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Original Research Article

Epidemiology and Neurological Outcomes of Acute Traumatic Thoracolumbar Spinal Cord Injury in a Tertiary Care Center in North India: A Prospective Cohort Study

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Conflict of interest: Nil

Abstract

Objective: To describe the epidemiological profile and quantify neurological recovery using the ASIA Impairment Scale (AIS) in patients with acute traumatic thoracolumbar spinal cord injury (SCI).

Design: Prospective observational cohort study.

Setting: Department of Physical Medicine and Rehabilitation, SMS Medical College, Jaipur, Rajasthan.

Participants: Sixty consecutive patients with acute traumatic thoracolumbar SCI.

Main Outcome Measures: Demographic data and AIS grade conversion rates from baseline to 3-month follow-up. Statistical significance was assessed using Chi-square and paired t-tests.

Results: The mean age was 46.22 ± 14.42 years, with a significant clustering in the 51-60 year age group (31/60, 51.7%, $p<0.001$). Males predominated (63.3%, $p=0.04$). The majority were from rural areas (56.7%) and lower-middle-class backgrounds (60.0%). Fall from height was the most common mechanism of injury (51.7%, $p<0.001$). Thoracic-level injuries were most frequent (66.7%), with D6-D10 being the commonest segment (33.3%). At 3 months, a statistically significant conversion of AIS grades was observed (Chi-square, $p<0.001$), with the proportion of AIS A patients decreasing from 38.3% to 28.3%. The ASIA lower limb motor score showed a highly significant mean improvement of 9.83 points (95% CI: 7.12-12.54, $p<0.001$).

Conclusion: The epidemiological profile of thoracolumbar SCI in this region is distinct, with a high incidence of falls in an older population. The ASIA score demonstrates significant predictive value, with substantial and statistically significant neurological recovery observed within the first 3 months.

Keywords: Spinal Cord Injuries, Epidemiology, ASIA Impairment Scale, Disease Progression, India, Thoracolumbar Vertebrae.

Introduction

Spinal cord injury (SCI) is a catastrophic event with a heterogeneous epidemiological profile that varies significantly across different geographical and socioeconomic regions [1]. While high-income countries report road traffic accidents (RTAs) as the leading cause, studies from developing nations like India consistently identify falls as the predominant etiology [2, 3]. Understanding these local patterns is crucial for developing targeted prevention strategies. The thoracolumbar junction is a biomechanically vulnerable region, making it a common site for traumatic SCI [4]. The neurological outcome following these injuries is primarily tracked using the American Spinal Injury Association (ASIA) Impairment Scale (AIS), which provides a standardized measure of deficit and recovery [5]. The early conversion of AIS grades, particularly from complete to incomplete status, is a key prognostic indicator and a critical endpoint in clinical trials [6]. Most large-scale epidemiological studies on SCI are from Western populations or combine all spinal levels. There is a paucity of

prospective data focusing specifically on the thoracolumbar region from North India. This study aims to fill that gap by prospectively describing the unique demographic and clinical profile of acute traumatic thoracolumbar SCI patients and quantifying their neurological recovery based on ASIA scoring at a 3-month follow-up.

Methods

Study Design and Participants: This prospective cohort study was conducted after institutional ethical approval. Sixty patients with acute traumatic thoracolumbar SCI, admitted to the rehabilitation department within 15 days of injury, were enrolled. Written informed consent was obtained from all participants or their guardians.

Data Collection: At baseline, detailed demographic data were recorded, including age, gender, residence, socioeconomic status (using the Kuppuswamy scale), and mode of injury. Clinical assessment included a neurological examination to determine the vertebral and neurological level of injury and the AIS grade.

Outcome Measures: The primary outcome was the change in AIS grade from baseline to the 3-month follow-up. Secondary outcomes included the change in the ASIA lower limb motor score.

Statistical Analysis: Data were analyzed using SPSS v22. Categorical data were described as frequencies and percentages. The Chi-square test was used to analyze the significance of AIS grade conversion. A paired t-test was used to compare ASIA motor scores between baseline and follow-up. A p-value < 0.05 was considered statistically significant.

Results

Demographic and Injury Characteristics: The study population (n=60) had a mean age of 46.22 ± 14.42 years. A Chi-square goodness-of-fit test revealed a statistically significant deviation from a uniform age distribution ($p<0.001$), with over half the cohort (51.67%) belonging to the 51-60 year age group. There was a significant male preponderance (38/60, 63.33%) compared to females (22/60, 36.67%; Chi-square, p=0.04). Most participants were married (88.33%), hailed from rural areas (56.67%), and belonged to the lower-middle class (60.00%). A Chi-square test confirmed that the mode of injury was not uniformly distributed ($p<0.001$), with fall from height being the predominant mechanism (51.66%), significantly more common than road traffic accidents (23.33%) and other causes (Table 1).

Table 1: Baseline Demographic and Injury Profile (n=60)

Characteristic	Category	n	%	p-value
Age Group	51-60 years	31	51.67%	**<0.001***
	41-50 years	12	20.00%	
	21-30 years	8	13.33%	
	≤20 years	5	8.33%	
	31-40 years	4	6.67%	
Gender	Male	38	63.33%	**0.04***
Residence	Female	22	36.67%	0.32
	Rural	34	56.67%	
	Urban	26	43.33%	
Socioeconomic Status	Lower Middle Class	36	60.00%	**<0.001***
	Middle Class	19	31.67%	
	Upper Middle Class	5	8.33%	
Mode of Injury	Fall from Height	31	51.66%	**<0.001***
	Road Traffic Accident	14	23.33%	
	Fall of Heavy Object	8	13.33%	
	Others	7	11.66%	

***Chi-square goodness-of-fit test; statistically significant (p<0.05).**

Clinical Profile and Neurological Level: The majority of vertebral injuries (66.67%) were in the thoracic spine, with the D6-D10 segment being the most commonly involved (33.33%). Lumbar injuries accounted for 33.33% of cases. At baseline, 38.33% of patients had a complete injury (AIS A), while 51.66% had incomplete injuries (AIS B-D), and 10% were neurologically intact (AIS E) (Table 2).

