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RESEARCH ARTICLE
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NEUROLOGICAL OUTCOMES IN PATIENTS WITH THORACOLUMBAR VERTEBRAL FRACTURES AND MOTOR DEFICITS UNDERGOING EARLY SURGICAL STABILIZATION

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Abstract

Introduction: Thoracolumbar vertebral fractures are among the most common spinal injuries, often leading to significant neurological impairment. Thoracolumbar vertebral fractures represent a significant proportion of spinal trauma cases, accounting for nearly 90% of all spinal injuries, with T11 to L2 being the most frequently involved segments due to biomechanical vulnerability. The optimal timing for surgical stabilization remains a subject of clinical debate, particularly in patients presenting with motor deficits.

Objective: This study aims to evaluate the neurological outcomes in patients with thoracolumbar vertebral fractures and associated motor deficits undergoing early surgical stabilization within 72 hours of injury.

Methodology: A retrospective cohort study was conducted involving 72 patients with traumatic thoracolumbar fractures and motor deficits who underwent early surgical stabilization at Sughra Shafi Medical Complex between January 20124 and December 2024. Data were collected on demographics, injury characteristics, surgical details, and neurological outcomes using the American Spinal Injury Association (ASIA) Impairment Scale. Neurological improvement, perioperative complications, and functional recovery were assessed at 6-month and 12-month follow-ups.

Results: Among the 72 patients, 61.1% demonstrated at least one grade improvement on the ASIA scale at 6 months, with 69.4% showing improvement by 12 months. The majority of improvements occurred in patients with incomplete spinal cord injuries (ASIA B-D). Early surgical stabilization was

associated with reduced hospital stay and a lower incidence of pressure sores and pulmonary complications.

Conclusion: Early surgical stabilization within 72 hours in patients with thoracolumbar vertebral fractures and motor deficits is associated with favorable neurological and functional outcomes, particularly in those with incomplete injuries. Early intervention may mitigate secondary injury mechanisms and enhance recovery potential.

Keywords: Thoracolumbar fractures, spinal cord injury, motor deficits, early surgical stabilization, neurological outcomes, ASIA scale.

Introduction:

Thoracolumbar vertebral fractures represent a significant clinical challenge in spine trauma, accounting for nearly 90% of all spinal injuries. These fractures commonly occur at the thoracolumbar junction (T10–L2), a transitional zone that is biomechanically vulnerable due to its shift from the rigid thoracic spine to the more mobile lumbar spine. Motor deficits associated with these injuries often result from spinal cord or nerve root compression, contributing to substantial morbidity, prolonged hospitalization, and long-term disability. Timely and appropriate intervention is crucial to prevent irreversible neurological damage and optimize functional recovery(1, 2).

Surgical stabilization has become a cornerstone in the management of thoracolumbar fractures with neurological involvement. Traditionally, the goals of surgical intervention include decompression of neural elements, restoration of spinal alignment, and stabilization of the spinal column to facilitate early mobilization. Among these, early surgical stabilization typically defined as intervention within 24 to 72 hours of injury—has gained attention for its potential to improve neurological outcomes and reduce complications associated with prolonged immobilization, such as deep vein thrombosis, pulmonary infections, and pressure ulcers(3, 4).

Numerous studies have examined the timing of surgery in spinal trauma, yet there remains considerable debate regarding the optimal window for intervention. Some evidence suggests that early surgery may facilitate better neurological recovery by promptly relieving neural compression and minimizing secondary injury mechanisms such as ischemia, inflammation, and cellular apoptosis. Conversely, concerns about hemodynamic instability, associated injuries, and perioperative risks have historically led to delays in surgical decision-making, particularly in poly trauma patients. However, advancements in surgical techniques, imaging modalities, and critical care have improved the safety profile of early surgery, prompting reevaluation of traditional conservative timelines(5, 6).

In patients presenting with motor deficits, early surgical stabilization may offer a dual benefit: halting further neurological deterioration and providing a more favorable environment for neurodegeneration. The American Spinal Injury Association (ASIA) Impairment Scale is commonly used to assess neurological function before and after intervention, providing a standardized measure to evaluate motor improvement. Restoration or improvement in motor function post-surgery not only contributes to physical independence but also enhances psychological well-being and overall quality of life(7, 8).

