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Demographic Profile of Traumatic Spine Injuries at a Level 1 Trauma Center of Eastern India: A Retrospective Study

Varun Tiwari[1] Shahid Iftekhar Sadique

[1] Department of Neurosurgery, IPGMER & SSKM Hospital, Bangur Institute of Neurosciences, Kolkata, West Bengal, India

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Address for correspondence Varun Tiwari, MCh, Neurosurgery, Department of Neurosurgery, IPGMER & SSKM Hospital, Bangur Institute of Neurosciences, Kolkata 700025, West Bengal, India (e-mail: drbigvarun@gmail.com).

Abstract

Background Trauma is a leading cause of hospitalization worldwide, with spinal injuries resulting from traumatic events having severe and lasting repercussions. The high incidence of these injuries places a significant burden on families and health care systems. Disparities in epidemiological findings often occur due to the location- or culture-specific factors. This study aims to address the inadequate attention given to morphological patterns and their impact on neurological damage severity, which affects functional outcomes over time.

Objectives The main objective of this study was to identify the injury patterns and detect associated spinal or extraspinal injuries in traumatic spine injury (TSI) patients who visited a level 1 trauma care facility in eastern India. Additionally, it aimed to establish a correlation between the severity, morphology, and grades of neurological damage with demographic characteristics.

Materials and Methods This retrospective cross-sectional study was conducted at the neurosurgery unit of the trauma and emergency department (TED) at a level 1 trauma center in eastern India. It involved TSI patients admitted between March 15, 2023, and March 14, 2024. Data were collected from paper-based records and compiled into a structured Excel format. The study included adult patients admitted to the TED with traumatic spinal cord injuries and excluded those from outpatient departments or those with incomplete data. Data analysis utilized the Muller AO classification, Injury Severity Score (ISS), and ASIA classification, with statistical analysis performed using IBM SPSS version 19.0.

Results Out of 320 patients, 309 met the inclusion criteria. The majority were males (263) with a median age of 39 years. Falling from a height (43.7%) was the most common mechanism of injury, followed by road traffic accidents (37.9%). Polytrauma was present in 73% of patients, with multilevel injuries more severe than single-region injuries. Type A fractures were most common (53.4%), and 67.6% of patients underwent surgery. A significant correlation was found between the ISS and ASIA scores.

Conclusion The study revealed differences in spinal injury epidemiology in eastern India compared to other regions, with multiple vertebral level injuries being more

Keywords

- American Spinal Injury Association (ASIA) classification
- eastern India
- epidemiology
- level 1 trauma center
- morphological patterns
- neurological damage
- polytrauma
- road traffic accidents
- traumatic spine injuries

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common. The findings highlight the need for government health care strategies focused on treatment and rehabilitation, especially for the younger age group that is predominantly affected. Preventive measures should also be strictly enforced to reduce the incidence of such injuries.

Introduction

Trauma is the primary cause of hospitalization worldwide, and spinal injuries resulting from traumatic events can have severe and lasting repercussions.[1,2] The high incidence of these injuries globally has placed significant burden on families and health care systems due to the associated costs.[3–7] While several epidemiological studies concerning spinal trauma exist within India as well as other countries globally, disparities in findings often occur due to differences in location and culture-specific factors.[3,5,6,8–12] Furthermore, there is an inadequate attention given toward morphological patterns, which can significantly affect neurological damage severity leading to diminished functional outcomes over time.[3,6,7] While associated injuries (AIs) may be elaborated upon by some researchers, these works typically center around extraspinal regions instead of taking into account multilevel involvement. However, with the advent of computed tomography (CT), identifying such injuries has become more manageable at most trauma centers today than previously anticipated.

The main objective of this study was to identify the injury pattern and detect any associated spinal or extraspinal injuries in traumatic spine injury (TSI) patients who visited our level 1 trauma care facility located in eastern India. Additionally, it aimed to establish a correlation between the severity, morphology, and grades of neurological damage with demographic characteristics. The results indicated that certain types of injuries were more common than anticipated.