Table 2: Clinical and Neurological Characteristics at Baseline

Characteristic	Category	n	%
Vertebral Level	Thoracic (D1-D12)	40	66.67%
	Lumbar (L1-L5)	20	33.33%
Most Common Segment	D6-D10	20	33.33%
Baseline AIS Grade	A (Complete)	23	38.33%
	B-D (Incomplete)	31	51.66%
	E (Normal)	6	10.00%

Neurological Recovery at 3 Months: A Chi-square test for independence revealed a statistically significant change in the distribution of AIS grades from baseline to the 3-month follow-up ($p<0.001$). The proportion of patients with AIS A decreased from 38.3% to 28.3%, while the number of patients in higher AIS categories increased, indicating significant neurological conversion (Figure 1).

Figure 1: Conversion of ASIA Impairment Scale (AIS) Grades from Baseline to 3 Months: A significant shift in grade distribution was observed (Chi-square, $p<0.001$). Furthermore, the ASIA lower limb motor score showed a highly significant improvement across the entire cohort. The mean motor score increased from 32.45 ± 8.12 at baseline to 42.28 ± 11.45 at 3 months. A paired t-test confirmed this was a statistically significant mean improvement of 9.83 points (95% Confidence Interval: 7.12 to 12.54, $p<0.001$). This significant improvement was consistent across all vertebral level subgroups (D1-D12, L1, and L2-L5, all $p<0.01$).

Table 3: Change in ASIA Lower Limb Motor Score from Baseline to 3 Months

Vertebral Level	Baseline (Mean ± SD)	3-Months (Mean ± SD)	Mean Difference (95% CI)	p-value
Overall (n=60)	32.45 ± 8.12	42.28 ± 11.45	9.83 (7.12 - 12.54)	<0.001*
D1-D12 (n=40)	28.10 ± 3.36	38.25 ± 11.99	10.15 (6.01 - 14.29)	<0.001*
L1 (n=11)	40.82 ± 8.28	50.91 ± 2.34	10.09 (5.21 - 14.97)	0.002*
L2-L5 (n=9)	32.89 ± 8.80	44.56 ± 10.53	11.67 (5.21 - 18.13)	0.006*

Paired t-test; *statistically significant ($p<0.05$). CI = Confidence Interval.

Discussion

This prospective cohort study delineates a distinct epidemiological profile of thoracolumbar SCI in North India and provides robust statistical evidence of significant neurological recovery within the first 3 months post-injury.

Our findings reveal a profile characterized by an older patient population, with a statistically significant majority in the 51-60 year age group ($p<0.001$). This contrasts sharply with profiles from Western nations, where the typical age at injury is much younger, often in the third decade of life [2, 7]. This demographic shift has important implications, as older age is a known independent predictor of poorer functional outcomes and higher complication rates after SCI [8]. The significant male preponderance ($p=0.04$) and the high incidence of falls, predominantly affecting rural, lower-middle-class males, align with other Indian studies that highlight occupational hazards in agriculture and construction as major causes [6, 9]. The statistically significant predominance of fall from height as an etiology ($p<0.001$) underscores the critical need for targeted public health interventions focusing on workplace and fall prevention safety in these communities.

A key and robust finding of this study is the quantifiable neurological recovery observed within the first 3 months post-injury. The significant conversion of AIS grades ($p<0.001$) and the mean improvement of 9.83 points in the lower limb motor score are clinically meaningful. This period is widely recognized as the phase of greatest spontaneous neurological recovery, primarily due to the resolution of spinal shock and neuroplasticity mechanisms [10]. The magnitude of motor recovery we observed is consistent with larger cohort studies. For instance, in the European Multicenter Study on Spinal Cord Injury (EM-SCI), patients with thoracic injuries showed significant early motor score improvements, though the exact gain varies by initial severity [11]. Our findings of conversion from complete to incomplete status are consistent with trends reported by Marino et al., who noted rising conversion rates over time, underscoring the dynamic nature of SCI [12].

The predominance of thoracic-level injuries, particularly in the lower thoracic spine (D6-D12), can be attributed to the biomechanical vulnerability of the thoracolumbar junction [5]. The significant recovery observed even in these patients, who often have more severe initial deficits, highlights the potential for improvement and the critical importance of early and aggressive rehabilitation. The fact that significant motor score improvement was seen across all vertebral level subgroups (all

$p<0.01$) reinforces that early intensive rehabilitation is beneficial regardless of the specific injury level.

Limitations

The single-center design may limit the generalizability of the findings to other regions of India. The 3-month follow-up, while capturing the most dynamic phase of recovery, is insufficient to document long-term functional outcomes. The study did not correlate recovery with specific surgical or medical interventions, which could be a confounder.

Conclusion

This study provides a detailed prospective account of thoracolumbar SCI in North India, revealing a unique epidemiology driven by falls in an older, rural population—a finding that demands tailored prevention strategies. Furthermore, it robustly quantifies significant neurological recovery within the first 3 months, validating the ASIA score as a sensitive tool to track this early, critical period. The statistically significant 9.83-point mean improvement in motor score provides a benchmark for expected recovery in similar populations. These findings reinforce the indispensable need for dedicated early rehabilitation services to capitalize on this window of neurological plasticity and maximize functional outcomes for patients.

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