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Dissection of the Demographic and Clinical Profile of Patients with Traumatic Spinal Cord Injury in Central India: A Retrospective Observational Study

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Abstract: ***Traumatic spinal cord injury is one of the leading causes of morbidity and mortality worldwide. The objective of this study was to establish the clinico-demographic profile of patients with TSCI. Between 25th July, 2020 and 24th July, 2022 218 patients with TSCI who presented to the trauma and emergency department of a level 1 trauma centre in central India were included in a retrospective cross-sectional study. Information on Demographic data, mode of injury, fracture morphology, neurological grading, treatment details were obtained. Correlation among neurological injury as per American Spinal Injury Association (ASIA) score, injury severity score (ISS), morphological patterns as per AO classification and final outcome was ascertained. The median age was 35 years, and the gender ratio was 2.6:1. Road traffic accident (54.1%) was the most common MOI. The median ISS was 19.4, and the percentage of patients with poly-trauma was 73.4% (ISS > 17). Cord contusion was present in 53.3% patients. Single level injury (83.5%) was the predominant pattern of injury with the Commonest vertebral level injured being Lumbar (37.7%) followed by Cervical (28.4%) and Thoracic (17.4%). Nearly one in every six patients (16.5%) had multiple level injury. The most common type of vertebra fracture as per AO Classification was AO Type A fractures (74.3%) followed by AO type C (11.0%) and AO type B injuries (8.2%) most patients had ASIA A neurology at the time of presentation (31.2%) followed by ASIA E (21.1%), ASIA B (20.2%), ASIA D (14.7%) and ASIA C (12.8%) which accounted for most patients with non-usable muscle power (ASIA A, B and C) at the time of presentation (64.2%) with only 35.8% patients having usable muscle power (ASIA D and ASIA E). The correlation between ISS and ASIA scores (Spearman's = 0.581, P < 0.001) and between morphology type and ASIA score (Pearson's $\chi 2 = 68.9$, P < 0.001) was statistically significant.***

Keywords: Traumatic Spinal Cord Injury TSCI, clinico-demographic profile, neurological grading ASIA score, injury severity score ISS, AO classification

1. Introduction

Globally, trauma is the leading cause of hospitalization, and spinal injuries due to trauma can be devastating and permanent. Several studies have reported a high prevalence of trauma-associated spinal injuries in the young and economically productive age group, wherein the patients require long-term intensive rehabilitation endeavours (1). The increasing prevalence has been a cause of a significant burden on the family and society in terms of health-care costs. A few epidemiological studies on spinal trauma have been performed in India and in other countries. However, findings pertaining to demographic profile and injury region are disparate in these studies because of varied geographical or cultural differences. Moreover, the morphological pattern has not been given due importance in most of the epidemiological studies. This pattern is closely related to injury severity, neurological damage, and eventually in the long-term functional outcome. Although studies have elaborated on associated injuries (AIs), most of them have mainly focused on extraspinal regions. However, most of the trauma centres perform computed tomography of the entire spine, which has facilitated the identification of multilevel involvement more frequently than expected (2).

The present study is aimed at primarily identifying the pattern of injury and presence of associated spinal and extraspinal injuries and to determine the correlation between severity, morphology, and grades of neurological damage in addition to the demographical characteristics of patients with traumatic spine injury (TSI) who presented to the emergency department of a level 1 trauma care centre in central India (3).

2. Methods

This retrospective cross-sectional study was performed at the trauma and emergency department (TED) of a level 1 trauma care centre in central India. The study sample included patients with TSI admitted to the TED between July 15, 2020 and July 14, 2022. The Investigational Review Board of All India Institute of Medical Sciences, Raipur, approved the study (IEC number AIIMS/ RPR/Acad/TRC/Surg/2021/15). The study is compliant with the Strengthening the Reporting of Observational Studies in Epidemiology statement guidelines for reporting observational studies. The inclusion criteria were as follows: (1) traumatic spinal cord injury; (2) hospital admission through a TED; and (3) adult patients of all age groups. The exclusion criteria were as follows: (1) presentation to an outpatient clinic rather than a TED; (2) non traumatic (i.e., pathological) spinal fracture; and (3) incomplete data.

