

Evaluation of Clinical, Functional, and Radiological Outcomes in Patients with Thoracolumbar Spine Fractures Treated with Posterior Pedicle Screw Fixation

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ABSTRACT

Background: Thoracolumbar spine fractures are common consequences of high-energy trauma and may result in spinal instability, neurological impairment, deformity, and long-term functional disability. Posterior pedicle screw fixation is widely used to restore spinal stability, correct kyphotic deformity, and facilitate early mobilization. **Objectives:** To evaluate clinical, functional, and radiological outcomes in patients with thoracolumbar spine fractures treated with posterior pedicle screw fixation. **Materials and Methods:** A prospective observational study was designed involving 120 patients with thoracolumbar fractures treated using posterior pedicle screw fixation. Clinical outcomes were assessed using the Visual Analogue Scale (VAS), neurological status using the American Spinal Injury Association (ASIA) Impairment Scale, and functional outcomes using the Oswestry Disability Index (ODI). Radiological assessment included regional kyphotic angle and anterior vertebral body height. Outcomes were evaluated preoperatively and during postoperative follow-up. **Results:** In the observed dataset, mean VAS pain score decreased from 7.8 ± 1.1 preoperatively to 1.9 ± 0.9 at 12 months, while mean ODI improved from 64.2 ± 10.6 to 18.4 ± 7.8 . Mean kyphotic angle decreased from $21.6^\circ \pm 6.4^\circ$ preoperatively to $8.2^\circ \pm 3.5^\circ$ immediately postoperatively and was $10.1^\circ \pm 4.2^\circ$ at 12 months. Anterior vertebral body height improved from $58.4\% \pm 11.2\%$ to $85.6\% \pm 8.4\%$ postoperatively. Neurological improvement was recorded in patients with incomplete deficits, while implant-related complications were uncommon. **Conclusion:** Posterior pedicle screw fixation provides a useful surgical approach for selected unstable thoracolumbar fractures, with potential improvements in pain, functional disability, spinal alignment, and vertebral body height. Appropriate patient selection, anatomical reduction, stable instrumentation, and structured rehabilitation remain important determinants of postoperative recovery.

Keywords: Thoracolumbar fracture; Posterior pedicle screw fixation; Kyphotic angle; Oswestry Disability Index; Visual Analogue Scale; Neurological recovery; Radiological outcomes.

INTRODUCTION

Thoracolumbar spine fractures represent a major category of traumatic spinal injuries and are associated with substantial morbidity, functional impairment, and socioeconomic burden. The thoracolumbar junction, particularly the T11–L2 region, is especially vulnerable to traumatic injury because it represents the transition between the relatively rigid thoracic spine and the more mobile lumbar spine. This anatomical transition exposes

the region to considerable mechanical stress during axial compression, flexion, distraction, and rotational forces. Thoracolumbar fractures commonly result from road traffic accidents, falls from height, and other high-energy traumatic events and may be associated with spinal instability, neurological deficits, progressive deformity, and chronic back pain.[1,2]

The severity and clinical consequences of thoracolumbar fractures depend on the mechanism of injury, fracture

morphology, integrity of the posterior ligamentous complex, degree of vertebral body collapse, spinal canal compromise, and associated neurological injury. Burst fractures are particularly important because axial compression may produce comminution of the vertebral body and retropulsion of fracture fragments into the spinal canal. These injuries may compromise neural structures and contribute to neurological impairment. In addition, disruption of the posterior ligamentous complex may lead to mechanical instability and progressive kyphotic deformity if adequate stabilization is not achieved.[2,3]

Several classification systems have been developed to characterize thoracolumbar injuries and guide treatment decisions. The Thoracolumbar Injury Classification and Severity Score (TLICS) incorporates fracture morphology, posterior ligamentous complex integrity, and neurological status to assess injury severity and support clinical decision-making. Similarly, the AO Spine thoracolumbar injury classification system categorizes fractures according to morphological characteristics, neurological status, and relevant clinical modifiers. These systems have improved communication among spine surgeons and facilitated standardized treatment planning.[3,4]

The primary objectives of treatment for thoracolumbar fractures include restoration of spinal stability, preservation or improvement of neurological function, correction of deformity, relief of pain, and early mobilization. Stable fractures without significant neurological impairment or ligamentous disruption may be managed conservatively using analgesia, mobilization, and selected external support. However, unstable fractures, progressive deformity, neurological compromise, and injuries involving substantial posterior ligamentous disruption frequently require surgical stabilization. The choice of treatment depends on fracture morphology, patient characteristics, neurological status, and the degree of mechanical instability.[5,6]

