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Original Research Article

Prevalence of Different Spinal Cord Injuries After Trauma and Its Comparison With the ASIA Scale

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Abstract: *Traumatic spinal cord injury (SCI) is a major cause of disability, particularly in low- and middle-income countries, where road traffic accidents and falls are common contributors. Early identification of injury patterns on magnetic resonance imaging (MRI) and their correlation with neurological grading systems such as the American Spinal Injury Association (ASIA) scale may provide prognostic value. However, limited data are available from Pakistan regarding MRI-defined SCI types and their relationship with neurological impairment.* ***Objective:*** *To determine the prevalence of MRI-defined traumatic spinal cord injury (SCI) types (cord contusion, oedema, haemorrhage) among adults presenting to SMBBIT, DUHS, Karachi, and to compare these with ASIA impairment grades at presentation.* ***Methods:*** *A six-month, cross-sectional study employed non-probability sampling conducted from 1st September 2024 to 28th February 2025. Adults (18–60 years) with traumatic SCI presenting within two months of injury were included; non-traumatic cord dysfunctions were excluded. Demographics, injury characteristics, and ASIA grades (A–E) were recorded. MRI categorised SCI as cord contusion, oedema, or haemorrhage. Quantitative variables were summarized as the mean ± SD; qualitative variables were summarized as n (%). Associations between SCI type and ASIA grade, as well as effect modification by age group, gender, mechanism, and injury duration, were assessed using chi-square tests (α = 0.05).* ***Results:*** *Eighty-three patients were analysed (mean age 37.77±10.15 years; 72% male; 74% urban). Mean height, weight, BMI, and injury-to-presentation interval were 1.71±0.09 m, 71.63±14.60 kg, 24.4±4.3 kg/m², and 32.46±18 days, respectively. Road traffic accidents predominated (59%), followed by falls from heights (23%), assaults (11%), and other incidents (7%). ASIA distributions were as follows: C-Incomplete (35%), D-Incomplete (22%), A-Complete (22%), B-Incomplete (18%), and E-Normal (4%). The MRI patterns were as follows: cord contusion (58%), cord oedema (23%), and cord haemorrhage (19%). The SCI type–ASIA association was not statistically significant (χ^2, P=0.298). Stratified analyses revealed no significant effect modification by age (P = 0.214), gender (P = 0.521), mechanism (P = 0.819), or duration (P = 0.903).* ***Conclusion:*** *In this young, predominantly male cohort, cord contusion was the commonest MRI pattern, and incomplete ASIA grades predominated. The SCI type did not show a significant correlation with the ASIA grade at presentation. Larger, longitudinal studies are warranted to refine prognostication and inform prevention strategies.*

Keywords: spinal cord injury; ASIA scale; MRI; cord contusion; cord oedema; intramedullary haemorrhage; road traffic accident; prevalence; Karachi; trauma

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Introduction

Spinal cord injury (SCI) is a life-altering condition with substantial personal and societal costs. Recent global estimates suggest annual traumatic SCI incidence around 13 per million population, with wide regional variation and higher incidence in many low- and middle-income countries (LMICs) (1,2). Road traffic crashes and falls are consistently reported as the leading mechanisms of injury worldwide (2,3). In Pakistan and comparable LMIC settings, preventable trauma mechanisms, limited prehospital care, and constrained rehabilitation capacity amplify disability burden, underscoring the need for locally relevant data to inform prevention and care pathways (4).

Beyond epidemiology, early imaging and standardised neurologic grading are central to prognosis after SCI. Magnetic resonance imaging (MRI) is considered the Gold standard modality for characterising intramedullary injury patterns in the acute phase. Classic T2-weighted sagittal signal patterns, including standard cord, single-level edema, multilevel/diffuse edema, and mixed edema-hemorrhage, carry prognostic value (5). Intramedullary haemorrhage portends the worst neurological recovery, whereas isolated oedema is associated with more favourable outcomes; the greater the longitudinal extent of oedema, the poorer the motor recovery (5,6). These MRI features, in conjunction with clinical assessments, can help stratify expected recovery and inform acute decision-making (7).