Data pertaining to patient demographics (age and sex), mode of injury (MOI), region of spinal injury (cervical, thoracic, lumbar, and sacral), and injury morphology were collected. The collected data were classified according to Muller AO (Arbeitsgemeinschaftfür Osteosynthesefragen) classifications, and injury severity score (ISS), surgical outcome, and 7-day mortality rate were determined. All patients underwent spinal imaging that included plain radiographs and whole spine computed tomography (CT) scan. The involvement of segments was noted as mono (1 segment), multicontinuous (≥2 segments), or multi-noncontiguous (≥2 segments, skip lesions) (4).

Spinal cord injuries were graded according to the American Spinal Injury Association (ASIA) classification. GradesA to C were grouped together as useless functional power, and Grades D to E were grouped together as useful functional power (5). The ISS was calculated on the basis of AIs classified as per the Advanced Trauma Life Support guidelines as follows: head injury (HI), maxillofacial injury, chest injury, abdominal injury, extremity injury, and external injuries. The outcome after injury was classified on the basis of the selected management approach, surgical or conservative. The number of patients referred was also noted along with early death (within 7 days). Statistical analysis was performed using R version 3.6.1© (The R foundation, Vienna, Austria). Categorical variables are expressed as frequency or percentages. Data were analysed for normality according to the Shapiro–Wilk test. Bivariate analysis of categorical variables was performed using Chi-square test. Numerical variables are expressed as median ± interquartile range (IQR). Spearman's correlation was used to determine the correlation between ISS and ASIA. $P < 0.05$ was considered statistically significant.

3. Results

This prospective observational study was conducted in the Department of Orthopaedics, AIIMS Raipur along with Department of Neurosurgery, AIIMS Raipur to study the clinic-demographic characteristics of patients with traumatic spinal cord injury presenting to a tertiary care centre in Central India. A total of 218 patients were included in this study over a span of 3 years and data related to their demographic and clinical features were collected and analysed. It was found that the younger population predominated with nearly half of the patients being in either age group <30 years (32.1%) or between 30 to 39 years (22.9%) with only 11.0% study participants being elderly (aged ≥60 years) with a male: female ratio of 2.6:1. The most common mechanism of injury was found to be RTA (54.1%) followed by Fall from height (> 2metres) (39.4%) followed by few other causes like electrocution, fall of heavy objects on back [Figure 1]. The majority of patients received inexperienced treatment on the initial encounter which indicated lack of appropriate pre-hospital handling of patients with traumatic spinal cord injury.

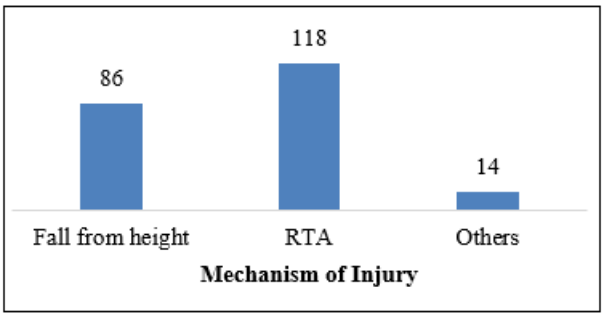

Figure 1: Distribution of the study subjects according to mechanism of injury [n=218]

Most of the patients with TSCI had Single level injury (83.5%) with the Commonest vertebral level of injury being Lumbar (37.7%) followed by Cervical (28.4%) and Thoracic (17.4%). Nearly one in every six patients (16.5%) had multiple level injury. Although, the commonest vertebrae involved were C2 and C3 (both 17.4%) followed by C5 (15.6%), C6 (14.7%) and T12, L1, L2 vertebrae (all 11.9%) [Figure 2]. 53.3% patients with TSCI had cord contusion upon presentation detected in MRI and it was found that it was most commonly present in patients with injury in cervicothoracic level and upper thoracic (T1-T6) level and least in lumbar region. The Injury Severity Score (ISS) of these patients ranged from 6 to 31 with the mean ISS being 19.4 which signified that most of the patients had severe injury with a high load of polytrauma in our region (73.4%) the most common associated injury was found to be lower limb injuries (28.5%) followed by upper limb injuries (20.2%) which was followed by head injuries (14.7%).