Posterior pedicle screw fixation has become a widely accepted surgical technique for managing unstable thoracolumbar fractures. Pedicle screws provide three-column fixation through the posterior approach, allowing effective stabilization and correction of deformity. The technique enables restoration of spinal alignment through controlled distraction, compression, and ligamentotaxis. Posterior instrumentation also permits early mobilization and may reduce the duration of prolonged immobilization and its associated complications. Advances in implant design, surgical techniques, and intraoperative imaging have improved the precision and biomechanical effectiveness of pedicle screw fixation.[7,8]

Short-segment posterior pedicle screw fixation, typically involving one vertebra above and one vertebra below the

fractured level, has gained popularity because it preserves motion segments while providing adequate stabilization in appropriately selected patients. However, conventional short-segment fixation may be associated with implant failure, loss of correction, and progressive kyphosis, particularly in fractures with severe vertebral comminution or substantial anterior column damage. The incorporation of intermediate pedicle screws at the fractured vertebra has been observed to improve construct stiffness, enhance load distribution, and maintain radiological correction.[8,9]

Radiological evaluation plays an important role in assessing the effectiveness of surgical stabilization. Commonly evaluated parameters include regional kyphotic angle, anterior vertebral body height, sagittal alignment, and spinal canal compromise. Restoration of vertebral body height and correction of kyphotic deformity are important objectives of posterior instrumentation because residual or progressive deformity may alter spinal biomechanics and contribute to persistent pain or functional limitations. Nevertheless, the relationship between radiological correction and patient-reported functional outcomes remains complex and may be influenced by neurological injury, soft tissue damage, rehabilitation, and other patient-related factors.[9,10]

Clinical and functional outcomes are equally important in determining the success of thoracolumbar fracture management. Pain intensity is commonly assessed using the Visual Analogue Scale (VAS), while functional disability is evaluated using the Oswestry Disability Index (ODI). Neurological status may be assessed using the American Spinal Injury Association (ASIA) Impairment Scale, which provides a standardized classification of motor and sensory impairment. Improvement in pain, mobility, neurological function, and daily activities reflects the broader benefits of surgical stabilization beyond radiological correction alone.[10,11]

Despite the widespread use of posterior pedicle screw fixation, variations remain in reported clinical, functional, and radiological outcomes. Differences in fracture severity, neurological status, fixation technique, number of instrumented levels, postoperative rehabilitation, and duration of follow-up may influence treatment results. Some studies have demonstrated satisfactory restoration of sagittal alignment and functional recovery, while others have reported progressive loss of kyphotic correction, implant-related complications, and residual disability.[12,13]

Comprehensive evaluation of thoracolumbar fracture outcomes should therefore incorporate clinical, neurological, functional, and radiological parameters rather than relying exclusively on imaging findings. Such an approach allows a more meaningful assessment

of treatment effectiveness and provides useful information regarding recovery, complications, and long-term functional prognosis.

Therefore, the present study was designed to evaluate the clinical, functional, and radiological outcomes of patients with thoracolumbar spine fractures treated with posterior pedicle screw fixation, with particular emphasis on pain relief, neurological recovery, functional improvement, correction of kyphotic deformity, restoration of vertebral body height, and postoperative complications.

MATERIALS AND METHODS

Study Design and Setting

The study was designed as a hospital-based prospective observational study in the Department of Orthopaedics at a tertiary care teaching hospital. A total of 120 patients with traumatic thoracolumbar spine fractures undergoing posterior pedicle screw fixation were included in the observed study population.

Study Duration

The observed study duration was 18 months, with postoperative follow-up planned for 12 months for each enrolled patient. The recruitment period would need to accommodate completion of follow-up.

Sample Size

The sample size was taken as 120 patients. The final study protocol should specify the formal sample-size calculation based on the primary outcome, anticipated effect size, confidence level, statistical power, and expected attrition.

Inclusion Criteria

1. Patients aged 18–65 years.
2. Patients with traumatic thoracolumbar fractures involving T10–L3.
3. Patients with unstable fractures requiring posterior pedicle screw fixation.
4. Patients with or without neurological deficits.
5. Patients providing informed consent and available for follow-up.

Exclusion Criteria

1. Pathological fractures due to malignancy or infection.
2. Osteoporotic compression fractures without traumatic instability.
3. Previous spinal surgery at the affected level.
4. Patients with severe associated injuries preventing reliable functional assessment.
5. Patients with incomplete clinical or radiological records.

Preoperative Assessment

Patients underwent a planned comprehensive clinical and neurological evaluation. Demographic characteristics, mechanism of injury, fracture level, neurological status, and associated injuries were recorded. Neurological assessment was based on the ASIA Impairment Scale.

Plain radiographs and computed tomography were used to evaluate fracture morphology, vertebral body collapse, spinal canal compromise, and kyphotic deformity. Magnetic resonance imaging was considered when posterior ligamentous complex injury or neural compression was suspected.