The International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) and the American Spinal Injury Association (ASIA) Impairment Scale (AIS) provide a validated common language for severity grading (A–E) and follow-up comparisons (8). The initial AIS grade is among the strongest predictors of one-year function; less severe grades (e.g., AIS D) show high probabilities of community ambulation. At the same time, AIS A completeness is associated with low rates of walking recovery (9–11). Natural-history data indicate that roughly 20–30% of AIS A patients convert to incomplete (AIS B–D) by one year, with higher conversion in cervical than thoracic injuries; however, meaningful ambulation remains uncommon in those initially complete (10,11). Integrating MRI lesion type with AIS may further refine prognostication: oedema-dominant lesions and higher admission motor scores predict better one-year functional independence, whereas hemorrhagic signal and older age predict worse outcomes (9).

Despite these advances, there is a paucity of contemporary, context-specific evidence from South Asia linking MRI-defined injury types (cord oedema, contusion, haemorrhage) to AIS grades at presentation. Given different trauma profiles (e.g., road traffic crashes, falls from height, heavy-weight impacts) and health-system constraints, local data are needed to benchmark prevalence patterns and test associations between imaging phenotypes and neurologic severity at intake.

The objective of the study is to determine the prevalence of different MRI-defined traumatic spinal cord injury types (cord oedema, contusion, haemorrhage) among adult patients presenting to SMBBIT, DUHS,

Karachi, and to compare these injury types across ASIA impairment grades (A–E) at presentation.

Methodology

This cross-sectional study was conducted at the Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Dow University of Health Sciences (DUHS), Karachi, over a period of six months from 1st September 2024 to 28th February 2025. A non-probability sampling technique was used. The minimum sample size was calculated as 83 traumatic spinal cord injury (SCI) patients, based on a cord oedema frequency of 22.5%, a 9% margin of error, and a 95% confidence level. Adult patients aged 18–60 years of either gender who presented within two months of injury and in whom SCI aetiology was attributable to trauma were eligible. Patients with spinal cord dysfunction secondary to central nervous system lesions (e.g., multiple sclerosis, pyogenic meningitis) or vascular insults (e.g., anterior spinal artery thrombosis) were excluded. Consecutive eligible patients attending the Department of Neurosurgery were approached, and written informed consent in Urdu was obtained from participants or, when necessary, from their attendants. Data were collected using a pre-designed questionnaire and a pro forma. Demographic and clinical variables included age, sex, height, weight, body mass index (BMI), educational status, residential status (urban/rural), duration since injury (days), and mechanism of injury (road traffic accident, assault, fall from height, or fall of heavy weight on head). Each patient's neurological status was graded using the American Spinal Injury Association (ASIA) Impairment Scale (A–E) according to operational definitions. All participants underwent MRI, and intramedullary injury was categorized as cord contusion, cord edema, or cord hemorrhage and recorded on the proforma. Data were entered and analysed in SPSS version 23. Quantitative variables (age, height, weight, BMI, and duration of injury) were tested for normality using the Shapiro–Wilk test. Variables with a P-value greater than 0.05 were summarised as the mean ± standard deviation; otherwise, they were summarised as the median (range). Qualitative variables (gender, educational and residential status, income category, mechanism of injury, ASIA grade, and SCI type) were presented as frequency (%). Associations between SCI type and ASIA grade were assessed using the chi-square test. Effect modification was explored through stratification by age, gender, mechanism, and duration of injury, followed by chi-square testing, with $P<0.05$ considered statistically significant.

Results

The study included 83 adults with traumatic SCI. The mean age was 37.77 ± 10.15 years; mean height 1.71 ± 0.09 m; mean weight 71.63 ± 14.60 kg; and mean BMI 24.4 ± 4.3 kg/m². The mean duration from injury to presentation was 32.46 ± 18.00 days. Most participants were male (60/83, 72%) and resided in urban areas (61/83, 74%). Educational attainment was predominantly secondary (38/83, 46%), followed by tertiary (20/83, 24%), primary (18/83, 22%), and no formal education (7/83, 8%). The monthly income status was clustered in the lower brackets: low (<50k PKR) in 38/83 (46%), middle (50,000–100k PKR) in 34/83 (41%), and high (>100k PKR) in 11/83 (13.3%). Road traffic accidents were the leading mechanism of injury (49/83, 59%), followed by falls from height (19/83, 23%), assaults (9/83, 11%), and falls of a heavy weight on the head (6/83, 7%).