Materials and Methods

At our level 1 trauma center in eastern India, a retrospective cross-sectional study was conducted at the neurosurgery unit of the trauma and emergency department (TED). The study involved patients of traumatic spinal cord injuries admitted to the TED between March 15, 2023 and March 14, 2024.

The inclusion criteria were the following: (1) patients with TSI, (2) trauma center admissions only, and (3) only adult patients of all the age groups. The exclusion criteria were the following: (1) patients coming to an outpatient department rather than at the trauma center, (2) patients with nontraumatic spinal fracture, and (3) patients having incomplete data set.

Patients' paper-based records were collected from the medical record departments compiled into a structured Microsoft Office Excel 365 worksheet, which included key demographic details like sex and age range as well as specifics regarding mode of the injury (MOI), region injured (cervical, thoracic lumbar findings) morphology, etc. Data were categorized according to the Muller AO classification[13] and the Injury Severity Score (ISS),[14] surgical outcome and 7-day mortality rate were determined. All the patients underwent radiography that included plain radiographs of the spine and whole spine CT scans. The involvement of the segments was notified as monosegment, multi-continuous segment (>2 segments), or multi-noncontinuous segment (>2 segments, i.e., skip lesions).

The ASIA classification[15] was used to grade spinal cord injuries. Grades A to C were considered useless functional power, while grades D and E indicated useful functional power. The ISS score was calculated using the Advanced Trauma Life Support (ATLS) guidelines for different types of injuries: head, maxillofacial, chest, abdominal, and external injuries.[16,17] Management approaches (surgical or conservative) determined postinjury outcomes with patient referrals noted along with early deaths within 7 days.

Statistical Analysis

The statistical analysis was carried out utilizing IBM, US SPSS version 19.0. Frequency or percentages are used to convey categorical variables. Data were normality assessed using the Shapiro–Wilk test. The chi-squared test was used for bivariate analysis of the categorical variables. The interquartile range (IQR) is the median for numerical variables. The correlation between the ISS and ASIA scores was ascertained using Spearman's correlation. It was deemed statistically significant when $p < 0.05$.

Results

In all, 320 patients were deemed qualified for the study, out of which 309 satisfied the inclusion criteria, and their full data were accessible. The median age of the patients was 39 years, with the IQR and age range of 28–49 years and 15–75 years, respectively. The ratio of men to women (M:F) was (263:46) or 5.87:1. The most common MOI was falling from a height (43.7%), which was followed by road traffic accidents (RTA) in 37.8%, and trauma in a small number of instances for unspecified reasons. Two individuals who had experienced an electrocution were included in the group for other reasons. The age group most frequently affected was 31 to 40 years, followed by 21 to 30 and 41 to 50 years.

The majority of the patients (50.5%) were transported by government ambulance, with private ambulances and

personal vehicles accounting for 28.2% and 20.4% of the patients' mode of transportation, respectively.

In all, 73% of patients exhibited polytrauma (ISS > 15), as indicated by the median ISS of 21. Patients of multilevel involvement had a higher mean ISS (31%) compared to patients with thoracic (23%) and cervical (20%) spine injuries. Ninety patients had cervical spine injuries, 72 had dorsal spine injuries, 39 had lumbar spine injuries, 9 had junctional (dorsolumbar) spine injuries, and 1 patient suffered a sacral fracture. The results showed 42 (13.6%) continuous multilevel injuries and 54 (17.5%) skipped multilevel injuries.

In the case of primary spine fractures, type A (A1–A4; $n = 166$, 53.7%) was the most common fracture morphology type, followed by type C ($n = 91$, 29.4%) and type B ($n = 49$, 15.9%). Three patients had type D fracture, including a sacral fracture, an odontoid fracture, and a Jefferson fracture, but were not included in the morphological groups mentioned above. Males were more likely than females (29:1) to have severe injuries of category C, with the C5–C6 vertebra being the most commonly displaced area. The majority of associated spine (secondary) injuries were seen in fractures of the A1 and A2 variants. Three patients who were skipped had an A0 fracture morphology; two of them displayed a spinous process fracture and one patient showed a transverse process fracture.

