viable approach for thoracolumbar burst fractures with intact posterior ligamentous complex in all types of thoracolumbar fractures, including type C and leads to an improvement the quality of life. Fracture morphology has a significantly positive correlation with a higher disability index score, with more severe fracture morphologies as per the Thoracolumbar Injury Classification and Severity (TLICS) score having a higher disability.

Keywords: Minimally Invasive Spinal (MIS) Surgery; Percutaneous Transpedicular Screw; Thoracolumbar fractures; Functional Outcomes; AO Fracture; Thoracolumbar Injury Classification and Severity (TLICS); Oswestry Disability Index (ODI); Pakistan.

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INTRODUCTION

Thoracolumbar fractures account for a major share of spinal column fractures and 76 – 91.5 (%) of the spinal cord injuries in Pakistan.¹⁻² These fractures lead to major morbidities due to the handicap functional status, and they influence patients and their families socially and financially as compared to other injuries.³ They are associated with chronic pain and prolonged absence from work. Over the last two decades, the interest in treating these fractures has increased due to the evolution of the surgical techniques. Various studies have been conducted utilizing techniques for fracture reduction and fixation.⁴ Open pedicle screw fixation and fracture reduction are well established and well-acquainted treatment for thoracolumbar fractures.⁵⁻⁶ The 'minimally invasive spinal surgery' (MISS) approach includes percutaneous transpedicular screw fixation in which the instrumentation enables a rigid bracing and lead to stability and early mobilization. This approach has been utilized in a variety of different diseases, i.e., from tumours to trauma and degenerative disease.⁷ We present our experience minimally invasive approach of percutaneous transpedicular screw fixation in all thoracolumbar fractures by AO classification and report the 6 months' functional outcomes through the Oswestry disability index (ODI). A comprehensive literature search shows that there are no such studies from Pakistan, especially as the uptake of this technique in spinal surgery has been slow nationwide. The studies that have been conducted, which only focused on more immediate parameters such as hospital stay, radiological outcomes and post-operative outcomes. These have shown favourable results in the MISS group compared to the open surgical group.⁸ Other Pakistani studies included the evaluation of functional outcome with an open surgical approach.⁹ Moreover, the current study utilized this approach for A1 or A2 fracture. We operated on all thoracolumbar fractures as per

the AO classification system in order to emphasize that MISS is suitable for distraction, translocation, and complex injuries as well. We presented our early experience of percutaneous transpedicular screw fixation MISS in patients with thoracolumbar region traumatic fractures and included patients of type A1, A2, A3, A4, B and C of AO spine classification. In addition, we evaluated the correlation between fracture severity as per the thoracolumbar injury classification severity (TLICS) score and ODI.

MATERIALS AND METHODS

Study Design & Settings

A prospective study descriptive case series was carried out at the Department of Neurosurgery, Allama Iqbal Medical College (AIMC), Jinnah Hospital Lahore (JHL) from July 2019 to February 2020. 20 patients met inclusion criteria and were included with written and informed consents. A prior institutional ethical review approval was taken.

Preoperative Clinical Data

All patients were managed at the local physiotherapy and rehabilitation centre. Detailed history, clinical examination, X-Ray, CT scan and MRI of dorso-lumbar spine were obtained from all cases preoperatively. The following data was collected on our proforma: age, sex, mechanism of injury, level of injury, AO classification, thoracolumbar injury severity classification (TLICS) score and intraoperative complications. The type of fracture was documented according to the AO Spine Classification Group. The Thoracolumbar injury classification system (TLICS) score was used to classify fracture severity. This score assess the overall injury by looking at 3 independent predictors pertaining to the fracture including fracture morphology, neurological injury/status, and posterior ligamentous complex (PLC) damage.¹⁰ The TLICS score from 0 to 3

recommends a constructive management, whilst greater than 4 suggests an operative intervention. However, a score of 4 is left to the surgeon's discretion.¹⁰

Inclusion

Male and female patients of all age groups were included who had a traumatic thoracolumbar fracture requiring surgical stabilization by posterior fixation.

Exclusion Criteria

Those patients were excluded, who required an ICU admission for any involvement of the vital organ. Cases of polytrauma, non-traumatic fracture etiology such as osteoporosis and tuberculosis, coagulopathy not corrected at the time of surgery, open fracture and multiple level fractures needing long segment fixation, were excluded. All patients who had a confirmed injury to the posterior ligamentous complex were also excluded.