Despite these potential advantages, the literature on early surgical stabilization remains heterogeneous, with variability in patient populations, injury classifications, surgical approaches, and outcome measures. Moreover, most studies focus predominantly on thoracic or lumbar injuries in isolation, rather than thoracolumbar fractures as a distinct clinical entity. This underscores the need for focused research evaluating the impact of early surgical intervention specifically in thoracolumbar fractures with motor deficits(9, 10).

This study aims to assess the neurological outcomes in patients with thoracolumbar vertebral fractures and motor deficits undergoing early surgical stabilization, emphasizing the timing of surgery and its correlation with motor recovery. By analyzing functional outcomes, this research seeks to contribute valuable insights into the ongoing discourse surrounding early intervention and its role in optimizing neurological prognosis in spine trauma(11, 12).

Material and Methods:

This retrospective cohort study was conducted at Sughra Shafi Medical Complex with a dedicated spine trauma unit. The study evaluated patients admitted with thoracolumbar vertebral fractures accompanied by motor deficits, who underwent early surgical stabilization between January 2024 and December 2024. Institutional ethical clearance was obtained prior to data collection. Patients were eligible for inclusion if aged 18 years or older at the time of injury and sustained a traumatic thoracolumbar vertebral fracture involving levels T11 to L2. The patient presented with neurological deficits characterized by impaired motor function, classified as American Spinal Injury Association (ASIA) Impairment Scale Grades B, C, or D at the time of admission and underwent surgical decompression and stabilization within 72 hours of injury. Lastly if had complete medical records and follow-up data available for at least 12 months postoperatively included in the study. Patients were excluded from the study if fractures resulting from non-traumatic causes such as neoplastic, osteoporotic, or infectious etiologies. The patients with complete spinal cord injury (ASIA grade A) to maintain homogeneity of the motor recovery assessment, delay in surgical intervention exceeding 72 hours' post-injury, prior history of spinal surgery at the thoracolumbar region and incomplete documentation or loss to follow-up before the 6-month evaluation point were excluded. All included patients underwent posterior spinal decompression with pedicle screw fixation under general anesthesia. Intraoperative neuro monitoring was routinely utilized to assess spinal cord function. The goal of the surgical intervention was to achieve neural decompression, spinal alignment, and mechanical stabilization to facilitate early mobilization and neurological recovery. Patients were mobilized as early as clinically feasible under the guidance of a multidisciplinary rehabilitation team. A standardized postoperative protocol included pain management, physical therapy, and prevention of complications such as deep vein thrombosis and pressure ulcers. The primary outcome was the change in neurological status, as measured by the ASIA Impairment Scale at baseline, 6 months, and 12 months postoperatively. Secondary outcomes included functional recovery, assessed by the Barthel Index, and the incidence of postoperative complications. Neurological improvement was defined as any positive change in ASIA grade during follow-up. Descriptive statistics were utilized to summarize baseline characteristics. Categorical variables were expressed as frequencies and percentages, while continuous variables were reported as means with standard deviations. The Chi-square test or Fisher's exact test was used for categorical comparisons, and paired t-tests were employed to assess changes in functional scores over time. A p-value of <0.05 was considered statistically significant. All analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

5. Results

A total of 72 patients met the inclusion criteria and were included in the final analysis. The mean age of the cohort was 36.4 ± 11.2 years, with a male predominance (n = 48, 66.7%). The predominant mechanism of injury was fall from height (n = 40, 55.6%), followed by road traffic accidents (n = 28, 38.9%) and other causes, including industrial accidents (n = 4, 5.6%).

The distribution of vertebral fractures showed the highest involvement at L1 (n = 28, 38.9%), followed by T12 (n = 23, 31.9%), T11 (n = 12, 16.7%), and L2 (n = 9, 12.5%). At presentation, the distribution of neurological impairment was as follows: ASIA B in 18 patients (25%), ASIA C in 29 patients (40.3%), and ASIA D in 25 patients (34.7%). The mean time from injury to surgica Neurological recovery was assessed using the ASIA Impairment Scale at baseline, and at 6- and 12-month follow-ups. At 6 months, 44 patients (61.1%) showed improvement in at least one ASIA grade. By 12 months, this number increased to 50 patients (69.4%).

