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Computed Tomography patterns of traumatic spine injury and their association with neurologic deficit at Addis Ababa burn emergency and trauma hospital

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Abstract

Background: The annual incidence of traumatic spine injury (TSI) is 10.5 cases per 100,000 persons, primarily caused by road traffic accidents (RTA) and falls. TSI can lead to lifelong paralysis, making early diagnosis with CT scans crucial. This study assesses CT scan patterns of TSI and their association with neurologic deficits from May 1, 2020, to June 1, 2021, at Addis Ababa Burn Emergency and Trauma (AaBET) hospital, Ethiopia.

Methods: An institutional-based cross-sectional study was conducted on all identified cases at AaBET hospital. Data were collected by trained general practitioners and senior radiology residents and analyzed using SPSS version 26. The Chi-square test was used to determine associations, with a p-value of <0.05 considered significant.

Results: Among 167 patients (82.6% male, mean age 31.8 ± 10.4 years), the most common causes of TSI were RTA (52.8%) and falls (28.1%). The thoracolumbar spine (T10-L2) was the most affected area (35.3%). Most patients (67.1%) had compression (type A) injuries, followed by rotational (type C) injuries (21%) and distraction (type B) injuries (12%). Neurologic deficits were present in 44.9% of patients, with incomplete deficits in 27.5% and complete deficits in 17.4%. Type C injuries had the highest likelihood of neurologic deficits (82.86%) compared to type A (28.57%) and type B (70%) injuries, with a statistically significant association (P = 0.001, Chi2 = 38.03).

Conclusion: Young men were the most common victims of spine injury, primarily due to RTA. The thoracolumbar spine was the most frequently injured level. Compression (type A) injuries were the most common, and the type of fracture according to AO classification predicted the likelihood of neurologic deficits.

Keywords: Traumatic spine injury, Spine fracture, AO Spine Trauma Classification system, and Computed Tomography.

Background

Traumatic spine injury (TSI) is a prevalent emergency trauma case with an annual global incidence of 10.5 cases per 100,000 people, amounting to approximately 768,473 new cases worldwide each year, excluding fatalities at the scene (1). These injuries, resulting from both high and low energy mechanisms, are commonly caused by road traffic accidents (RTA) and falls from heights (2). Young adult men, aged 18 to 25 years, are the most affected demographic (3). Research indicates that TSI is more prevalent in low and middle-income countries compared to high-income countries. While the exact incidence in Ethiopia is unknown, the high rate of RTAs suggests a significant prevalence of TSI (1).

TSI encompasses a range of injuries to the spinal cord, nerve roots, osseous structures, and disco-ligamentous components of the spinal column. These injuries can lead to mechanical instability, pain, impaired mobility, and, in severe cases, partial or complete paralysis. Approximately 48.8% of TSI patients require surgery (1,3). In acute spinal trauma settings, imaging plays a crucial role in detecting injuries, assessing their extent and stability, and guiding management. Computed Tomography (CT) is the preferred imaging modality due to its rapid execution and detailed visualization of osseous anatomy and fractures. However, CT has limitations, such as its inability to screen for ligamentous and spinal cord injuries directly, though the injury pattern can indicate such pathologies. This study focuses on the sub axial cervical, thoracic, and lumbar levels of the spine, excluding the unique anatomical and injury mechanisms of the upper cervical spine (C1 and C2) (4). Early detection and treatment of spinal column injuries, particularly those causing spinal cord compression, are crucial to prevent complete spinal cord injury and its devastating outcomes (5,6).

According to the World Health Organization (WHO), injuries are a major health concern globally. While the exact prevalence of spine injuries is not precisely known, it is estimated that 768,473 to 790,695 new cases occur worldwide annually, with 37.3% resulting in severe disability due to spinal cord injuries. A significant proportion (36.4% to 59.1%) of TSI patients require surgical intervention for neurological improvement. The reported mortality rates for TSI vary widely, from 0% to 60%, reflecting differences in diagnosis and treatment quality between high and low-income countries (1).

