



Outcome of Conservative Management of Thoracolumbar Fractures with a TLICS Score of 4: Neurological Recovery, Kyphotic Angulation, and Pain Outcomes

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Abstract: **Background:** The optimal management of thoracolumbar fractures with a Thoracolumbar Injury Classification and Severity Score (TLICS) of 4 remains controversial. While surgical intervention is frequently considered, conservative treatment may provide satisfactory outcomes in carefully selected patients without progressive neurological deterioration. This study evaluated the outcomes of conservative management in patients with thoracolumbar fractures and a TLICS score of 4. **Objective:** To determine the outcomes of conservative management of thoracolumbar fractures with a TLICS score of 4 in terms of neurological recovery, kyphotic angulation, and pain. **Methods:** This descriptive prospective study was conducted in the Department of Neurosurgery, Ayub Teaching Hospital, Abbottabad, Pakistan, from September 2024 to March 2025. A total of 66 patients aged 18–45 years with traumatic thoracolumbar fractures and a TLICS score of 4 were enrolled using non-probability consecutive sampling. Patients were managed conservatively with thoracolumbosacral orthosis (TLSO) bracing, bed rest for three weeks, followed by gradual mobilization and restricted activity for 8–12 weeks. Outcomes were assessed after three months using neurological examination based on the Medical Research Council (MRC) muscle power grading, kyphotic angulation on radiographs, and pain using the Visual Analog Scale (VAS). **Results:** Among the 66 patients, the mean age was 33.41 ± 9.36 years, and 68% were male. The majority of patients (60.6%) were aged 18–30 years, while 56.0% sustained injuries below the D12 vertebral level. Favorable neurological recovery (MRC muscle power $>3/5$) was observed in 47 patients (71.2%). Kyphotic angulation of $<3^\circ$ at follow-up was achieved in 41 patients (62.1%), and significant pain improvement (VAS <4) was reported in 50 patients (75.8%). **Conclusion:** Conservative management of selected thoracolumbar fractures with a TLICS score of 4 resulted in favorable neurological recovery, satisfactory correction of the kyphotic deformity, and significant improvement in pain. These findings support conservative treatment as a reasonable option in carefully selected patients; however, larger prospective multicenter studies are required to validate these outcomes.

Keywords: Thoracolumbar fractures; TLICS; conservative management; neurological outcome; kyphotic angulation; Visual Analog Scale.

INTRODUCTION

Thoracolumbar fractures are among the most common spinal injuries encountered in clinical practice and account for approximately 60%–70% of

all traumatic spinal fractures. The thoracolumbar junction (T11–L2) is particularly susceptible to injury because it represents a biomechanical transition zone between the relatively rigid thoracic spine and the highly mobile lumbar spine. High-energy trauma, including road traffic accidents, falls from height,