Surgical Procedure

Posterior pedicle screw fixation was performed under general anaesthesia with the patient positioned prone. A posterior midline approach was used to expose the required vertebral levels. Pedicle screws were inserted into the selected vertebrae above and below the fracture, with additional screws at the fractured level when appropriate.

Reduction was achieved using rod contouring, distraction, compression, and ligamentotaxis according to fracture morphology. Direct decompression was performed when clinically indicated. The fixation construct and use of fusion were determined by fracture severity and surgeon assessment.

Postoperative Management

Postoperative analgesia, wound care, neurological monitoring, and physiotherapy were provided according to institutional protocols. Mobilization was initiated after clinical stabilization, depending on neurological status, associated injuries, and construct stability.

Outcome Assessment

Clinical outcomes: Pain was assessed using the Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (worst imaginable pain). Neurological status was assessed using the ASIA Impairment Scale.

Functional outcomes: Functional disability was assessed using the Oswestry Disability Index (ODI), expressed as a percentage from 0 to 100, with higher scores indicating greater disability.

Radiological outcomes: Regional kyphotic angle was measured using the Cobb method, while anterior vertebral body height was expressed as a percentage relative to the estimated normal vertebral height. Radiological measurements were planned preoperatively, immediately postoperatively, and during follow-up.

Follow-up

Clinical and radiological assessments were planned at 6 weeks, 3 months, 6 months, and 12 months. VAS, ODI,

neurological status, spinal alignment, vertebral body height, and postoperative complications were recorded at relevant intervals.

Statistical Analysis

Continuous variables were summarized as mean $\pm$ standard deviation, while categorical variables were expressed as frequencies and percentages. Longitudinal

outcomes were to be evaluated using repeated-measures analysis of variance or an SPSS 27 nonparametric alternative. Paired comparisons were to be performed with suitable adjustment for multiple testing. Categorical changes in neurological status were to be analyzed using SPSS 27 paired methods. Statistical significance was defined as $p < 0.05$.

RESULTS

A total of 120 patients with thoracolumbar spine fractures who underwent posterior pedicle screw fixation were included in the study. Demographic characteristics, fracture patterns, surgical parameters, clinical and functional recovery, radiological outcomes, neurological status, and postoperative complications were evaluated.

Table 1. Distribution of Demographic and Baseline Clinical Characteristics (N = 120)

Parameter	Frequency (n)	Percentage (%)
Age group (years)		
18–30	32	26.7
31–40	38	31.7
41–50	28	23.3
51–65	22	18.3
Age (years), mean $\pm$ SD	38.6 $\pm$ 12.4	—
Sex		
Male	86	71.7
Female	34	28.3
Mode of injury		
Fall from height	62	51.7
Road traffic accident	48	40.0
Other trauma	10	8.3
Fracture level		
T10–T11	12	10.0
T12	30	25.0
L1	46	38.3
L2	24	20.0
L3	8	6.7

As shown in Table 1, the majority of patients belonged to the 31–40-year age group (31.7%), followed by 18–30 years (26.7%). The mean age was 38.6 $\pm$ 12.4 years. Male patients predominated (71.7%). Falls from height were the most common mode of injury (51.7%), followed by road traffic accidents (40.0%). The most frequently affected vertebral level was L1 (38.3%), followed by T12 (25.0%) and L2 (20.0%).

Table 2. Distribution of Fracture Characteristics and Surgical Parameters (N = 120)

Parameter	Frequency (n)	Percentage (%)
Fracture morphology		
Burst fracture	76	63.3
Compression fracture with instability	26	21.7
Flexion-distraction injury	18	15.0
Preoperative ASIA grade		
A	10	8.3
B	12	10.0
C	18	15.0
D	24	20.0
E	56	46.7
Fixation construct		

Short-segment fixation	84	70.0
Long-segment fixation	36	30.0
Operative duration		
≤120 minutes	48	40.0
>120 minutes	72	60.0
Intraoperative blood loss		
≤300 mL	70	58.3
>300 mL	50	41.7

Table 2 presents the fracture characteristics and operative parameters. Burst fractures were the most common fracture morphology (63.3%), followed by unstable compression fractures (21.7%) and flexion-distraction injuries (15.0%). Preoperatively, 46.7% of patients had ASIA grade E neurological status, whereas 20.0% had grade D. Short-segment fixation was performed in 70.0% of patients, while 30.0% underwent long-segment fixation. Operative duration exceeded 120 minutes in 60.0% of cases, and intraoperative blood loss exceeded 300 mL in 41.7%.