Neurologically, ASIA grades at presentation were most commonly C-Incomplete (29/83, 35%), followed by D-Incomplete (18/83, 22%), and A-Complete (18/83, 22%). B-Incomplete was observed in 15/83 (18%), and E-Normal in 3/83 (4%). On MRI, cord contusion was the most frequent type of SCI (48/83, 58%), followed by cord oedema (19/83, 23%) and cord haemorrhage (16/83, 19%).

In the association between SCI type and ASIA grade, counts were as follows: for cord contusion, A = 14, B = 8, C = 15, D = 10, E = 1; for cord edema, A = 2, B = 2, C = 7, D = 6, E = 2; and for cord hemorrhage, A = 2, B = 5, C = 7, D = 2, E = 0. The overall chi-square test indicated no statistically significant association ($P = 0.298$). Effect-modification analyses (stratified summaries with ASIA as outcome) likewise showed no significant differences across strata. By age group, ASIA distributions were: 18–30 years (A = 3, B = 6, C = 12, D = 5, E = 0), 31–40 years (A = 2, B = 5, C = 7, D = 6, E = 1), 41–50 years (A = 12, B = 3, C = 7, D = 4, E = 2), and 51–60 years (A = 1, B = 1, C = 3, D = 3, E = 0), with $P = 0.214$. By gender, males had A = 13, B = 13, C = 19, D = 12, E = 3 and females had A = 5, B = 2, C = 10, D = 6, E = 0 ($P = 0.521$). By mechanism, road traffic accident (A = 10, B = 8, C = 17, D = 13, E = 1), assaults (A = 1, B = 2, C = 4, D = 2, E = 0), fall from height (A = 5, B = 4, C = 5, D = 3, E = 2), and fall of heavy weight (A = 2, B = 1, C = 3, D = 0, E = 0) yielded $P = 0.819$. By duration group, 0–30 days (A = 8, B = 6, C = 14, D = 10, E = 1) versus 31–60 days (A = 10, B = 9, C = 15, D = 8, E = 2) produced $P = 0.903$. Overall, none of the stratified comparisons demonstrated statistically significant variation in ASIA grade distributions across the examined modifiers.

Table 1: Demographic and clinical variables

Variables	Mean and Frequency
Age (years)	37.77±10.15
Height (m)	1.71±0.09
Weight (kg)	71.63±14.6
BMI (kg/m2)	24.4±4.3
Gender	
Male	60 (72%)
Female	23 (27%)
Residential Status	
Urban	61 (74%)
Rural	22 (26%)
Education Status	
Secondary	38 (46%)
Tertiary	20 (24%)
Primary	18 (22%)
None	7 (8%)
Monthly Income Status	
Low (<50k PKR)	38 (46%)
Middle (50–100k PKR)	34 (41%)
High (>100k PKR)	11 (13.3%)
Mechanism of Injury	
Road Traffic Accident	49 (59%)

Fall from height	19 (23%)
Assaults	9 (11%)
Fall of heavy weight on the head	6 (7%)
Duration of Injury (days)	32.46 ±18

Table 2: Frequency of ASIA score and SCI type

ASIA Scale	Frequency
C-Incomplete	29 (35%)
D-Incomplete	18 (22%)
A-Complete	18 (22%)
B-Incomplete	15 (18%)
E-Normal	3 (4%)
SCI Type	Frequency
Cord Contusion	48 (58%)
Cord Edema	19 (23%)
Cord Hemorrhage	1619%

Table 3: Association of ASIA with SCI

SCI Type	A-Complete	B-Incomplete	C-Incomplete	D-Incomplete	E-Normal	P Value
Cord Contusion	14	8	15	10	1	0.298
Cord Edema	2	2	7	6	2	
Cord Hemorrhage	2	5	7	2	0	

Table 4: Effect modifiers

Age_Group	A-Complete	B-Incomplete	C-Incomplete	D-Incomplete	E-Normal	P Value
18–30	3	6	12	5	0	0.214
31–40	2	5	7	6	1	
41–50	12	3	7	4	2	
51–60	1	1	3	3	0	
Gender						
Male	13	13	19	12	3	0.521
Female	5	2	10	6	0	
Mechanism of Injury						
Road Traffic Accident	10	8	17	13	1	0.819
Assaults	1	2	4	2	0	
Fall from height	5	4	5	3	2	
Fall of heavy weight on the head	2	1	3	0	0	
Duration_Group						
0–30 days	8	6	14	10	1	0.903
31–60 days	10	9	15	8	2	