Surgical Technique for Percutaneous Transpedicular Fixation

Patient was placed in prone position on Wilson frame. Level of fixation was identified with the help of a fluoroscope (**Figure 1**). The junction of the transverse process and pedicle were marked on the skin under fluoroscope and a 1-2 cm incision is made. Skin, subcutaneous tissue and muscles were opened. Jamshidi needle was used under fluoroscopic guidance to navigate the desired pedicle (**Figure 2**). Stylet of Jamshidi needle was removed and guide wire was introduced. Then sequential dilators were passed followed by tapping of the pedicle (**Figure 3**). Appropriate length and diameter of the screw were finalized, and fixation was done (**Figure 4**). Same steps were followed on all the levels and subsequently connecting rods were passed and secured.



Figure 1: Pedicle marking under fluoroscopic guidance.

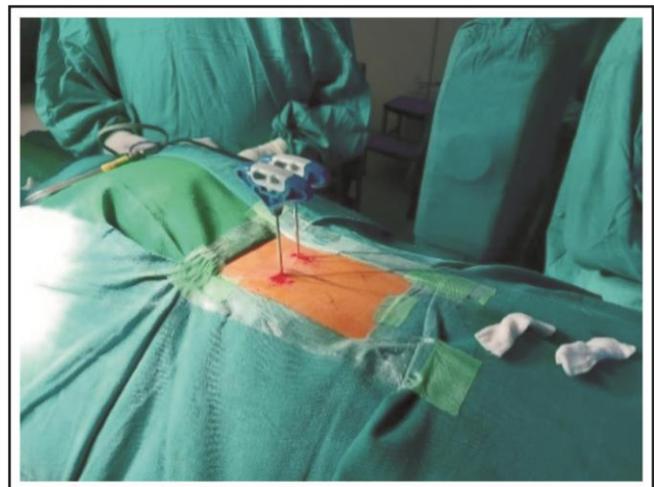


Figure 2: Jamshidi Needle in Pedicle.

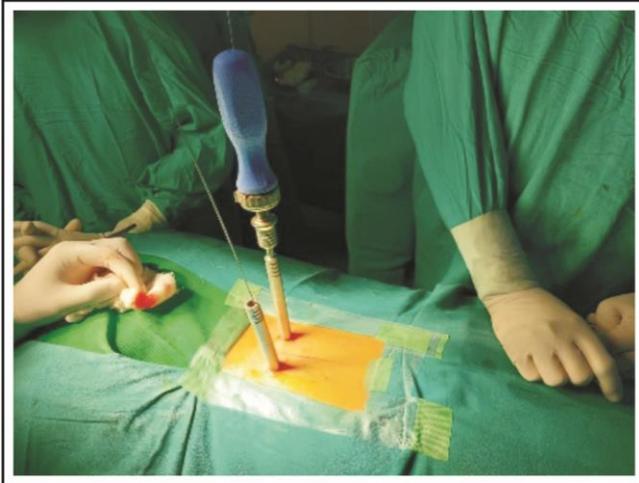


Figure 3: Sequential Dilators by Tapping Pedicle.