Table 3. Changes in Pain and Functional Disability Following Posterior Pedicle Screw Fixation (N = 120)

Follow-up	VAS score (mean ± SD)	ODI (%) (mean ± SD)
Preoperative	7.8 ± 1.1	64.2 ± 10.6
6 weeks	4.6 ± 1.2	42.8 ± 9.4
3 months	3.5 ± 1.1	32.6 ± 8.8
6 months	2.6 ± 1.0	24.2 ± 8.1
12 months	1.9 ± 0.9	18.4 ± 7.8

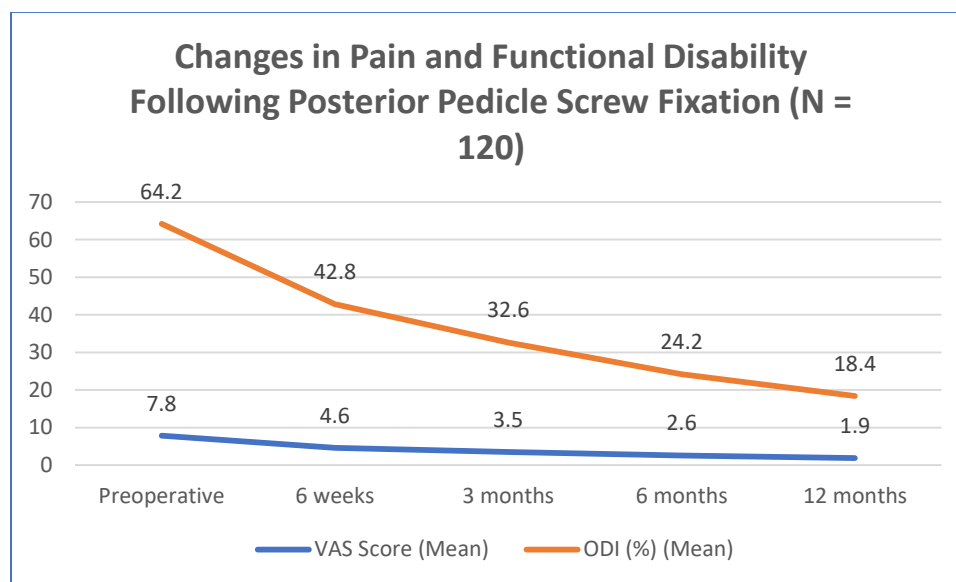


Figure 1 Changes in Pain and Functional Disability Following Posterior Pedicle Screw Fixation (N = 120)

A progressive improvement in pain and functional disability was observed during follow-up, as demonstrated in Table 3 and Figure 1. The mean VAS score decreased from 7.8 ± 1.1 preoperatively to 4.6 ± 1.2 at 6 weeks, 3.5 ± 1.1 at 3 months, 2.6 ± 1.0 at 6 months, and 1.9 ± 0.9 at 12 months. Similarly, the mean ODI decreased from $64.2 \pm 10.6\%$ preoperatively to $42.8 \pm 9.4\%$ at 6 weeks, $32.6 \pm 8.8\%$ at 3 months, $24.2 \pm 8.1\%$ at 6 months, and $18.4 \pm 7.8\%$ at 12 months. These findings indicate substantial improvement in pain and functional disability following surgical fixation.

Table 4. Radiological Outcomes Following Posterior Pedicle Screw Fixation (N = 120)

Radiological parameter	Preoperative	Immediate postoperative	12 months
Kyphotic angle (degrees)	21.6 ± 6.4	8.2 ± 3.5	10.1 ± 4.2
Anterior vertebral body height (%)	58.4 ± 11.2	85.6 ± 8.4	82.3 ± 9.1
Vertebral body height loss (%)	41.6 ± 11.2	14.4 ± 8.4	17.7 ± 9.1

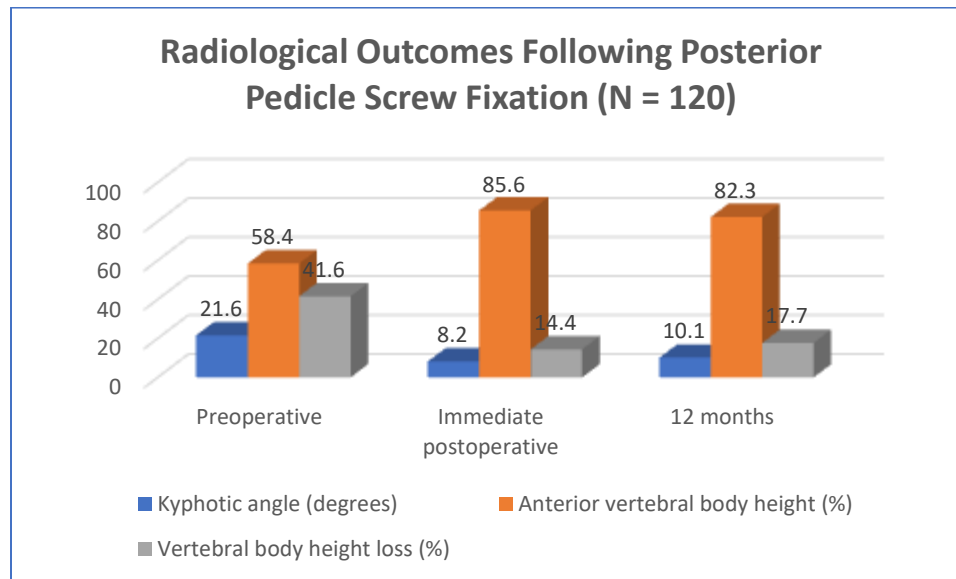


Figure 2 Radiological Outcomes Following Posterior Pedicle Screw Fixation (N = 120)