Of all the patients, the majority ($n = 90$, 29.3%) had complete neurological impairment, or ASIA-A, whereas 40 patients had ASIA-E (neurologically intact). Among patients with incomplete neurology, 123 were found to possess worthless functional power (i.e., ASIA-B, $n = 60 +$ ASIA-C, $n = 63$), while 56 were found to have beneficial functional power (ASIA-D). The AIs are compiled in ►**Tables 1** and **2**. A few examples of fracture patterns are shown in ►**Figs. 1**–**3**.

We observed a substantial association (Spearman's $\rho = 0.560$, $p < 0.001$) between the ISS and ASIA scores. A statistically significant chi-squared correlation was also identified between morphology to grade and neurological grade (ASIA; Pearson's $\chi^2 = 69.7$, $p < 0.001$).

At our center, 209 TSI patients (67.6%) had surgery, whereas 90 patients (29.1%) received conservative care.

Table 1 Scheme of other associated spine injuries ($N = 96$)

Type of injury	Region involved	Frequency (n)
Multilevel continuous spine injuries ($N = 42$)	Cervical	22
	Dorsal	7
	Lumbar	4
	Junctional (dorsolumbar)	9
Multilevel discontinuous spine injuries ($N = 54$)	Cervical and dorsal	9
	Cervical and lumbar	3
	Dorsal and lumbar	12
	Lumbar and lumbar	9
	Dorsal and dorsal	15

Table 2 Scheme of associated nonspinal injuries ($N = 309$)

Type of Injury	Frequency, n (%)
Associated nonspinal injuries	
Head injury	75 (24)
Maxillofacial injuries	36 (12)
Blunt trauma chest	57 (18)
Blunt trauma abdomen	12 (4)
Soft tissue injury	180 (58)
Extremity injury	84 (27)
Associated fracture injuries	
Skull	18 (6)
Ribs	36 (12)
Pelvis	6 (2)
Shoulder	9 (3)
Upper extremity	48 (16)
Lower extremity	36 (12)

Polytrauma caused 10 hospitalized patients to pass away too soon, before any intervention could be done.

Discussion

Patients with TSI who were admitted to the TED of the level 1 trauma center located in eastern India over a 1-year period were included in our study. Males and younger individuals (20–30 years) were the most affected group. This finding is consistent with the majority of studies conducted in India and overseas.[3,7,12] In contrast, the mean age of the affected individuals in Aleem et al was 51.2 years.[5] It is interesting to note that Singh et al observed a declining tendency (M:F ratio of 2.85:1) in the sex skewness among injury patients in multiple studies conducted chronologically.[12] In contrast to Aleem et al's findings, which revealed a low sex ratio of 1.52:1, we observed a higher M:F ratio of 5.9:1.[5] The majority of our patients came from rural areas where men are typically the primary breadwinners; in contrast, the sample included in Aleem et al's study was primarily from metropolitan areas where sex skewness is lower. In line with Leucht et al's findings, we discovered that more men had more serious injuries.[3]

With the exception of the study by Singh et al that indicated RTA to be the more frequent cause as mentioned in the western studies, we discovered that fall from height (roof, trees, and poles) is the most prevalent cause of injury (MOI). This finding is consistent with those of other Indian studies.[3,6] The greater AIs in our study, however, can be explained by the fact that our RTA percentage was higher than that of previous Indian studies. We also had two instances of electrocution that resulted in falls from heights that matched Mathur et al's observations.[18] According to Leucht et al, RTA is the main cause of thoracic injuries because it takes a significant amount of effort to break the robust rib cage that protects the dorsal spine.[3]