Most TSI studies are based on data from developed countries, with limited research available from developing countries like Ethiopia. A hospital-based cross-sectional study at Tikur Anbessa Specialized Teaching Hospital in Addis Ababa from April 2008 to March 2012 highlighted a male predominance in TSI cases, with peak incidence in the 21-30 age group. RTAs and falls were the main causes of TSI, with 103 patients suffering paraplegia and 7 fatalities from complete cervical injuries. However, this study did not detail the imaging patterns of spine injuries (4,7). Another retrospective study at Tikur Anbessa Specialized Hospital and Myungsung Christian Medical Centre (2011-2014) found that RTAs and high falls were the primary trauma causes, with compression fractures being the most common injury type, followed by distraction and rotational injuries. This study focused only on surgically treated patients and did not assess the subtypes of compression injuries, which are important for management (8). Most other Ethiopian studies on spine injuries focus on spinal cord injury or surgical outcomes, without detailing spinal column injury patterns (5,9).

This study aims to fill this gap by detailing the patterns of spine injury using Multi-Detector Computed Tomography (MDCT) and examining their association with neurologic deficits, a research area not previously explored at AaBET hospital. Understanding the injury patterns on CT scans, the most commonly used imaging modality, is essential for radiologists to accurately and promptly detect and report findings to treating physicians.

Materials and Methods

Study setting, design, period, and population

This institutional-based cross-sectional study was done at Addis Ababa Burn Emergency and Trauma (AaBET) hospital from May 2020 to June 2021 in one of the public health facilities found in Addis Ababa, Ethiopia. AaBET Hospital was established in 2015 as part of St. Paul millennium medical college and it is one of the first health sectors with an entire trauma and burn unit. It includes departments in Emergency and critical care, Neurosurgery, Orthopedics, Traumatology, and an academic program in Plastic and Reconstructive Surgery. The hospital has more than 200 beds and around 800 staff.

AaBET hospital has approximately 20000 to30,000 emergency visits to the hospital per year and provides emergency and outpatient services and elective and emergency surgeries of the respective departments (22).

All patients who undergo CT scans for evaluation of spine trauma in AaBET hospital from May /1/2020 – June/1 /2021 were included. Patients with lost CT scan images or charts and spine CT scan with poor image quality, like cut films and images with an artifact were excluded.

Study procedure

Cases were identified by reviewing both the CT scan room registry of the radiographers and the registry of the radiology department report. One hundred sixty-seven patients with proper CT scan images and complete medical records were included in the study. The data from medical charts were extracted using a structured data abstraction tool, prepared in English, which is composed of sociodemographic characteristics, cause of the trauma, neurologic findings, fracture location, fracture type, and associated spine findings. The data collected from the chart was undertaken by three trained general practitioners. The CT scan of the patients was also reviewed by two trained senior radiology residents and they compared the finding with what was reported in the patient card and they also used AO classification to classify the fracture type. The primary investigator has checked the completeness of the data.

Data collection and tools

Cases were identified by reviewing both the CT scan room registry of the radiographers and the registry of the radiology department report. One hundred sixty-seven patients with proper CT scan images and complete medical records were included in the study. The data from medical charts were extracted using a structured data abstraction tool, prepared in English, which is composed of sociodemographic characteristics, cause of the trauma, neurologic findings, fracture location, fracture type, and associated spine findings. The data collected from the chart was undertaken by three trained general practitioners. The CT scan of the patients was also reviewed by two trained senior radiology residents and they compared the finding with what was reported in the patient card and they also used AO classification to classify the fracture type. The primary investigator has checked the completeness of the data.

Operational definition (17)

Level of injury: Cervical: C3 - C7; Thoracic: T1- T9; Thoracolumbar: T10-L2; Lumbar: L3 - L5

Wedge fracture: compression fracture involving a single endplate without the involvement of the posterior wall of the vertebral body.