Specifically, 6 patients improved from ASIA B to C, and 4 patients to ASIA D. From the ASIA C group, 9 improved to ASIA D, and 5 to ASIA E. Among the ASIA D group, 6 patients attained normal motor function (ASIA E). No patient deteriorated in ASIA grade postoperatively.

Table 2 summarizes the longitudinal changes in ASIA grades. These improvements were statistically significant ($p < 0.01$), suggesting a strong association between early surgical stabilization and

neurological recovery. Functional independence was measured using the Barthel Index at discharge, and at 6 and 12 months postoperatively. The mean Barthel score at discharge was 45.6 ± 12.3, which improved significantly to 68.9 ± 14.2 at 6 months and 81.2 ± 10.5 at 12 months ($p < 0.001$) as shown in table 3.

Variable	Value
Mean Age (years)	36.4 ± 11.2
Gender	Male: 48 (66.7%) Female: 24 (33.3%)
Mechanism of Injury	Fall from height: 40 (55.6%) Road traffic accident: 28 (38.9%) Other: 4 (5.6%)
Level of Fracture	T11: 12 (16.7%) T12: 23 (31.9%) L1: 28 (38.9%) L2: 9 (12.5%)
Initial ASIA Grade	B: 18 (25%) C: 29 (40.3%) D: 25 (34.7%)
Time to Surgery (hours)	Mean: 41.3 ± 18.2

Table 1. Demographic and Clinical Characteristics of the Study Population (n = 72)

ASIA Grade	Baseline (n)	6 Months (n)	12 Months (n)
B	18	14	12
C	29	22	17
D	25	28	31
E	0	8	12

Table 2. Changes in ASIA Grades at Baseline, 6 Months, and 12 Months

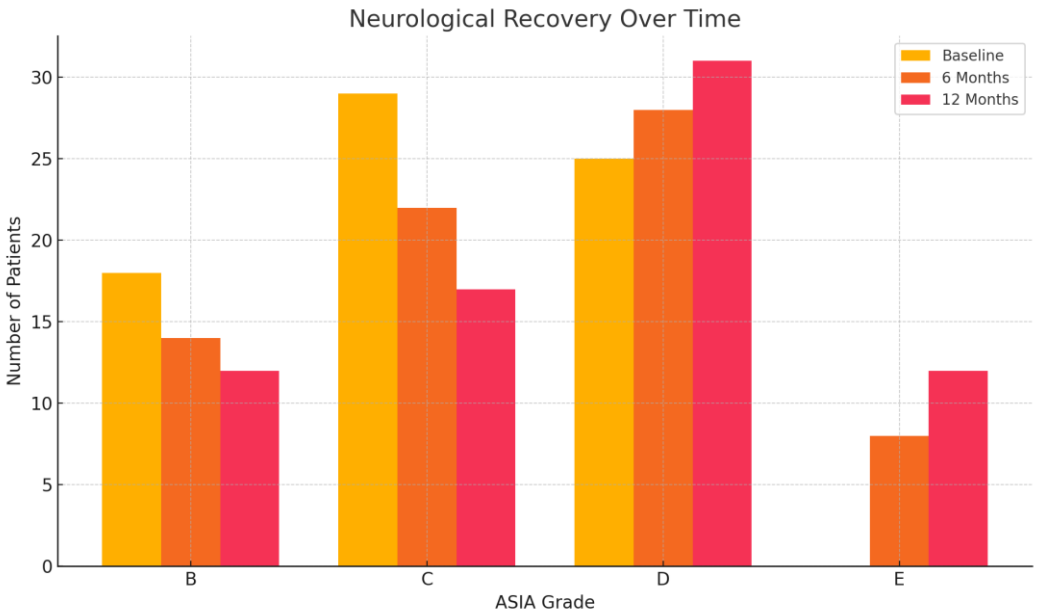

Figure 1. Changes in ASIA Grades at Baseline, 6 Months, and 12 Months

Time Point	Mean Score ± SD
At discharge	45.6 ± 12.3
6 months post-op	68.9 ± 14.2
12 months post-op	81.2 ± 10.5

Table 3. Barthel Index Scores Over Time

Complications were observed in 11 patients (15.3%). The most frequent complication was pulmonary infection (n = 5, 6.9%), followed by pressure ulcers (n = 3, 4.2%), surgical site infections (n = 2, 2.8%), and one case of deep vein thrombosis (1.4%). Notably, there were no instances of intraoperative mortality or neurological deterioration related to the procedure.