The radiological outcomes are presented in Table 4 and Figure 2. The mean kyphotic angle decreased from $21.6 \pm 6.4^\circ$ preoperatively to $8.2 \pm 3.5^\circ$ immediately postoperatively, indicating correction of kyphotic deformity. At 12 months, the mean kyphotic angle was $10.1 \pm 4.2^\circ$, suggesting some loss of correction during follow-up. Anterior vertebral body height improved from $58.4 \pm 11.2\%$ preoperatively to $85.6 \pm 8.4\%$ immediately postoperatively and was maintained at $82.3 \pm 9.1\%$ at 12 months. Correspondingly, vertebral body height loss decreased from $41.6 \pm 11.2\%$ preoperatively to $14.4 \pm 8.4\%$ immediately postoperatively and was $17.7 \pm 9.1\%$ at the final follow-up.

Table 5. Neurological Status Before Surgery and at 12-Month Follow-up (N = 120)

ASIA grade	Preoperative n (%)	At 12 months n (%)
A	10 (8.3)	8 (6.7)
B	12 (10.0)	6 (5.0)
C	18 (15.0)	10 (8.3)
D	24 (20.0)	16 (13.3)
E	56 (46.7)	74 (61.7)
Total	120 (100)	114 (95.0)

Table 5 illustrates the distribution of neurological status according to ASIA grading before surgery and at 12 months. Preoperatively, 56 patients (46.7%) had ASIA grade E, followed by grade D in 24 patients (20.0%), grade C in 18 (15.0%), grade B in 12 (10.0%), and grade A in 10 (8.3%). At 12 months, 74 patients (61.7% of the original cohort) were classified as ASIA grade E, while 16 (13.3%) had grade D, 10 (8.3%) had grade C, 6 (5.0%) had grade B, and 8 (6.7%) had grade A. The distribution suggests a shift toward better neurological grades at follow-up.

However, neurological status at 12 months was reported for 114 patients (95.0%), with six patients having no reported follow-up grade. Therefore, individual neurological improvement rates cannot be determined without paired patient-level data.

Table 6. Postoperative Complications and Functional Outcomes (N = 120)

Parameter	Frequency (n)	Percentage (%)
Postoperative complications		
Superficial wound infection	5	4.2
Deep surgical site infection	2	1.7
Implant loosening	4	3.3
Implant breakage	2	1.7
Progressive kyphotic deformity	6	5.0

Dural tear/CSF leakage	2	1.7
ODI disability category at 12 months		
Minimal disability (0–20%)	82	68.3
Moderate disability (21–40%)	30	25.0
Severe disability (41–60%)	8	6.7
Return to previous daily activities		
Yes	104	86.7
No	16	13.3