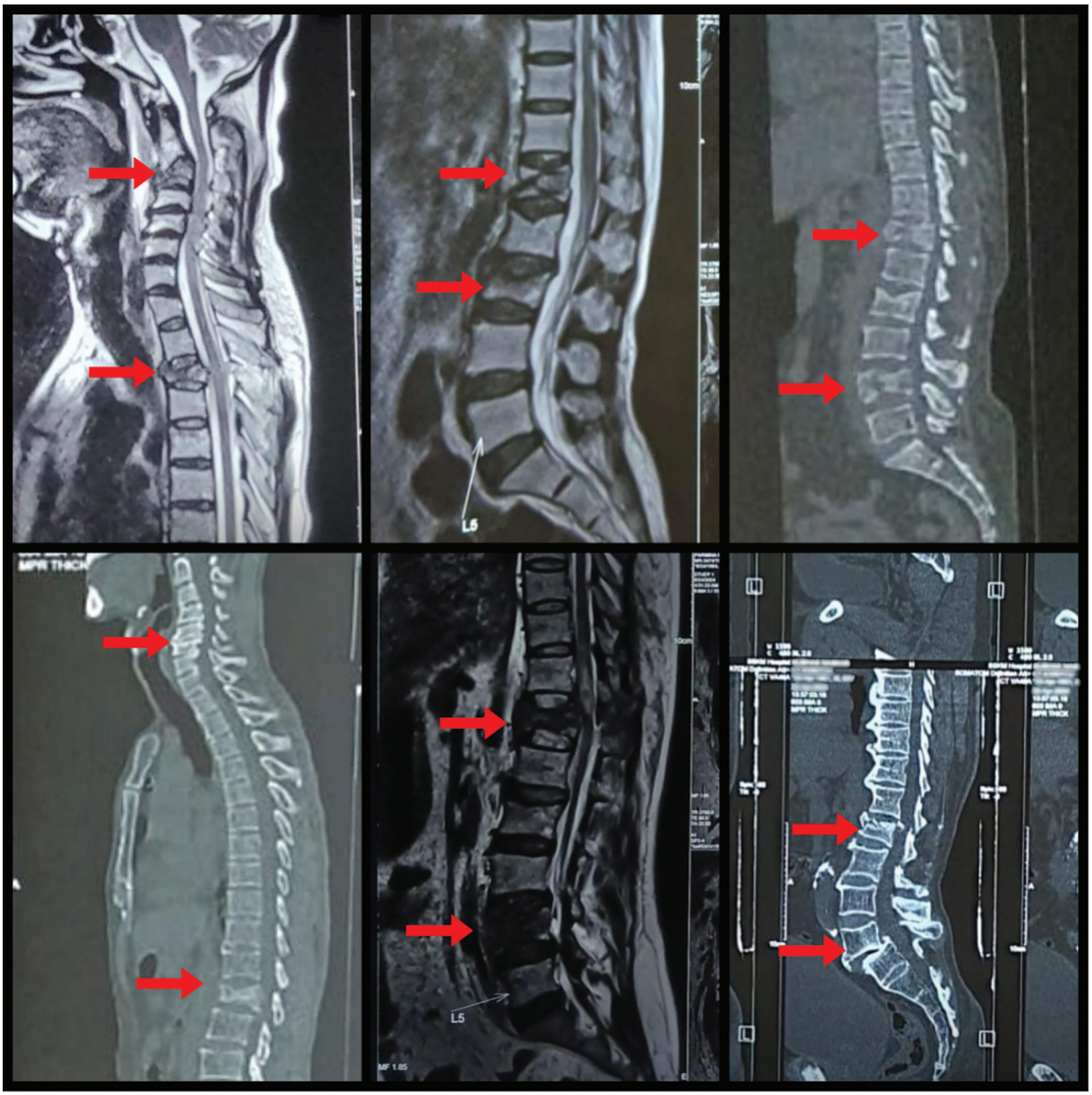

Fig. 1 Various types of noncontinuous spinal fractures. The arrows indicate the level of injury in the spine as seen in CT or MRI images.