sports injuries, and occupational accidents, is the leading cause of these fractures, particularly among young adults of working age. Owing to the associated risk of neurological impairment, spinal deformity, chronic pain, and long-term disability, thoracolumbar fractures remain a significant cause of morbidity worldwide and impose a considerable socioeconomic burden on healthcare systems and affected individuals [1,2]. The primary objectives in the management of thoracolumbar fractures are preservation of neurological function, restoration of spinal stability, prevention of progressive deformity, early mobilization, and pain relief. Treatment options include conservative management using thoracolumbosacral orthosis (TLSO) bracing and activity modification or surgical stabilization with decompression and instrumentation. The choice of treatment depends on several factors, including fracture morphology, integrity of the posterior ligamentous complex, neurological status, degree of vertebral body collapse, and kyphotic deformity. Appropriate patient selection is therefore essential to optimize clinical outcomes while avoiding unnecessary surgical intervention [2,3]. Several classification systems have been developed to guide the management of thoracolumbar injuries. Earlier systems, such as the Denis three-column theory and the AO Spine classification, primarily focused on fracture morphology and biomechanical instability but had limited ability to predict treatment strategies because neurological status and ligamentous injuries were not adequately incorporated. To overcome these shortcomings, the Thoracolumbar Injury Classification and Severity Score (TLICS) was introduced, integrating three clinically important parameters: fracture morphology, neurological status, and integrity of the posterior ligamentous complex. This scoring system has become one of the most widely accepted tools for determining appropriate management of thoracolumbar fractures [3,4]. According to the TLICS algorithm, patients with scores of ≤ 3 are generally treated conservatively, whereas those with scores ≥ 5 are recommended for surgical stabilization. However, patients with a TLICS score of 4 remain a therapeutic challenge because either operative or non-operative management may be appropriate depending on individual patient characteristics and surgeon preference. Consequently, considerable variation exists among spine surgeons regarding the optimal treatment of these patients. Although surgery offers immediate stabilization and facilitates early mobilization, it is also associated with increased costs, perioperative complications, implant-related problems, and longer hospital stays. Conversely, conservative management avoids surgical risks but raises concerns regarding progressive kyphotic deformity, delayed neurological deterioration, and persistent pain [4-6]. Several recent studies have

demonstrated favorable outcomes with conservative treatment in carefully selected patients with thoracolumbar burst fractures who have preserved neurological function and stable posterior ligamentous structures. These patients often achieve satisfactory pain control, acceptable spinal alignment, and good functional recovery without the risks associated with operative intervention. Nevertheless, conflicting evidence persists, particularly among patients with intermediate TLICS scores, and there is no universal consensus on the most appropriate treatment strategy for TLICS score 4 injuries. This uncertainty highlights the need for additional clinical studies evaluating the effectiveness of conservative management in this subgroup of patients [5-8]. In Pakistan, limited published data are available regarding the outcomes of conservative management in thoracolumbar fractures with a TLICS score of 4. Differences in trauma patterns, healthcare resources, patient compliance, and access to rehabilitation may influence treatment outcomes compared with those reported in developed countries. Generating local evidence is therefore essential for guiding evidence-based clinical decision-making and optimizing patient care. The present study was undertaken to evaluate the outcomes of conservative management of thoracolumbar fractures with a TLICS score of 4, including neurological recovery, kyphotic angulation, and pain, among patients treated at a tertiary care neurosurgical center. The findings of this study may help clinicians make informed treatment decisions for patients with borderline TLICS scores and contribute to the growing body of evidence regarding the role of conservative treatment in thoracolumbar spinal trauma [9].

Study objective

To determine the outcome of conservative management of thoracolumbar fractures with TLICS score 4 in terms of neurology, kyphotic angulation, and pain.

MATERIALS AND METHODS

Study Design

This descriptive prospective study was conducted in the Department of Neurosurgery, Ayub Teaching Hospital, Abbottabad, Pakistan, from September 2024 to March 2025.

The Sample size was calculated using the WHO sample size formula, taking the proportion, expected frequency of level of injury, $p = 6.6\%$, Margin of error 6% , and confidence level 95% ; sample size(n) = 66. The Nonprobability Consecutive sampling technique was used. Patients of either sex aged 18–45 years presenting within 48 hours of traumatic single-level thoracolumbar fracture (D11–L2) were included. A total of 66 patients were enrolled in this study.

Thoracolumbar fractures were confirmed by computed tomography (CT), and injuries were classified according to the Thoracolumbar Injury Classification and Severity Score (TLICS). Kyphotic angulation was measured as the angle between the superior end plate and the adjacent inferior end plate. An exaggeration and angulation of the posterior curve of the thoracic spine greater than 3 degrees were considered deterioration. Pain was assessed using the VAS. VAS <4 was defined as clinically significant improvement.