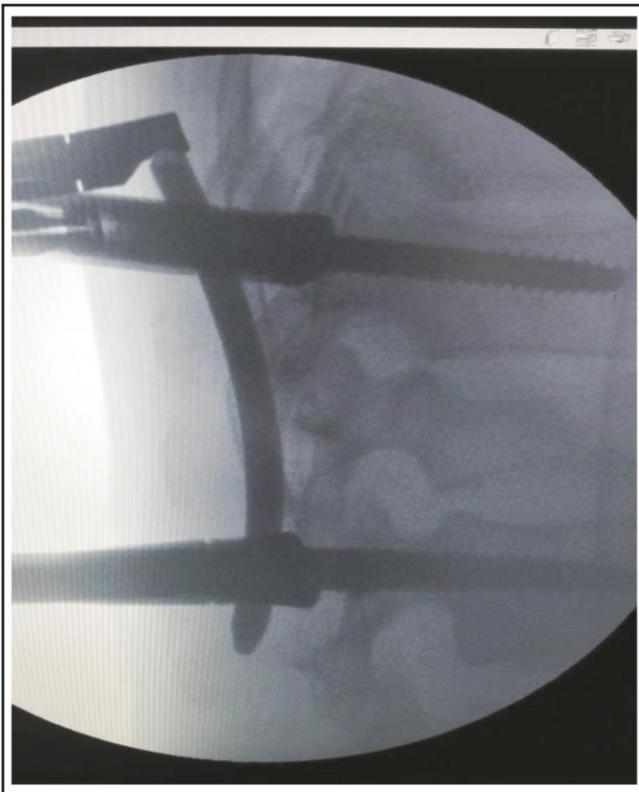


Figure 4: Connecting Rods.

Pre- and Post-Procedural Evaluations

Oswestry disability index (ODI) questionnaire was used to assess functional outcomes. This questionnaire records ten parameters with each parameter assessing the activities of a daily living.

Each parameter scored from 0 to 5, with 0 representing the normal activity and 5 representing the maximum disability.¹¹ The index is calculated by dividing the patient score by the total score, and multiplying this by 100. The questionnaire was filled at 1 week, 1 month, 3 months and 6 months following discharge. The interpretation of this score was based on the following scale: Minimal disability: 0 to 20%; minimal disability: 21 to 40%; moderate disability: 41 to 60%; severe disability: 61 to 80%, crippled and bed bound: 81 to 100%.¹¹ The Oswestry score was documented 1 week after discharge and then 1, 3, and 6-months following discharge as was neurology status.

The Visual Analogue Scale (VAS) is a subjective and valid measure to assess both acute and chronic pain where a patient rates their pain on a scale of 0 to 10 (0: no pain; 1 – 3: mild pain; 4 – 5: moderate pain; 6-7: severe pain; 8-9: very severe pain; & 10: excruciating pain) along a 10 centimetre line.¹² Screw placement was confirmed with post-operative CT scan. The VAS score was documented a day prior to surgery and on the first postoperative day.

Patients' complications and neurological status were noted. Patients were followed up for up to 6 months.

Statistical Analysis & Correlations

The descriptive statistics (mean/ minimum/ maximum) including frequencies were calculated for all relevant parameters. Kendall's tau correlations were conducted for fracture morphology vs. Oswestry disability index (ODI) scale & age and between VAS scores vs. age). Spearman's rho correlations were conducted for i.e., fracture morphology vs. gender and VAS scores vs. gender). Pearson correlations were conducted for ODI scores vs. age. Point biserial correlations were conducted for gender vs. ODI scores.

RESULTS

General Clinical Information

Mean age of the patients was 34.45 ± 11.70 years. The maximum age was 70 years and minimum age was 18 years. There were 6 (30%) female and 14 (70%) male patients. 17 (85%) patients' injury was reported from 'fall from height', whereas, 3 (15%) patients' injury's cause was from the 'road/traffic accident'.

The most common (11 patients, 55%) level of fracture was the dorsal-lumbar junction (T12 – L1). 3 (15%) patients reported A1 fracture, 6 (30%) reported A3, 6 (30%) reported A4, 1 (5%) reported B and 4 (20%) reported C fracture type.

The type C fracture' three patients had a translational/rotational fracture morphology and one patient was with the distraction morphology (**Table 1**). Burst type of morphology was reported in maximum number of patients (13, 65%). As per neurological status, intact neurology was reported in most of the patients (11, 55%) (**Table 1**).

Information on Scores (VAS, TLIC & ODI Scores)

Table 2 shows the detail of VAS, TLIC and

Oswestry disability index (ODI) scores. It is observed that the ODI score's mean percentage decreased from 40% to 23% during the first week to six months, which indicates an improvement in the disabilities. **Table 3** shows the distribution of the ODI scores (at: 1 week, 1 month, 3 months & 6 months) in following categories: bed bound, crippled, minimal, moderate and severe. 40-65% patients were found in the category of 'minimal' in one week, one month, three months and six months, respectively. Less number of patients were found in the 'severe' category. **Table 4** illustrates frequency of TLICS scores. TLIC scores 4 and 7 were reported in the majority (35%) of the patients. Six patients had a complete cord injury and amongst them the average disability score was 74.67% at 1 week after discharge. At 6 months the average disability in this group was 53.55%. Type C fracture patients reported average 66.5% disability at 1 week and 56.5% at 6 months following discharge. **Table 4** also highlights the average frequency of VAS scores pre and postoperatively. It was observed that postoperatively lower VAS scores had a much higher frequency. Majority patients (30%) were having VAS 4 preoperatively, whereas, majority patients were having VAS 3 (postoperatively).