Split fracture: Coronal fracture involving both endplates without the involvement of the posterior wall of the vertebral body.

Incomplete burst fracture: Burst fracture involving a single endplate with involvement of the posterior vertebral wall.

Complete burst fracture: Burst fracture or sagittal split involving both endplates.

Bony posterior tension band injury: Physical separation through fractured bony structures only.

Translational injuries: Displacement or translation in any axis of one vertebral body relative to another in any direction.

Non-displaced facet joint fracture - a fracture that does not affect more than 1 cm or more than 40% of the facet joint dimension.

Displaced facet joint fracture - fracture affecting more than 1 cm or more than 40% of facet joint dimension.

Neurologic deficit - Based on ASIA Impairment Scale (23)

A) **Complete** - No motor or sensory function is preserved in the sacral segments S4–S5.

Incomplete

B) Sensory function preserved but not motor function is preserved below the neurological level and includes the sacral segments S4–S5.

C) Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.

D) Incomplete motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.

E) Normal if motor and sensory function are normal.

Data collection procedures

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Results

In this study, a total of 167 cases of Spine injuries were reviewed. One hundred thirty-eight patients (82.6%) were males and 29(17.4%) were females, making a male to female ratio of 4.76:1. The mean (SD) age of the affected individuals was 31.8(±10.4) years, ranging from 15 to 60 years. As it is reported in figure1, the commonest age affected was those lie between 21-30 years (44.3%), followed by 31-40 years (22.2%) (Figure 1).

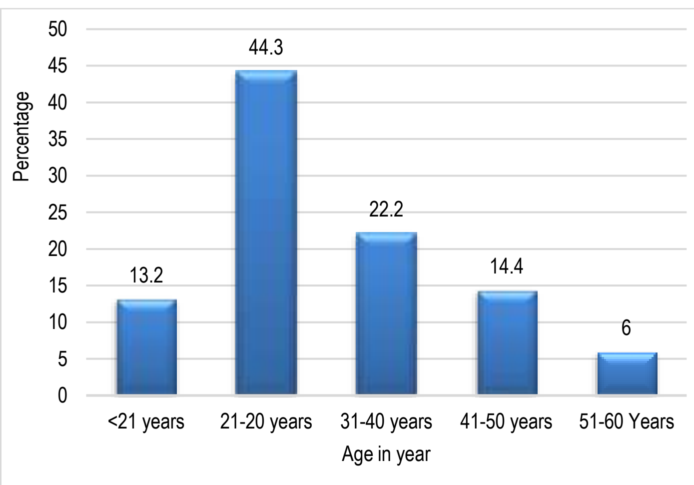

Figure 1: Age distribution of patients who undergo CT for evaluation of spine trauma in AaBET hospital from May 2020 to June 2021.

Road traffic accidents (RTA) and falling down accidents were the main cause of spine injuries in 106 (63.5%) and 47 (28.1%) of the patients respectively. The remaining cases were caused by direct trauma (5.4 %) and bullet injury (0.6%).

Fifty-nine patients (35.3%) had thoracolumbar (T10-L2) fracture making it the most common location to be affected followed by cervical (C3-C7) level accounting for 53(31.7%) cases. Thoracic (T1-T9) and Lumbar (L3-L5) spine fracture were seen in 26(15.6%) and 21(12.6%) cases respectively. Multilevel involvement of the spine was seen only in 8 cases (4.8 %) (Figure 2).