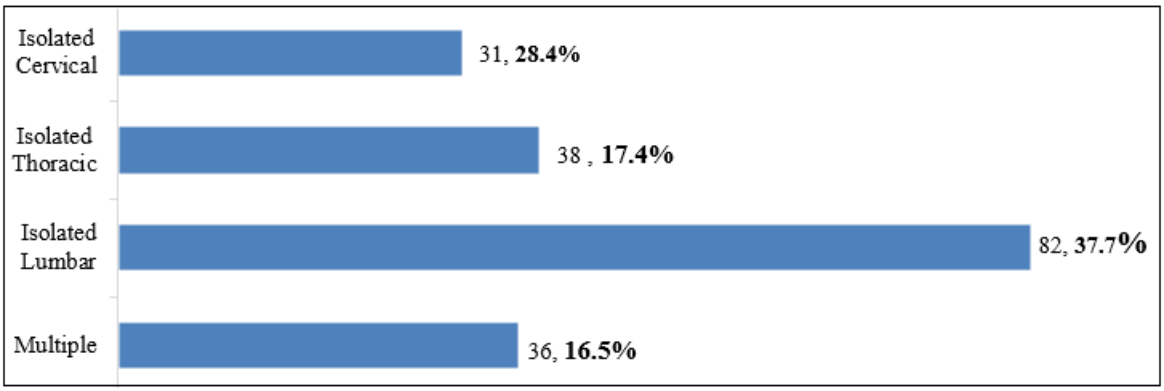

Figure 2: Distribution of the study subjects according to Spinous level of injury [n =218]

The most common type of vertebra fracture as per AO Classification was found to be AO Type A fractures (74.3%) followed by AO type C (11.0%) followed by AO type B injuries (8.2%) followed by few other types which couldn't be classified as per AO classification. The severe Type C injuries which consisted of translation injuries were more commonly seen in males as compared to females. Also C5-C6 was the most common vertebra to sustain translation injuries. In multilevel vertebral involvement, the most common associated fractures were A1 and A2 types followed by A0 type injuries. In cervical injury Type A (41.9%) and Type C (32.3) fractures are the most common type whereas in thoracic level injury Type A (68.4) and Type B (21.1) are common. All of the isolated lumbar injury had Type A lesion. Among multiple level injury Type, A (77.8) and Type B (11.1) are common. (FIGURE 3).

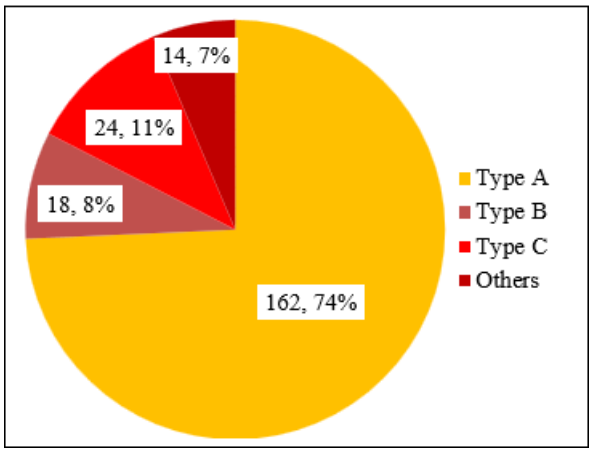

Figure 3: Distribution of study participants according to the AO grading [n =218]

In our study most of the patients had ASIA A neurology at the time of presentation (31.2%) followed by ASIA E (21.1%), ASIA B (20.2%), ASIA D (14.7%) and ASIA C (12.8%) which accounted for most patients with non-usable muscle power (ASIA A, B and C) at the time of presentation (64.2%) with only 35.8% patients having usable muscle power (ASIA D and ASIA E) at the time of presentation (FIGURE 4). Baseline ASIA scoring had a statistically significant association with polytrauma status calculated by injury severity score. Patients with AO Type C injury or translation type of injury had ASIA A (23.5%) neurology as the most common presentation followed by ASIA B (13.6%) neurology and few had ASIA C (7.1%) neurology. The baseline ASIA scoring had a statistically significant association with AO grading.