Nevertheless, we did not detect this in our investigation, even though the mean ISS for thoracic injuries was higher than that for cervical injuries, supporting the conclusions of den Ouden et al.[11]

According to Singh et al, prehospital services are accessible to roughly 79% of patients since they are put up organizationally.[6] About 25% of our patients were not taken by ambulance but rather by private vehicles. Since the country's toll free ambulance services were introduced, the trend in the usage of ambulance services has changed; only 23% of patients had access to ambulance services 15 years ago, per a survey.[12] Birua et al found that over 90% of patients were not accompanied by qualified staff in more difficult terrains, such the northeastern region of our nation, where patients continue to use private automobiles.[7]

Numerous studies conducted in India have found significant variations in the regional pattern of damage. While Singh et al[6] observed that the thoracic area was the most frequently injured region, Birua et al[7] found that the cervical region was the most frequently injured region. According to Singh et al[12] and Aleem et al,[5] the most prevalent sites of injury were the lumbar spine and the thoracolumbar area, respectively. We established that the cervical spine region was the most often affected location, while the overall percentage was dominated by multilayer vertebral injuries. Higher lumbar involvement has been documented in studies from China and Germany.[3,19] On the other hand, our investigation confirmed the high thoracic damage and multilevel involvement reported in a study conducted in the Netherlands.[11] Not a single study conducted in India has examined the morphological pattern of damage. At the time of hospitalization, we discovered a high correlation between the morphological pattern and the ISS and neurological impairment. More than half of the