Discussion

This single-centre cross-sectional series from Karachi reflects the demographic and injury patterns typically reported from low- and middle-income countries (LMICs). The cohort's young mean age (37.8 years) and male predominance (72%) are aligned with regional and global syntheses that show the highest traumatic SCI (TSCI) burden in working-age men, with incidence and case mix shaped by rapid urbanisation and road traffic growth (1–3). Road traffic accidents (59%) were the leading mechanism in our data, with falls (23%) and assaults (11%) contributing smaller shares, again mirroring Pakistani trauma system reports and local road-injury audits that identify motorised two-wheelers as a major driver of severe trauma in young males (13–15). The predominance of urban residence (74%) is also consistent with tertiary-centre catchment patterns in major Pakistani cities (13, 15).

Neurologically, incomplete injuries (AIS C 35%, AIS D 22%) outnumbered complete injuries (AIS A 22%). On MRI, cord contusion was most frequent (58%), followed by oedema (23%) and haemorrhage (19%). These distributions are plausible in light of classical MRI prognostic schemas originating from Kulkarni's description of oedema, haemorrhage, and mixed patterns—and subsequent reviews showing that haemorrhage is less common but portends worse neurological status and recovery, whereas isolated oedema carries a relatively better outlook (16–18). Prospective cervical SCI work by Miyanji et al. demonstrated that intramedullary haemorrhage and greater lesion length correlate with poorer outcomes, while oedema-predominant lesions fare comparatively better (16). Contemporary reviews reiterate that T2-weighted imaging is optimal for detecting oedema, and that GRE/SWI sequences improve sensitivity for haemorrhage and microhemorrhage, which typify contusion (17,18).

Against that backdrop, our chi-square test revealed no statistically significant association between SCI type and ASIA grade at presentation (P = 0.298). Several explanations are plausible. First, case-mix heterogeneity (cervical vs. thoracic level, polytrauma, and time-to-MRI)

and modest cell counts for less common categories (e.g., AIS E, haemorrhage) reduce statistical power. Second, MRI–clinical relationships can be time-dependent: MRI patterns capture tissue pathology, whereas ASIA grades reflect neurological impairment that may evolve with early care and treatment. Third, while haemorrhage is a known adverse sign, a purely cross-sectional baseline association may be diluted by confounding from level of injury and mechanism; stronger relationships often emerge in longitudinal analyses that track recovery trajectories (16–18).

Stratified analyses also yielded non-significant variation in ASIA distributions by age, gender, mechanism, or injury-to-presentation interval. Prior work links older age with poorer functional outcomes and higher mortality, and high-energy mechanisms with greater severity, but such effects may not manifest as differences in baseline ASIA categories once patients arrive at tertiary centres; instead, they more often influence recovery and complications over time (1–3,16–18). The absence of significant differences in our strata likely reflects limited subgroup sizes. It underscores the importance of larger, multicenter datasets and longitudinal follow-up to detect effect modification with adequate precision. Practically, our findings support the routine use of standardized ASIA grading and MRI reporting at intake, while recognizing that prognostication should integrate the level of injury, imaging details (including hemorrhage and lesion length), and time-to-care—factors that are better captured in prospective designs. In the context of Karachi, the high contribution of road traffic crashes underscores the need for preventive measures (helmet and speed enforcement) and system improvements (prehospital care, rapid imaging access), which can modify both initial severity and downstream outcomes (1,13–15).

Conclusion

This cross-sectional series from Karachi shows a young, predominantly male cohort with road-traffic crashes as the leading cause of traumatic SCI. ASIA grades were mostly incomplete, and cord contusion was the most frequent MRI pattern; however, SCI type was not significantly associated with ASIA grade at presentation. These findings support routine standardised ASIA and MRI assessment while highlighting the need for larger, longitudinal, multicenter studies to refine prognostication. Strengthening injury-prevention and early trauma care systems may further improve outcomes.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC--24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