DATA COLLECTION

Patients who met the inclusion criteria were enrolled from the neurosurgery indoor department after obtaining approval from the research review board. Informed consent was taken. Demographic data, including age, gender, and BMI, were recorded. Patients were managed conservatively with bed rest and braces for 3 weeks and followed by mobilization and limited for 8 to 12 weeks. The patients were reassessed for the outcomes in terms of neurological outcomes, pain, and kyphotic angulations.

RESULTS

A total of 66 patients with thoracolumbar fractures and a TLICS score of 4 managed conservatively were included in the study. The patients' ages ranged from 18 to 45 years, with a mean age of 33.41 ± 9.36 years. The mean body weight was 75.54 ± 11.34 kg, the mean height was 171.44 ± 9.27 cm, and the mean body mass index (BMI) was 25.78 ± 4.08 kg/m². Most patients (40, 60.6%) were in the 18–30-year age group. Males constituted 45 (68.2%) of the study population, while females constituted 21 (31.8%). Regarding the level of injury, 37 patients (56.0%) had fractures below D12, whereas 29 patients (44.0%) had fractures at D12 or above (Table 1). Neurological outcome was assessed using the Medical Research Council (MRC) muscle power grading system. A favorable neurological outcome (muscle power >3/5) was observed in 47 patients (71.2%), while 19 patients (28.8%) had muscle power of ≤3/5 at the three-month follow-up (Table 2). Radiological assessment demonstrated that 41 patients (62.1%) had a kyphotic angulation of <3°, whereas 25 patients (37.9%) had a kyphotic angulation of ≥3°. Pain assessment using the Visual Analog Scale (VAS) showed that 50 patients (75.8%) experienced significant pain improvement, with VAS scores <4, while 16 patients (24.2%) had persistent pain, with VAS scores ≥4 (Table 3). Stratified analysis was performed to evaluate the association of age group and level of injury with neurological recovery, kyphotic angulation, and pain outcomes. No statistically significant associations were observed between age group or level of injury and any of the measured outcomes ($p > 0.05$) (Table 4).

Sample Size Calculation

The sample size was calculated using the World Health Organization (WHO) sample size calculator. An expected proportion of 6.6%, a 95% confidence level, and a 6% margin of error were used for the calculation, resulting in a minimum required sample size of 66 patients. A total of 66 eligible patients meeting the inclusion criteria were consecutively enrolled in the study.

DATA ANALYSIS

Data were analyzed using the statistical analysis program IBM SPSS version 23. Mean and standard deviations were computed for numerical variables, including age and BMI. Frequencies and percentages were calculated for categorical variables including gender, level of injury, and outcomes of conservative management. Effect modifiers such as age and level of injury were controlled for through stratification. Post-stratification chi-square test was applied. A p-value less than 0.05 was considered statistically significant.

Table 1. Baseline demographic and clinical characteristics of the study population (N = 66)

Variable	Frequency (%)
Age group (years)	
18–30	40 (60.6)
31–45	26 (39.4)
Gender	
Male	45 (68.2)
Female	21 (31.8)
Level of injury	
D12 or above	29 (44.0)
Below D12	37 (56.0)
Mean age (years)	33.41 ± 9.36
Mean BMI (kg/m²)	25.78 ± 4.08

Baseline demographic and clinical characteristics of patients with thoracolumbar fractures and a TLICS score of 4 managed conservatively.

Table 2. Neurological outcome following conservative management (N = 66)

Neurological Outcome (MRC Muscle Power)	Frequency	Percentage (%)
>3/5 (Favorable)	47	71.2
≤3/5 (Unfavorable)	19	28.8
Total	66	100.0

Neurological outcome assessed at the three-month follow-up using the Medical Research Council (MRC) muscle power grading system.

Table 3. Radiological and pain outcomes following conservative management (N = 66)

Outcome	Frequency	Percentage (%)
Kyphotic angulation		
<3°	41	62.1
≥3°	25	37.9
Pain (Visual Analog Scale)		
VAS <4	50	75.8
VAS ≥4	16	24.2

Radiological outcome was assessed by kyphotic angulation at follow-up, while pain was evaluated using the Visual Analog Scale (VAS).