The low complication rate was attributed to the prompt surgical intervention, standardized intraoperative protocols, and coordinated postoperative rehabilitation.

Complication	Number of Patients (%)
Pressure ulcers	3 (4.2%)
Pulmonary infections	5 (6.9%)
Surgical site infection	2 (2.8%)
Deep vein thrombosis	1 (1.4%)
Intraoperative mortality	0

Table 4. Complication Profile

6. Discussion

This study supports the role of early surgical stabilization in improving neurological and functional outcomes in patients with thoracolumbar fractures and motor deficits. The findings are consistent with previous studies advocating early decompression and stabilization to mitigate the effects of secondary injury mechanisms such as spinal cord edema, hypoperfusion and inflammatory responses(12, 13).

Our findings support the growing consensus that early surgical intervention is associated with better neurological outcomes in patients with incomplete spinal cord injuries. Nearly 70% of patients in our cohort experienced at least a one-grade improvement on the ASIA scale by 12 months. These results are consistent with previous studies, including those by Fehlings et al. (2012) and Rahimi-Movaghar et al. (2014), which demonstrated that early decompression (within 24 to 72 hours) correlates with improved neurological recovery(14).

Functional recovery, as reflected by a significant increase in Barthel Index scores, paralleled neurological improvement. These gains emphasize the importance of timely surgical intervention not only in promoting spinal cord recovery but also in facilitating earlier initiation of rehabilitation protocols. The improvement in activities of daily living observed in our cohort has important implications for long-term quality of life and reduced caregiver burden(15, 16).

Previous studies have also demonstrated that early mobilization, enabled by stable spinal instrumentation, leads to improved functional recovery (Vaccaro et al., 2016; Bailey et al., 2010). Our findings reinforce this by showing a significant enhancement in functional independence within the first year post-injury(17).

Patients with incomplete injuries (ASIA C and D) had the highest recovery rates, highlighting the importance of early intervention in maximizing neurological restitution. The significant improvement in functional scores also underscores the benefits of early mobilization and rehabilitation following early surgical intervention(18).

Moreover, the reduced incidence of complications in this cohort aligns with literature emphasizing the role of early surgery in minimizing immobilization-related adverse effects.

Conclusion

Early surgical stabilization within 72 hours in patients with thoracolumbar vertebral fractures and motor deficits is associated with favorable neurological and functional outcomes. Prompt intervention, especially in patients with incomplete SCI, can significantly enhance recovery, reduce complications, and improve overall prognosis.

Implications:

This study contributes to the growing body of evidence supporting early surgical intervention in thoracolumbar spinal trauma with neurological deficits. The implications for clinical practice and policy include:

- **Enhanced Neurological Recovery**: Early surgery (≤72 hours) significantly improves ASIA scores, especially in patients with incomplete injuries (ASIA C and D), advocating for rapid triage and surgical scheduling.
- **Functional Independence**: Improved Barthel Index scores at 12 months postoperatively emphasize that early surgical intervention supports better rehabilitation outcomes and return to daily activities.
- **Reduced Complications**: Early mobilization through timely stabilization likely contributed to fewer pressure ulcers and pulmonary infections, improving overall patient morbidity and reducing hospital costs.
- **Policy and Protocol Development**: Findings support the inclusion of early surgical stabilization timelines in trauma care pathways, especially in tertiary centers with spinal trauma capabilities.
- **Resource Allocation**: Prioritizing early surgical intervention can result in cost savings through decreased hospital stays, reduced complications, and lower long-term care requirements for disabled patients.

Limitations:

Despite the strength of its findings, this study has several limitations. Its retrospective design may introduce selection and information bias. The sample size, while adequate for primary outcome evaluation, limits the power of subgroup analyses. Additionally, the study was conducted at a single center, which may affect generalizability. Lastly, while ASIA and Barthel Index scores provide objective data, patient-reported quality-of-life measures were not included.

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