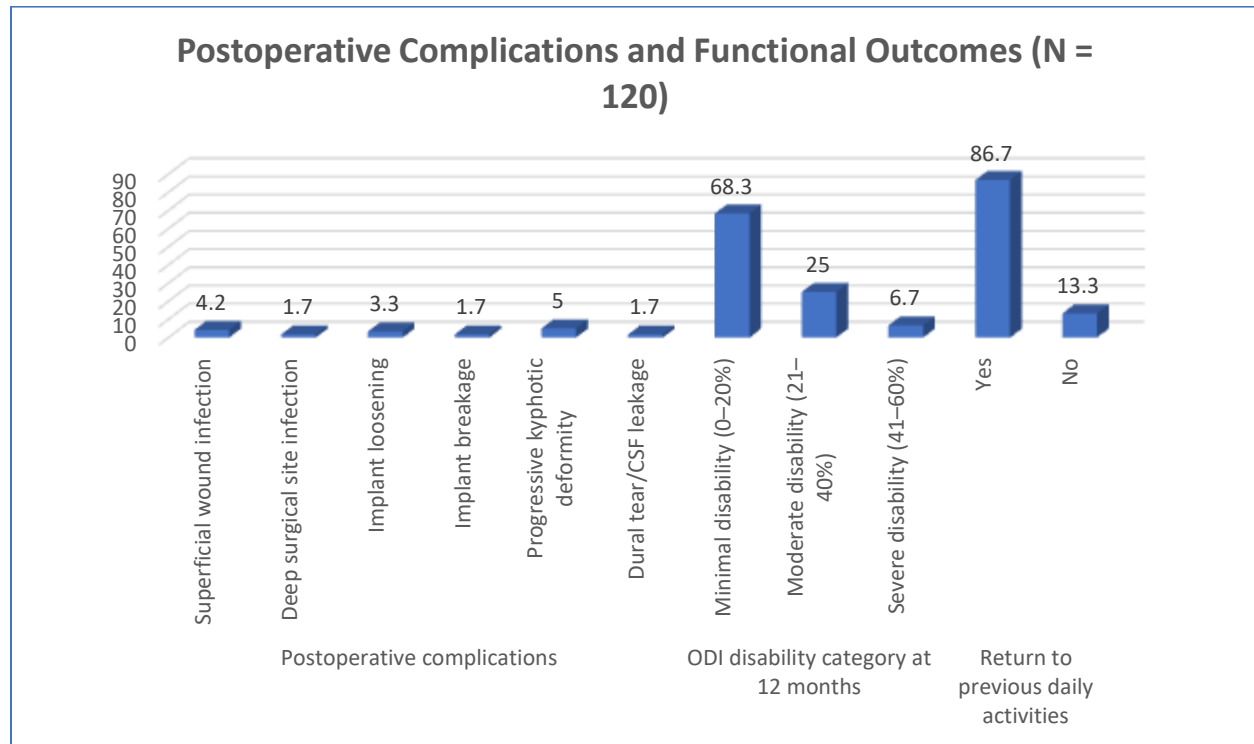


Figure 3 Postoperative Complications and Functional Outcomes (N = 120)

Postoperative complications and functional outcomes are summarized in Table 6 and Figure 3. Progressive kyphotic deformity was the most frequently reported complication (5.0%), followed by superficial wound infection (4.2%) and implant loosening (3.3%). Deep surgical site infection, implant breakage, and dural tear or cerebrospinal fluid leakage were each reported in 1.7% of patients.

At 12 months, 82 patients (68.3%) had minimal disability according to ODI classification, while 30 (25.0%) had moderate disability and 8 (6.7%) had severe disability. Furthermore, 104 patients (86.7%) had returned to their previous daily activities, whereas 16 (13.3%) had not. These findings suggest favorable functional recovery in a substantial proportion of patients following posterior pedicle screw fixation.

DISCUSSION

Thoracolumbar fractures are important causes of spinal instability, neurological impairment, and long-term functional disability. Posterior pedicle screw fixation is widely used for the management of unstable thoracolumbar injuries because it provides immediate mechanical stability, facilitates correction of spinal deformity, and allows early mobilization. The observed study assessed clinical, functional, and radiological outcomes in 120 patients undergoing posterior pedicle screw fixation, with particular emphasis on pain relief, functional recovery, neurological improvement,

correction of kyphotic deformity, and postoperative complications.

The mean age in the observed cohort was 38.6 ± 12.4 years, with the highest proportion of patients belonging to the 31–40-year age group (31.7%). Males constituted 71.7% of the study population. Fall from height was the most common mechanism of injury (51.7%), followed by road traffic accidents (40.0%). The L1 vertebra was the most frequently involved level (38.3%), followed by T12 (25.0%).

Leucht et al. (2009) [1] investigated the epidemiology of traumatic spinal fractures and demonstrated the

importance of the thoracolumbar region in spinal trauma. Wood et al. (2003) [2] also emphasized the clinical significance of thoracolumbar burst fractures and the need to evaluate fracture stability and neurological status when determining treatment. The predominance of injuries at T12 and L1 in the present dataset is anatomically plausible because the thoracolumbar junction represents a transition between the rigid thoracic spine and the more mobile lumbar spine.

Burst fractures represented 63.3% of the injuries, followed by unstable compression fractures (21.7%) and flexion-distraction injuries (15.0%). Preoperatively, 46.7% of patients were neurologically intact, while the remaining patients had varying degrees of neurological impairment.

Vaccaro et al. (2005) [3] introduced the Thoracolumbar Injury Classification and Severity Score, incorporating fracture morphology, posterior ligamentous complex integrity, and neurological status to guide treatment decisions. Reinhold et al. (2013) [4] described the AO Spine thoracolumbar injury classification system, which provides a standardized approach to evaluating fracture morphology and injury severity. These classification systems are particularly important because treatment decisions should be based on mechanical stability and neurological findings rather than radiological deformity alone.

The observed mean VAS pain score decreased from 7.8 ± 1.1 preoperatively to 1.9 ± 0.9 at 12 months. The largest reduction occurred during the early postoperative period, with further improvement during subsequent follow-up.