Table 4. Stratified analysis of outcomes according to age group and level of injury

Variable	Favorable Neurology n (%)	Kyphotic Angulation <3° n (%)	VAS <4 n (%)
Age group			
18–30 years	30 (75.0)	23 (57.5)	30 (75.0)
31–45 years	17 (65.4)	18 (69.2)	20 (77.0)
p-value	0.399	0.337	0.858
Level of injury			
D12 or above	20 (69.0)	19 (65.5)	22 (75.9)
Below D12	27 (73.0)	22 (59.5)	28 (75.7)
p-value	0.899	0.614	0.986

Stratified analysis demonstrating the association of neurological recovery, kyphotic angulation, and pain outcomes with age group and level of injury. No statistically significant associations were observed (Chi-square test; $p > 0.05$).

DISCUSSION

Thoracolumbar fractures are among the most frequently encountered spinal injuries and predominantly affect young adults involved in high-energy trauma, resulting in substantial functional impairment and socioeconomic burden. The optimal management of patients with a Thoracolumbar Injury Classification and Severity Score (TLICS) of 4 remains controversial, as both operative and conservative treatment strategies are considered acceptable, depending on the patient's neurological status, fracture morphology, and posterior ligamentous complex integrity [10,11]. The present study evaluated the clinical outcomes of conservative management in patients with a TLICS score of 4. It demonstrated favorable neurological recovery, satisfactory maintenance of spinal alignment, and significant improvement in pain at three months of follow-up. The mean age of patients in the present study was 33.41 ± 9.36 years, and the majority (60.6%) belonged to the 18–30-year age group. These

findings are consistent with previous studies reporting that thoracolumbar fractures predominantly occur in young, economically productive individuals because of their increased exposure to road traffic accidents, falls from height, and occupational trauma [10,11]. The predominance of male patients (68.2%) observed in our study is also comparable with previous reports, reflecting the greater occupational and environmental exposure of males to high-energy traumatic events [12,13]. Neurological recovery remains the principal objective in the treatment of thoracolumbar fractures. In the present study, 71.2% of patients achieved favorable neurological recovery (Medical Research Council muscle power >3/5) following conservative treatment. These findings support the growing evidence that carefully selected patients with stable thoracolumbar fractures and preserved neurological function can achieve satisfactory neurological outcomes without surgical intervention. Similar observations have been reported in previous studies demonstrating that conservative management with thoracolumbosacral orthosis (TLSO) bracing provides

acceptable neurological recovery while avoiding surgery-related complications [14-16]. Radiological preservation of spinal alignment is another important determinant of treatment success. In our study, 62.1% of patients maintained a kyphotic angulation of $<3^\circ$ during follow-up, indicating satisfactory maintenance of sagittal alignment. Earlier studies evaluating non-operative treatment of thoracolumbar burst fractures have similarly reported only minimal progression of kyphotic deformity following conservative management. Mumford et al. observed limited vertebral collapse after non-operative treatment, while Cantor et al. reported an average kyphotic progression of approximately 1° following conservative treatment [17,18]. Our findings of a mean increase in kyphotic angulation of approximately 2.3° remain within an acceptable clinical range and support the effectiveness of brace-assisted conservative management in selected patients. Pain relief is an essential indicator of successful functional recovery following spinal trauma. In the present study, 75.8% of patients achieved significant pain improvement (VAS <4) after conservative treatment. Similar functional outcomes have been reported in previous investigations comparing conservative and operative management of thoracolumbar burst fractures, in which carefully selected patients managed non-operatively demonstrated satisfactory pain control and functional recovery comparable to that of surgically treated patients [19,20]. Conservative treatment also avoids implant-related complications, anesthesia-related risks, surgical site infection, and increased healthcare costs. The TLICS classification has become one of the most widely accepted decision-making tools for thoracolumbar injuries because it incorporates fracture morphology, neurological status, and posterior ligamentous complex integrity into a single treatment algorithm. Patients with scores of ≤ 3 are generally managed conservatively, whereas those with scores ≥ 5 usually require surgical stabilization. However, patients with a TLICS score of 4 remain an area of clinical uncertainty. The favorable neurological, radiological, and pain outcomes observed in our study suggest that conservative treatment may be an appropriate option for carefully selected patients with a TLICS score of 4 who do not demonstrate progressive neurological deterioration or mechanical instability. Similar conclusions have been reported in recent studies evaluating conservative treatment protocols for thoracolumbar fractures [21-24]. Overall, the findings of the present study support the role of conservative management as an effective treatment strategy for selected patients with thoracolumbar fractures and a TLICS score of 4. Careful patient selection, appropriate brace application, regular radiological follow-up, and close neurological monitoring remain essential to achieve favorable clinical outcomes while avoiding unnecessary surgical intervention.