Table 1: Type of Fracture and Fracture Morphology (n = 20).

Type of Fracture	Frequency n(%)	Fracture Morphology	Frequency n(%)	Neurological Status	Frequency n(%)
A1	3 (15%)	Compression	2 (10%)	Intact	11 (55%)
A3	6 (30%)	Burst	13 (65%)	Complete Cord Injury	6 (30%)
A4	6 (30%)	Translational/Rotational	4 (20%)	Incomplete Cord Injury	3 (15%)
B	1 (5%)	Distraction	1 (5%)		
C	4 (20%)				

Table 2: Minimum & Maximum Values of Scores.

VAS (Pre-surgery)		VAS (1 st Post-op)		TLIC		OSWESTRY (%) (1 Week)			OSWESTRY (%) (1 Month)			OSWESTRY (%) (3 Months)			OSWESTRY (%) (6 Months)		
Min	Max	Min	Max	Min	Max	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2	10	0	4	2	8	8	90	40.15±28.5	3	90	33.9±29.93	4	90	27.4±25.51	2	80	23.2±26.28

Statistical Correlations

According to Kendall’s tau correlation test, a significant moderate, positive correlations were found between Fracture Morphology and Oswestry disability index (ODI) scale at 1 week, 1 month and 3 months, in following p-values: 0.011, 0.010, 0.016 & 0.004, respectively (Table 5).

According to Point-Biserial correlation test, a significant correlations were found between gender and ODI scores at 1 week, 1 month, 3 months and 6 months in following p-values: 0.030, 0.037, & 0.037, respectively (Table 6). The VAS scores were not significantly associated with age or gender (Table 7).

Complications

All patients had an accurate screw trajectory postoperatively and no postoperative complications were documented. Neurology was stable for all patients at 1, 3 and 6 months.

Table 3: Oswestry Disability Index (ODI) Score (Frequencies & Percentages).

Category	OSWESTRY (1 week) n(%)	OSWESTRY (1 month) n(%)	OSWESTRY (3 months) n(%)	OSWESTRY (6 months) n(%)
Bed bound	2 (10%)	2 (10%)	1 (5%)	-
Crippled	5 (25%)	3 (15%)	1 (5%)	2 (10%)
Minimal	8 (40%)	12 (60%)	12 (60%)	13 (65%)
Moderate	4 (20%)	-	2 (10%)	3 (15%)
Severe	1 (5%)	3 (15%)	4 (20%)	2 (10%)

Table 4: Frequencies and Percentages of TLIC Score.

TLIC Score	Frequency (n, %)	VAS Score (Pre Surgery)	Frequency (n, %)	VAS Score (First Post-Op)	Frequency (n, %)
2.00	2 (10%)	2.00	3 (15%)	0.00	2 (10%)
3.00	2 (10%)	3.00	3 (15%)	1.00	5 (25%)
4.00	7 (35%)	4.00	6 (30%)	2.00	5 (25%)
6.00	1 (5%)	5.00	4 (20%)	3.00	7 (35%)
7.00	7 (35%)	6.00	2 (10%)	4.00	1 (5%)
8.00	1 (5%)	7.00	1 (5%)	Total	20 (100%)
Total	20 (100%)	10.00	1 (5%)		
		Total	20 (100%)		

Table 5: Correlations: Fracture Morphology vs. ODI Scores, Age and Gender.

Correlation (Kendall’s Tau)	Correlation Co-Efficient	p-value	Strength, Direction
Fracture Morphology vs. ODI (1 week)	0.476	0.011*	Moderate, positive
Fracture Morphology vs. ODI (1 month)	0.482	0.010*	Moderate, positive
Fracture Morphology vs. ODI (3 months)	0.450	0.016*	Moderate, positive
Fracture Morphology vs. ODI 6 months)	0.549	0.004*	Moderate, positive
Fracture Morphology vs. Age	0.263	0.162	-
Correlation (Spearman’s rho)	Correlation Co-Efficient	p-value	Strength, Direction
Fracture Morphology vs. Gender	0.045	0.852	-

* Statistically significant result

Table 6: Correlations: ODI vs. Age and Gender.