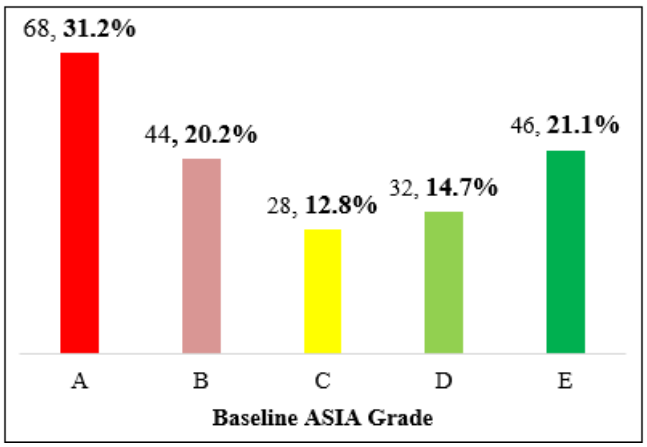

Figure 4: Distribution of study participants as per baseline ASIA grading [n =218]

Most of the patients underwent surgical management (83.5%) with only 16.5% patients underwent conservative management with bracing. Out of those who were managed surgically, posterior approach was the most commonly used approach (82.4%) followed by anterior approach which was exclusively used in cervical injuries and thereby followed by combined (anterior and posterior approach) which was also mostly used for complex cervical trauma. In the time span between 2020 march to 2021july amidst the COVID 19 pandemic we had operated 40 patients with traumatic spinal cord injury strictly adhering to the prevailing COVID 19 Guidelines, out of which 20 patients were having cervical vertebral injury, 10 with thoracic and remaining 10 with lumbar injury. There was no significant association of the outcome of patients with TSCI managed surgically with COVID infection or without COVID infection.

In our follow-up over a span of 1 year we compared the neurology in terms of ASIA grading and documented the poor outcomes (pneumonia, UTI, bed sores, etc including death). 6 patients had died in our entire study span out of which 2 patients died in the post-operative period due to post-operative pneumonia and remaining 4 patients died in their pre-operative preparatory phase all of whom had cervical AO type C injury with cord contusion with ASIA A neurology. It was also found that 20 patients (9.2%) had developed bed sore during the follow up span of 1 year.

In our follow-up after 1 year from the time of presentation, it was found that the most common neurology was ASIA E (49.1%) followed by ASIA C (17%), ASIA B (13.2%), ASIA D (11.3%) and finally ASIA D (9.4%). This observation too emphasized that maximum of our study participants had favourable outcome after 1 year of presentation. Thereafter we grouped the outcome of patients as “GOOD” if the patient had usable muscle power i. e ASIA D or ASIA E neurology and as “POOR” if the patient had non-usable muscle power i.e. ASIA A, ASIA B or ASIA C neurology or death.

Majority of the patients (70%) who had undergone surgery had improvement in their neurology, only one patient had deterioration in neurology and nearly one-fourth (28.9%) had same neurology. A statistically significant association was noted between type of management and change of neurological status. Only one person of all the patients in our study population had improvement in conservative management and the change of baseline ASIA grade was by grade 1. Among five people showing in improvement after anterior approach, mostly improved by grade1 (40%) or grade 2 (40%) as per the ASIA grading. In person having improvement after surgery by posterior approach majority improved by grade 1 (55.6%) or grade 2 (35.2%) ASIA Grades. Similar finding was also seen for combined approach where majority (75%) hade grade 1 improvement followed by grade 2 (25%). There was no statistically significant difference in grades of improvement by different approaches

Among the 182 participants who underwent surgery as the modality of treatment, good outcome (usable muscle power-ASIA D or ASIA E neurology) was present in 48.4% patients immediate post-operatively and in 56.9% patients in 1 year follow-up.

Based on the observation in our study we analysed the association of our study variables with the final outcome whereby we interpreted that no significant association of final outcome was noticed with age, gender, presence of comorbidity, delay in hospitalization and use of methyl prednisolone at the time of presentation. Mode of Injury like Road Traffic Accident (42.4%) and fall from height > 10 feet (51.2%) had a significantly higher chance of poor outcome (P Value = 0.040). On evaluation of level of vertebral injury, Multiple injury had highest incidence of

poor outcome (66.7%) followed by isolated Cervical (58.1%), Thoracic (57.9%) and Lumbar (14.6%) and this differential pattern was statistically significant (P value <0.001). Presence of cord contusion (79.3%) had significantly higher risk of poor outcome (P Value <0.001). Type C AO grade (91.7%) had significantly (P value =0.002) higher risk of poor outcome followed by Type B (55.6%) and Type A (35.8%). Higher injury severity score was significantly (P value< 0.001) associated with poor outcome. Absence of usable muscle power (67.1%) had significantly higher chance of poor outcome (P value< 0.001). All of them who needed ventilator support had poor outcome (p value=0.004).