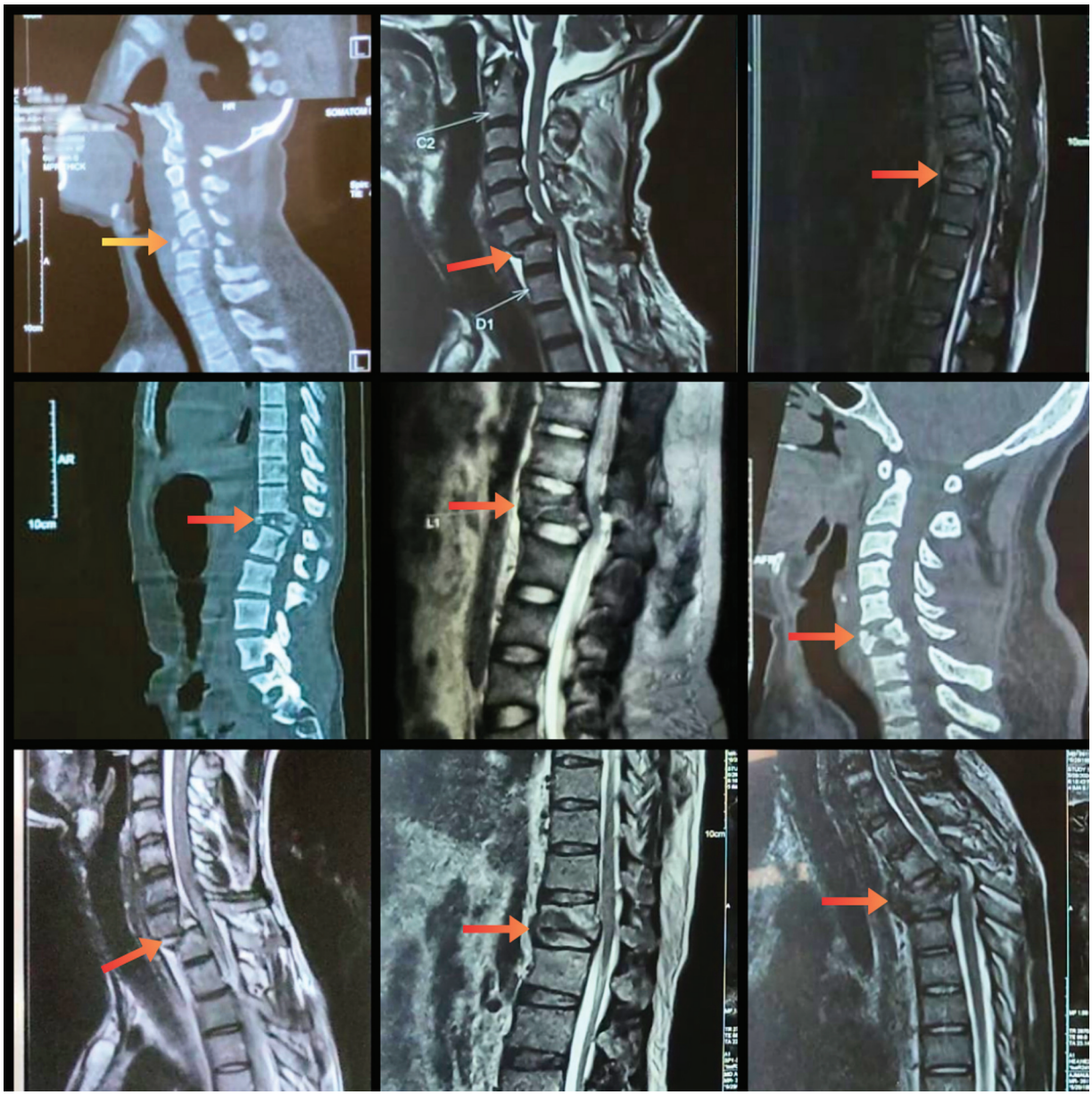

Fig. 2 Various types of isolated spinal fractures.

patients in Leucht et al were type A (54%), with type B accounting for 16.9% patients and type C 18.5% patients. Roughly 10% of the patients had C1–C2 injuries.[3] A similar pattern was seen in our analysis, where 53% of cases were type A (A1–A4), compared to a higher type C of 29% and only two cases of C1-C2 fractures and one case of sacral fracture. In contrast to Leucht et al's data, we observed only nine dorsolumbar injuries and no fracture bias toward the dorsal spine's junctional area.[3]

Compared to other Indian research, our study showed a higher number of patients who had neurological impairment at the time of hospitalization.[6,18] Conversely, Leucht et al discovered that intact neurology was present in 75% of the patients.[3] According to Van Asbeck et al[20] and Kiwerski,[21] the incidence of paraplegia (ASIA-A) and total tetraplegia was 4.8 to 50.6 and 16.0 to 85.1%, respectively. Comparing worthless motor power (ASIA-A to ASIA-C) to useful motor power (ASIA-D to ASIA-E), only 13.65% of patients in our study possessed ASIA-E. Significant brain damage suggests much more dire financial ramifications for the sufferer, family, and state. Leucht et al reported a high amount of type A fractures that were osteoporotic spine injuries, especially in female patients. The authors' stated undamaged neurology and balanced sex distribution may be attributed to this observation.[3] According to a study, type B and C fractures result in more neurological impairment than type A fractures.[22] We discovered a positive link between morphology and ASIA-based grading severities, as well as between the severity of the injury and the degree of neurological impairment. Additionally, Leucht et al noted that over 60% of patients with multiple traumas were totally paralyzed.[3] In contrast, multilevel fractures were less common among the patients who had cervical spine injuries in our study and were placed in the ASIA-A group.