References

1. Lu Y, et al. The global incidence and characteristics of spinal cord injury since 2000–2021: a systematic review and meta-analysis. BMC Med. 2024;22:285. https://doi.org/10.1186/s12916-024-03514-9
2. Liu Y, et al. Spinal cord injury: global burden from 1990 to 2019 and projections to 2030 using Bayesian age-period-cohort analysis. Front Neurol. 2023;14:1304153. https://doi.org/10.3389/fneur.2023.1304153
3. Kumar R, Lim J, Mekary RA, et al. Traumatic spinal injury: global epidemiology and worldwide volume. World Neurosurg. 2018;113:e345-e363. https://doi.org/10.1016/j.wneu.2018.02.033
4. Ullah ZB, Yaqoob E, Khan SA, Chaurasia B, Javed S. Struggle with traumatic spinal cord injury: a need for improved surgical and rehabilitation services. Neurosurg Rev. 2024;47:485. https://doi.org/10.1007/s10143-024-03304-7
5. Bozzo A, Marcoux J, Radhakrishna M, Pelletier J, Goulet B. The role of MRI in the management of acute spinal cord injury. J Neurotrauma. 2011;28(8):1401-11. https://doi.org/10.1089/neu.2009.1236
6. Mahmood NS, Kadavigere R, Ramesh AK, Rao VR. MRI in acute cervical SCI: correlation with spinal cord changes and 1-month motor recovery. Spinal Cord. 2008;46:791-7. https://doi.org/10.1038/sc.2008.55
7. Hussain AR, Saboo A, Ashraf M. Role of MRI to detect and evaluate spinal cord injury after trauma. Life (Basel). 2023;13(5):1140. https://doi.org/10.3390/life13051140
8. Rupp R, Biering-Sørensen F, Burns SP, et al. International Standards for Neurological Classification of Spinal Cord Injury: Revised 2019. ASIA; 2019.
9. Wilson JR, Grossman RG, Frankowski RF, et al. A clinical prediction model for long-term functional outcome after traumatic SCI. J Neurotrauma. 2012;29(13):2263-71. https://doi.org/10.1089/neu.2012.2417
10. Kirshblum SC, Botticello AL, Dyson-Hudson TA, et al. Characterising natural recovery after traumatic SCI. J Neurotrauma. 2021;38(10):1431-46. https://doi.org/10.1089/neu.2020.7316
11. Scivoletto G, Tamburella F, Laurenza L, et al. Who is going to walk? Factors influencing walking recovery after SCI. Front Hum Neurosci. 2014;8:141. https://doi.org/10.3389/fnhum.2014.00141
12. Ning GZ, Wu Q, Li YL, Feng SQ. Epidemiology of traumatic spinal cord injury in Asia: a systematic review. J Spinal Cord Med. 2012;35(4):229–39. https://doi.org/10.1179/2045772312Y.0000000021
13. Salman S, Saleem SG, Shaikh Q, Yaffee AQ, Selim M, Razzak JA, et al. Epidemiology and outcomes of trauma patients at The Indus Hospital, Karachi, Pakistan. Pak J Med Sci. 2020;36(S-1):S34–S39. https://doi.org/10.12669/pjms.36.ICON-Suppl.1717
14. Muhammad K, Shaikh S, Ashraf J, Hayat S. Characteristics, reasons, and patterns of road traffic injuries in Karachi: a cross-sectional study. Pak J Med Sci. 2022;38(4):862–7. https://doi.org/10.12669/pjms.38.4.4490
15. Qureshi MA, Khalique AB, Pasha IF, et al. Epidemiology of non-disaster spinal injuries at a spine unit: Rawalpindi experience. J Coll Physicians Surg Pak. 2010;20(10):667–70.
16. Miyanji F, Furlan JC, Aarabi B, Arnold PM, Fehlings MG. Acute cervical traumatic spinal cord injury: MR imaging findings

correlated with neurologic outcome—prospective study. Radiology. 2007;243(3):820–7. https://doi.org/10.1148/radiol.2433060583
17. Kurpad SN, Martin AR, Tetreault LA, Fischer DJ, Skelly AC, Mikulis D, et al. Impact of baseline magnetic resonance imaging on classification and prediction of outcomes after cervical spinal cord injury. Global Spine J. 2017;7(3 Suppl):151S–174S. https://doi.org/10.1177/2192568217703666
18. Parashari UC, Khanduri S, Bhadury S, Kohli N, Parihar A, Singh R, et al. Diagnostic and prognostic role of MRI in spinal trauma, its comparison and correlation with clinical profile and neurological outcome. J Craniovertebral Junction Spine. 2011;2(1):17–26. https://doi.org/10.4103/0974-8237.85309