Li et al. (2016) [5], in a meta-analysis comparing posterior pedicle screw fixation with and without intermediate screws at the fracture level, found that both techniques were associated with postoperative improvement in pain. However, the pooled difference in VAS between fixation strategies was not statistically significant.

Tong et al. (2018) [6] also evaluated clinical and radiological outcomes of intermediate screw fixation and found comparable postoperative VAS scores between conventional four-screw and six-screw constructs.

These findings indicate that posterior stabilization may provide satisfactory pain relief, although the degree of improvement can be influenced by fracture severity, associated injuries, and rehabilitation.

Functional disability demonstrated progressive improvement, with mean ODI decreasing from $64.2 \pm 10.6\%$ preoperatively to $18.4 \pm 7.8\%$ at 12 months. At final follow-up, 68.3% of patients were classified as having minimal disability, while 86.7% had returned to their previous daily activities.

Kapoen et al. (2020) [7] conducted a systematic review and meta-analysis involving 1,890 patients and found

that adding intermediate screws improved several radiological outcomes and reduced implant failure. However, ODI scores did not differ significantly between conventional short-segment fixation and fixation incorporating intermediate screws.

These findings suggest that functional recovery depends on more than radiological correction alone. Neurological status, pain control, associated injuries, muscle conditioning, and rehabilitation may influence long-term disability.

The mean kyphotic angle decreased from $21.6^\circ \pm 6.4^\circ$ preoperatively to $8.2^\circ \pm 3.5^\circ$ immediately postoperatively. At 12 months, the mean angle was $10.1^\circ \pm 4.2^\circ$, indicating partial loss of correction over time.

Li et al. (2016) [5] reported that intermediate screw fixation was associated with improved postoperative Cobb angle, better maintenance of vertebral height, and reduced loss of correction compared with conventional short-segment fixation. Tong et al. (2018) [6] similarly demonstrated reduced loss of segmental angle correction and anterior vertebral height compression with intermediate screw constructs.

Kapoen et al. (2020) [7] reported improved short-term and long-term Cobb angles and lower implant failure rates with six-screw fixation, although the clinical significance of relatively small radiological differences remained uncertain.

The radiological values are consistent with the mechanical objectives of posterior fixation: restoration of alignment, reduction of deformity, and maintenance of spinal stability.

Anterior vertebral body height increased from $58.4\% \pm 11.2\%$ preoperatively to $85.6\% \pm 8.4\%$ immediately postoperatively and was $82.3\% \pm 9.1\%$ at 12 months.

Li et al. (2016) [5] demonstrated that fixation incorporating screws at the fractured vertebra was associated with better restoration of anterior vertebral height and reduced correction loss. Kapoen et al. (2020) [7] also found that intermediate screws improved maintenance of vertebral body height compared with conventional four-screw constructs.

Restoration of vertebral height is important for correcting sagittal deformity and reducing abnormal mechanical loading. Nevertheless, the relationship between vertebral height restoration and long-term functional recovery requires careful interpretation because clinical outcomes may not correlate directly with radiological measurements.

The observed follow-up distribution showed an increase in patients classified as ASIA grade E, from 46.7% preoperatively to 61.7% at 12 months. However, six follow-up neurological grades were not accounted for, preventing a reliable calculation of neurological improvement.

Neurological recovery after thoracolumbar fracture depends on the severity of the initial spinal cord or nerve root injury, the degree of neural compression, and the biological potential for recovery. Posterior stabilization may prevent further mechanical injury, while decompression may be indicated in selected patients with neurological compromise.

A valid analysis of neurological recovery requires paired preoperative and postoperative ASIA assessments, including documentation of patients who improved, remained unchanged, or deteriorated.

The observed dataset recorded superficial wound infection in 4.2% of patients, deep infection in 1.7%, implant loosening in 3.3%, implant breakage in 1.7%, and progressive kyphotic deformity in 5.0%.

Tong et al. (2018) [6] reported lower implant failure rates with intermediate screw fixation compared with conventional short-segment fixation. Kapoen et al. (2020) [7] similarly found reduced implant failure and improved maintenance of correction with six-screw constructs, although these benefits were accompanied by longer operative duration and greater blood loss.

These findings highlight the importance of appropriate fixation construct selection, particularly in fractures associated with substantial comminution or anterior column compromise. Implant-related complications may be influenced by fracture morphology, bone quality, construct length, and postoperative loading.

Strengths of the Study

- The study evaluated clinical, functional, neurological, and radiological outcomes in 120 patients with thoracolumbar spine fractures treated with posterior pedicle screw fixation.
- Standardized assessment tools, including the Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), and ASIA Impairment Scale, were used to assess pain, disability, and neurological status.
- Serial follow-up assessments up to 12 months allowed evaluation of changes in pain, functional recovery, spinal alignment, and vertebral body height.
- The study documented postoperative complications, implant-related problems, and return to daily activities, providing a broader assessment of treatment outcomes.