Correlation (Pearson's)	Correlation Co-efficient	p-value
ODI (1 week) vs. Age	-0.090	0.707
ODI (1 month) vs. Age	-0.039	0.869
ODI (3 months) vs. Age	-0.204	0.388
ODI (6 months) vs. Age	-0.022	0.928
Correlation (Point Biserial)	Correlation Co-efficient	p-value
ODI (1 week) vs. Gender	-0.485	0.030*
ODI (1 month) vs. Gender	-0.469	0.037*
ODI (3 months) vs. Gender	-0.468	0.037*
ODI (6 months) vs. Gender	-0.422	0.064

* Statistically significant result

Table 7: Correlations: VAS vs. Age and Gender.

Correlation (Kendall's Tau)	Correlation Co-efficient	p-value
VAS (pre surgery) vs. Age	-0.282	0.108
VAS (1 st Post Op) vs. Age	-0.276	0.125
Correlation (Spearman's rho)	Correlation Co-efficient	p-value
VAS (pre surgery) vs. Gender	-0.010	0.968
VAS (1 st Post Op) vs. Gender	-0.187	0.431

DISCUSSION

Thoracolumbar fractures account for a major share in spinal column fractures and are a major cause of morbidity. A controversy still exists regarding the effectiveness of MISS approach for thoracolumbar fractures with an incomplete spinal cord injury, as the open technique is usually favoured to decompress the spinal canal, which offers a chance of neurological improvement.¹³ We propose on the principle of ligamentotaxis, MISS can result in the spinal canal returning to a normal diameter and thus the approach will serve the purpose of the decompression that is achieved through an open technique. We had excluded all patients in whom the posterior ligamentous complex was known to be damaged. Hence, an intact ligamentous complex is a key to ligamentotaxis during reduction and fixation through percutaneous

transpedicular screw fixation MISS approach. Patients with an incomplete spinal cord injury had historically warranted an open approach to achieve decompression and fixation, as it is believed that if the canal diameter were compromised secondary to fractured bony pieces, then an open posterior decompression would relieve the neural elements and fixation could be performed at the same time.¹³ Patients with a complete spinal cord injury are usually operated through an open technique in developing countries like Pakistan. Of the 6 patients, who had a complete cord injury, there was an average Oswestry disability index (ODI) score of 74.67% at 1 week, which had reduced to 53.33% at 6 months following discharge. This suggests a better quality of life for a complete cord injury.

Over the past decade, MISS has gained popularity for A1 and A2 fractures, which have a minimal bony deformity.¹⁴⁻¹⁵ Court and Vincent (2012)¹⁶ discussed through a systematic and mentioned that, on the basis of ligamentotaxis and the fact that owing to the nature of injury in A1 and A2 fractures, patients tend to be neurologically intact and there is spinal alignment. In A1 and A2 fractures, the fracture displacement is minimal and thus alignment is more likely to occur generally, which may be beneficially given the narrow operating corridor of MISS approach. The severe bony deformity, translational and rotational features seen in A3, A4, B, and type C fractures had made open techniques a preferred approach as these fractures were considered a contraindication for MISS approach.¹⁶ These fracture morphologies are more likely to lead to canal compression and warrant an open approach such as laminectomy and open fixation. We proposed that in such classifications, utilizing the MIS technique would lead to ligamentotaxis and hence the restoration of canal diameter. We believed that if neurology is likely to remain stable when MISS is employed successfully as would be the case with an open approach, then the MISS approach would be

superior as among many reasons, it would reduce the duration of hospitalization and will have a less surgical morbidity associated with an open approach.