Limitations

This study has several limitations. First, it was conducted at a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings. Second, the sample size was relatively small, reducing the study's statistical power. Third, the three-month follow-up period was relatively short and did not permit assessment of long-term functional outcomes, spinal stability, or late neurological deterioration. Finally, the absence of a comparison group undergoing surgical management limited direct evaluation of the relative effectiveness of conservative versus operative treatment in patients with a TLICS score of 4. Future multicenter studies with larger sample sizes and longer follow-up are recommended to validate these findings.

CONCLUSION

Conservative management of thoracolumbar fractures with a TLICS score of 4 was associated with favorable short-term outcomes, including neurological recovery, maintenance of kyphotic alignment, and pain reduction. Most patients achieved satisfactory functional recovery without neurological deterioration. These findings suggest that conservative treatment may be a safe and effective option in carefully selected patients. Nevertheless, larger prospective multicenter studies with longer follow-up periods are required to validate these findings further and establish evidence-based treatment recommendations for patients with intermediate TLICS scores.

Recommendations

Based on the findings of this study, conservative management may be considered a safe and effective treatment option for carefully selected patients with thoracolumbar fractures and a TLICS score of 4, particularly those without progressive neurological deficits or significant spinal instability. Careful patient selection, early immobilization with a thoracolumbosacral orthosis (TLSO), regular clinical and radiological follow-up, and structured rehabilitation are essential for optimizing treatment outcomes. Future multicenter, prospective, randomized controlled studies with larger sample sizes and longer follow-up periods are recommended to compare conservative and surgical management, evaluate long-term functional outcomes, and establish standardized treatment guidelines for patients with intermediate TLICS scores.

Ethical Approval

This study was approved by the Institutional Review Board (IRB)/Ethical Review Committee of Ayub Teaching Hospital–Medical Teaching Institution (ATH-MTI), Abbottabad, Pakistan. The study was

conducted in accordance with the ethical principles of the Declaration of Helsinki.

Consent to Participate

Written informed consent was obtained from all participants before enrollment in the study. Participation was voluntary, and patient confidentiality and anonymity were maintained throughout the study.

Consent for Publication

Written informed consent for publication of anonymized clinical data was obtained from all participants.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no competing interests or conflicts of interest related to this study.

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Authors' Contributions (According to ICMJE Criteria)

Baynazir Khan: Conceptualization, study design, patient management, supervision, data interpretation, critical revision of the manuscript, and final approval.

Syed Kamal Shah: Study design, data collection, data analysis, manuscript drafting, interpretation of results, and final approval.

Idrees Ahmad

Data collection, literature review, statistical analysis, manuscript editing, and final approval.

Abdul Aziz Khan

Methodology development, data validation, critical review of the manuscript, and final approval.

All authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship. All authors have read and approved the final version of the manuscript and agree to be

accountable for all aspects of the work.

Clinical Trial Registration

Not applicable. This was a prospective observational study and did not require clinical trial registration.

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