Among the patients managed surgically, increased delay in surgery (P value=0.015) was significantly associated with poor surgical outcome. Those who were managed by combined approach had relatively higher (P value = 0.013) chance of poor outcome (85.7%) compared to anterior (22.2%) and posterior (52%) approach. All of them who developed bed sores also had poor outcome (p value<0.001)

Upon prognosticating our study participants based on the initial ASIA Scoring at the time of presentation where we found that all six deaths had occurred in patients with ASIA A neurology at the time of presentation. Only one person who had ASIA C grading in baseline deteriorated to ASIA B grading otherwise all of them either improved or maintained their grading. Significant improvement of ASIA score (improvement by grade 1 or 2) was noticed in most of the patients (P value <0.001). it was found that patients with ASIA A neurology had the worst outcome followed by ASIA B and ASIA C whereas patients with ASIA D and ASIA E neurology at presentation had best outcome.

On grading the improvement of ASIA Scores of the patients in follow-up based on the initial ASIA Score at presentation, it was found that most patients showed improvement in ASIA Scores by grade 1 and 2 with few patients having improvement by >=grade3. It was established that without sacral sparing, individuals with extended zones of sensory preservation who were motor-complete had a lower conversion rate to motor-incomplete status. Improvements in the motor score at 1 year were associated with injury severity score, with significant increases for better ASIA grades except grade D due to threshold effects. The prognosis for people with ASIA grade B injuries were mostly variable.

4. Discussion

With an ever growing population in India, the incidence and prevalence of traumatic injuries has been increasing, out of which traumatic spinal cord injuries does bear a significant proportion. Traumatic spinal cord injuries have been imposing a great socio-economic burden on the affected patient as well as their families. Despite the increasing load of traumatic spinal cord injuries in our country, there lacks proper epidemiological studies especially in central India with a wide disparity in between the existing studies. Also there is a lack of dedicated spine injury management centres in most of the government settings, which often leads to improper management of patients initially in primitive health care centres (3). All these data pertaining to the clinical and demographic pattern of TSCI thereby goes missing. Thus, there is a need to conduct study to understand the clinic-demographic pattern of patients with traumatic spinal cord injury so as to not only understand the clinic-demographic parameters of patients with TSCI but also prioritize the areas to focus in TSCI patients so as to decrease the socio-economic impact of these devastating injuries in the long run. AIIMS Raipur being an apex tertiary care institute in Central India with a dedicated trauma centre receives a huge patient load with traumatic spinal cord injuries, a study was conducted in our centre, wherein all the patients with traumatic spinal cord injury presenting to our institute over a span of 2 years after meeting our inclusion criteria were included in our study to get a knowledge about the clinical data and demographic parameters of patients with TSCI. In this study we also incorporated data related to management of patients with TSCI and correlated the outcome of the patients based on several parameters in order to help prognosticating patients. This would help us prioritize our focus in the loopholes of existing system which could potentially improve outcome of the patients with TSCI.

In our study it was found that the young population predominated in the scenario of TSCI with the mean age being 38.5 years similar to that in studies like those by Yusuf SA et al. (36 years), Chhabra et al. (34.4 years), and Movaghar et al (32.4 years) (6, 7). There was a large male preponderance (72.50%) comparable to that in similar studies by Chhabra et al., Movaghar et al., and Grivna et. al. The commonest mode of trauma was RTA (54.1%) followed by Fall from height (> 10 feet) (39.4%) similar to the findings in studies like that of Pickett *et al.* and Chhabra *et al.* while in few other studies the most common cause of TSCI was found to be fall from height (>2metres) as in that of Agarwal *et al.*, Mathur *et al.* and Birua *et al.* Among the 118 subjects facing RTA, majority had high velocity trauma (79.7%) and commonest mode in RTA is two-wheeler based accidents (50.8%) (3, 8, 9).