Our study reported an improvement in the functional status of patients after MISS in all types of AO classification fractures, particularly A3, A4, B and type C fractures. Among four patients with type C fractures, three had a translational/rotational fracture morphology and one had a distraction morphology. The average disability at one week following discharge was 66.5%, which was reduced to 56.5% at six months. Thus, this approach is beneficial for all types of thoracolumbar fractures. Type C injuries are generally considered to warrant an open approach as these are severe injuries, however, we reported that four of our patients who were operated with MISS approach, reported an improved quality of life as demonstrated by an improvement in their ODI at 6 months. These patients did not have any intraoperative complications and screw trajectory was also found to be accurate. We found that fracture morphology was significantly positively correlated with ODI scores from one week to six months. Because those with A1 fractures generally had a less damaging fracture morphology, they did better in terms of disability at 6 months, however those with type C fractures that had a more damaging morphology such as translational and rotational injuries, these patients also benefitted from MISS as their average ODI scores dropped from 66.5% to 56.5% over 6 months. Open fixation of traumatic thoracolumbar fractures is a standard surgical treatment, but these techniques are known to cause pain due the requirement of substantial dissection to access pedicles activates pain receptors.¹⁷ The open approach prolongs the operation time and hospital stay and is associated with the increased blood loss and a higher infection rate with meaningful post-operative muscle atrophy and pain.⁷ This mechanism of the prolonged post-operative muscle pain and

disability is the result of the dissection of the paraspinal muscle, which may lead to denervation, ischemia and necrosis of the muscles and revascularisation injury.¹⁸ Scarring and atrophy of muscles has also been reported.¹⁷ In the international literature, the paradigm for treating these fractures is rapidly changing as surgeons are adopting MISS approaches. Percutaneous pedicle screw fixation MISS has emerged as a safe option, which minimizes the morbidity associated with an open approach.¹⁸ In addition, there is a reduced postsurgical inflammatory response.¹⁹

The smaller incision, minimum muscle dissection, lack of manipulation of posterior vertebral elements & ligaments, reduced intraoperative bleeding, improved postoperative muscle strength along with a reduced exposure to anesthesia, a quicker recovery, early mobilization and reduced hospital stay are all favourable outcomes. MISS seems to be beneficial as it reduces the length of stay, blood loss, and post-operative pain and hence favours an early return to work benefits.²⁰ However, the reported disadvantages include injury to the nerve roots and spinal cord, pedicle fracture, cerebrospinal fluid fistula and lack of bony fusion.²¹ These can be credited to the rather a steep initial learning curve. However, we did not encounter any of these such complications in current case series owing to our gradual shift in adopting MISS. In addition to these immediate post-operative comparative parameters, modern surgery should (where possible), favour an early return to work. Comparative studies have shown that long term clinical, functional, and radiological results were at least as favorable for MISS as those with an open approach.^{15, 22} Thus, it is desirable to adopt MISS approach as the perioperative comparisons yielded more advantages, especially a reduced hospital can be a very important factor for a patient, especially in a lower middle income like Pakistan where economic opportunity is under-sized. Although,

our data was limited and pertaining to only 20 patients, it provided encouraging results to the surgeons who wishing to adopt the MISS approach, which is only in its infancy nationally. The surgical team recommends that there is a steep learning curve associated with such a technique and before moving to A3, A4, B and C fractures a surgeon should practice the technique on at least 50 cases of A1 and A2. However, this is only our own subjective evaluation and not prescriptive.

CONCLUSION & RECOMMENDATION

Percutaneous transpedicular screw fixation can be a viable approach for thoracolumbar burst fractures with intact posterior ligamentous complex in all types of thoracolumbar fractures, including type C and leads to an improvement the quality of life.

Further multicentre, randomised trials with long term follow up are required in our population to affirm our conclusions. Fracture morphology has a significantly positive correlation with a higher disability index score, with more severe fracture morphologies as per the TLICS score having a higher disability.

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Additional Information

Disclosures: Authors report no conflict of interest.

Ethical Review Board Approval: The study was conformed to the ethical review board requirements.

Human Subjects: Consent was obtained by all patients/participants in this study.

Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Usman Ahmad Kamboh	Study design and methodology.
2.	Mehreen Mehboob	Methodology and data collection.
3.	Mohammad Ashraf	Data calculations and paper writing.
4.	Saman Shahid	Analysis of data and paper writing.
5.	Kashif Ali Sultan	Interpretation of results and Literature review.
6.	Muhammad Asif Raza	Literature review.
7.	Syed Shahzad Hussain	Literature review.
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