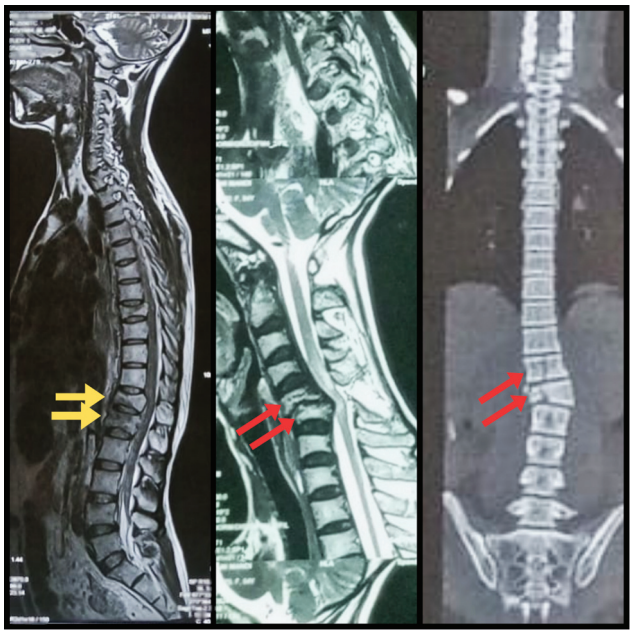

Fig. 3 Various types of continuous spinal fractures.

Multiple vertebrae are involved in spinal injury, according to several studies.[23,24] None of the Indian investigations, nonetheless, have identified any patterns. Decades ago, Calenoff et al described three kinds of skipped engagement.[23] In 28% of patients with cervical spinal injuries, Choi et al found noncontiguous cervicothoracic junction or upper thoracic spine injuries.[24] While the dorsal and lumbar spines showed noncontinuous involvement, the cervical area showed continuous multilevel involvement. The predominant pattern in secondary vertebral fractures was type A, or compression type. This secondary injury morphology has not been documented before. Additional biomechanical assessment is necessary to determine the precise cause and mechanism of this intricate kind of injury. However, most patients in our study had severe neurological damage, that is, ASIA C and above, larger ISS, AI, and RTA as the mechanism of injury.

Extraspinal AIs were found in around 25.7% of the participants in Mathur et al's investigation.[18] With sexually transmitted illnesses excluded, we found a rate as high as 57.3% in our study, which is lower than what was reported by van Ouden et al.[11] The most frequent related injury, according to Aleem et al[5] and Singh et al,[6] is head injury (HI).[5,6] According to Iida et al, moderate or severe HI was linked to one-third of patients with spinal cord injuries.[22] As opposed to HI (24.3%), we obtained more extremities injuries (27.3%). Higher extremity injuries and a strong correlation between multilevel spinal and related injuries were also documented by Leucht et al.[3] We discovered that rib injuries are more frequent in thoracic spine injuries, as noted by Mathur et al.[18]

Compared with patients included in other different Indian trials, where they were treated conservatively, over 50% of our patients had surgery.[7,12] More individuals with unstable morphology and neurological impairment necessitating surgery made up our study population.

We tried to find a relationship between different spinal and extraspinal regions and the morphological and neurological patterns in several areas, despite the small dataset. However, due to the retrospective nature of the study and the lack of appropriate data, we were forced to eliminate several individuals. The limited number of participants in our study group can be explained by patient segregation, and Kolkata, the capital city, has five to six additional medical colleges. Furthermore, we omitted information about prehospital management and whether the patient was accompanied by trained staff when they were admitted to the hospital. Since the majority of the patients had neurological impairment, long-term results in terms of functional status were not assessed. Prospective multicenter studies are necessary to confirm and provide a detailed picture of the different associations with TSI.

Conclusion

There are differences in the spinal injury epidemiology in eastern India compared to other regions of the nation. We discovered that multiple vertebral level injuries were more common than a single, isolated regional damage. In our study cohort, neurological impairment, AIs, and injury severity were more common. Given that the young age group is primarily impacted, there is a significant chance of long-term effects. In light of the lack of suitable spinal rehabilitation facilities, which are essential for helping these patients to achieve some degree of physical independence, government health care strategies should be focused on the treatment and rehabilitation of these patients. Simultaneous preventive actions should also be strictly enforced.

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None.

Conflict of Interest
None declared.

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