In our study, the most common type of vertebra fracture was found to be AO Type A fractures (74.3%) followed by AO type C (11.0%) and AO type B injuries (8.2%) followed by few other types which couldn't be classified as per AO classification. The severe Type C injuries which consisted of translation injuries were more commonly seen in males as compared to females. Also, C5-C6 was the most common vertebra to sustain translation injuries. In multilevel vertebral involvement, the most common associated fractures were A1 and A2 types followed by A0 type injuries. Comparison of study results which incorporated AO Classification distribution of patients with TSCI-

Study	Fracture morphology distribution as per AO classification
Our Study	Type A (74.3%)> Type C (11%)> Type B (8.2%)
Leucht et al (10)	Type A (54%)> Type C (18.5%)> Type B (16.9%)
Jain et al (11)	Type A (53%)> Type C (29%)> Type B (15.5%)

In cervical injury Type A (41.9%) and Type C (32.3) fractures were the most common type whereas in thoracic level injury Type A (68.4) and Type B (21.1) were common. All of the isolated lumbar injury had Type A lesion. Among multiple level injury Type A (77.8) and Type B (11.1) were common. This differential pattern was statistically significant. Based on neurological involvement at the time of presentation it was deciphered that the most had ASIA A (31.2%) followed by ASIA E (21.1%), ASIA B (20.2%), ASIA D (14.7%) and ASIA C (12.8%) similar to the findings in studies of Mathur N et al, Ibrahim A et al , Pickett E et al and Jain et al (11, 12).

Patients with ASIA A (91.2%), ASIA B (81.8%) and ASIA E (73.9%) neurology had higher incidence of being associated with polytrauma as compared to patients with ASIA C (50%) and ASIA D (43.8%) neurology. Baseline ASIA scoring had a statistically significant association with polytrauma status calculated by injury severity score.
Patients with AO Type C injury or translation type of injury had ASIA A (23.5%) neurology as the most common presentation followed by ASIA B (13.6%) neurology and few had ASIA C (7.1%) neurology. The baseline ASIA scoring had a statistically significant association with AO grading.

Based on the findings of our study, it was deciphered that majority of the study participants (74%) who had unusable muscle power at the time of presentation had improved in their neurological status as per ASIA grading, one deteriorated and nearly one-fourth (23.9%) remained same. Among patients with usable muscle power, majority (64.1%) maintained their status, none deteriorated and rest (35.9%) had improvement. A statistically significant association was noted between baseline usability of muscle power and change of neurological status.

Only two of all the patients in our study population had improvement in neurology with conservative management and the change of baseline ASIA grade was by grade 1. Among the ten patients showing in improvement after anterior approach, mostly improved by grade 1 (40%) or grade 2 (40%) as per the ASIA grading. In patients having improvement after surgery by posterior approach majority improved by grade 1 (55.6%) or grade 2 (35.2%) ASIA Grades. Similar finding was also seen for combined approach where majority (75%) had grade 1 improvement followed by grade 2 (25%). There was no statistically significant difference in grades of improvement by different approaches and conservative management.

Upon studying the common complications in follow-up like bed sore, pulmonary complications (like upper respiratory tract infection) and urinary tract infection it was found that the pulmonary and urinary tract infection at 1 month follow-up were well managed medically so that these complications were treated well and were absent at our final follow-up at 1 year thereby not affecting our final outcome. We had bed sores in 20 patients in our follow-up (9.2%), while 16 patients had pulmonary infection at 1 month follow-up (7.3%) and only 6 patients had urinary tract infection at 1 month follow-up (2.75%). These complications were much less as compared to other studies incorporating these findings. The distribution is given below-

Study	Bed Sore At 1 Month Follow Up	Respiratory Infection At 1 Month Follow Up	Urinary Trcat Infection At 1 Month Follow Up
Our Study	9.2%	7.3%	2.75%
Kumar S *et al.* (13)	5.37%	16.11%	3.35%
Yang R *et al.* (14)	13.6%	37.6%	26.3%

These findings emphasized that a good quality of post-operative care and apt family care in post discharge period would cater to the need of decreasing the postoperative dreadful complications. Also the existence of dedicated rehabilitation centres would help in proper adherence to the post-operative protocol.

5. Conclusion

The epidemiology of spinal injuries in central India is different from that reported in other parts of the country. We found more than one vertebral level injury to be predominant than any regional isolated injury. Because the younger age group is predominantly affected, the risk of long-term consequences is considerable. Hence, government health-care policies should be directed toward the treatment and rehabilitation of these patients considering the dearth of proper spinal rehabilitation centres that are crucial for making such patients physically independent to some extent. Furthermore, simultaneous preventive measures should be stringently implemented.

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