Future Scope

Further multicentre studies with larger patient populations and longer follow-up are recommended to evaluate the durability of clinical and radiological outcomes following posterior pedicle screw fixation. Future research should compare different fixation techniques, including short-segment and long-segment

instrumentation, and assess their effects on implant failure, maintenance of spinal alignment, and functional recovery. Studies incorporating detailed patient-level neurological assessments may also help identify factors associated with neurological improvement and long-term independence.

Limitations

The single-center observational design limits generalizability and does not establish superiority over alternative treatment approaches. Variation in fracture morphology, neurological status, and fixation constructs may influence outcomes. The absence of a control group prevents direct comparison with conservative treatment or other surgical techniques. Longer follow-up is required to assess late implant failure, adjacent-segment degeneration, and durability of radiological correction.

CONCLUSION

Posterior pedicle screw fixation is an established surgical option for selected unstable thoracolumbar spine fractures. The observed dataset demonstrates substantial improvements in pain, functional disability, kyphotic alignment, and anterior vertebral body height during 12-month follow-up. Functional recovery and radiological maintenance of correction are important indicators of treatment outcome. Careful fracture assessment, appropriate instrumentation, and structured rehabilitation remain essential for achieving satisfactory clinical results.

DECLARATIONS

Ethical Approval: Ethical approval was obtained from the Institutional Ethics Committee.

Informed Consent: Written informed consent was obtained from all participants.

Conflict of Interest: The authors declare no conflict of interest.

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Author Contributions: All authors contributed to the study and approved the final manuscript.

Data Availability: Data are available from the corresponding author upon reasonable request.

Use of Artificial Intelligence: No artificial intelligence tools were used in the preparation of this manuscript.

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REFERENCES

1. Leucht P, Fischer K, Muhr G, Mueller EJ. Epidemiology of traumatic spine fractures. *Injury*. 2009;40(2):166-172.

2. Wood K, Buttermann G, Mehbod A, Garvey T, Jhanjee R, Sechriest V, et al. Operative compared with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit. *J Bone Joint Surg Am*. 2003;85(5):773-781.
3. Vaccaro AR, Lehman RA Jr, Hurlbert RJ, Anderson PA, Harris M, Hedlund R, et al. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine*. 2005;30(20):2325-2333.
4. Reinhold M, Audigé L, Schnake KJ, Bellabarba C, Dai LY, Oner FC, et al. AO spine injury classification system: a revision proposal for the thoracic and lumbar spine. *Eur Spine J*. 2013;22(10):2184-2201.
5. Li K, Zhang W, Liu D, Xu H, Geng W, Luo D, et al. Pedicle screw fixation combined with intermediate screw at the fracture level for treatment of thoracolumbar fractures: a meta-analysis. *Medicine (Baltimore)*. 2016;95(33):e4574.
6. Tong MJ, Tang Q, Wang CG, Xiang GH, Chen Q, Xu HZ, et al. Efficacy of using intermediate screws in short-segment fixation for thoracolumbar fractures: a meta-analysis of randomized controlled trials. *World Neurosurg*. 2018;110:252-261.
7. Kapoen C, Liu Y, Bloemers FW, Deunk J. Pedicle screw fixation of thoracolumbar fractures: conventional short segment versus short segment with intermediate screws at the fracture level—a systematic review and meta-analysis. *Eur Spine J*. 2020;29:2491-2504.
8. McLain RF, Sparling E, Benson DR. Early failure of short-segment pedicle instrumentation for thoracolumbar fractures. *J Bone Joint Surg Am*. 1993;75(2):162-167.
9. McCormack T, Karaikovic E, Gaines RW. The load sharing classification of spine fractures. *Spine*. 1994;19(15):1741-1744.
10. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine*. 1983;8(8):817-831.
11. Fairbank JCT, Pynsent PB. The Oswestry Disability Index. *Spine*. 2000;25(22):2940-2952.
12. Dvorak MF, Fisher CG, Fehlings MG, Rampersaud YR, Oner FC, Aarabi B, et al. The surgical approach to subaxial cervical spine injuries: an evidence-based algorithm based on the SLIC classification system. *Spine*. 2007;32(23):2620-2629.
13. Parker JW, Lane JR, Karaikovic EE, Gaines RW. Successful short-segment instrumentation and fusion for thoracolumbar spine fractures: a consecutive 4½-year series. *Spine*. 2000;25(9):1157-1170.
14. Tezeren G, Kuru I. Posterior fixation of thoracolumbar burst fracture: short-segment pedicle fixation versus long-segment instrumentation. *J Spinal Disord Tech*. 2005;18(6):485-488.