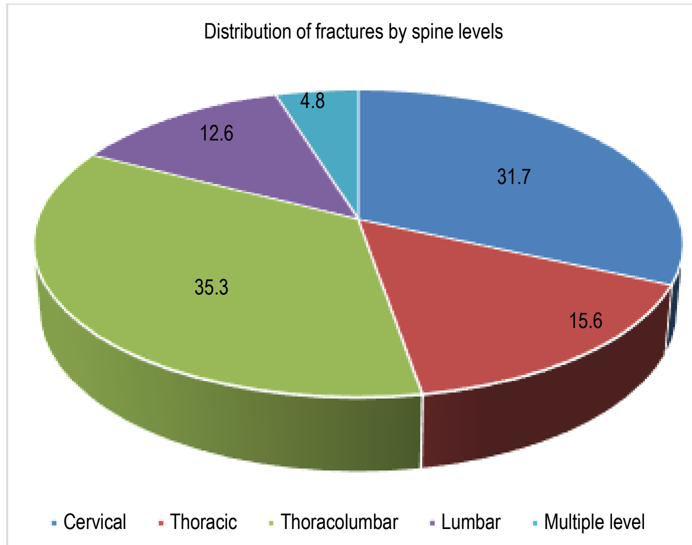

Figure 2: Percentage distribution of fractures on spine levels

Observation of relation of causes of the accident to the level of injury showed road traffic accident (RTA) was the commonest cause in all cervical, thoracic, thoracolumbar and lumbar levels of the spine (Table 1).

Table 1: Proportion of specific level of spine injury by cause

	Cervical (N, %)	Thoracic (N, %)	Thoracolumbar (N, %)	Lumbar (N, %)	Multiple levels (N, %)
Road traffic accident (RTA)	29 (54,7)	20 (76.9)	32 (54.2)	19 (90.5)	6 (75.0)
Falling down accident	16 (30.2)	3 (11.5)	24 (40.7)	2 (9.5)	2 (25.0)
Bullet injury	1 (1.9)	2 (7.7)	2 (3.4)	0 (0.0)	0 (0.0)
Direct trauma	7 (13.2)	1 (3.8)	1 (1.7)	0 (0.0)	0 (0.0)

AO type A fracture, compression injuries represented the commonest type of injury occurring in 112 (67.1%) patients. AO type C, rotational / translational injury was seen in 35 (21.0%) patients while 20 (12 %) patients sustained AO type B, distraction injury (Table 2). All the AO types of injuries showed male predominance and type A injuries were the most common in both sexes. Type B and C injuries were much less common in females each accounting for 6.9% of cases (Table 2).

Table 2: Type of spine injury according to AO classification and AO injury type distribution according to sex

	Male		Female		Total	
	N	%	N	%	N	%
Compression	87	63.0%	25	86.2%	112	67.1
Distraction	18	13.0%	2	6.9%	20	12.0
Rotational	33	23.9%	2	6.9%	35	21.0
Overall					167	100.0

The majority of type A and type C injuries were more frequently occurred in the thoracolumbar spine, 35.7%, and 42.9%, respectively whereas type B injury was more frequently (55.0%) observed in the cervical spine (Table 3).

Table 3: AO injury type and spinal level distribution

	Cervical (N, %)	Thoracic (N, %)	Thoracolumbar (N, %)	Lumbar (N, %)	Multiple levels (N, %)
Compression	31 (58.5)	15 (57.7)	40 (67.8)	18 (85.7)	8 (100.0)
Distraction	11 (20.8)	4 (15.4)	4 (6.8)	1 (4.8)	0 (0.0)
Rotational	11 (20.8)	7 (26.9)	15 (25.4)	2 (9.5)	0 (0.0)

Minor fracture (A0 subtype) was the commonest subtype of type A injury, 73 patients had only minor injuries which includes isolated pedicle, lamina, spinous or transverse process fractures. Sixty-seven patients had burst fractures, (30 incomplete (A3) and 37 complete (A4) burst fracture) and most of these injuries occurred in the thoracolumbar spine (38 cases) and thoracic spine (14 cases). There were also 16 cases of Wedge fracture (A1 subtype) from these 9 cases occurred at thoracolumbar spine and there were only 2

Table 4: Frequency of compression (type A) injury subtype distribution on spine level cases of split (A2 subtype) fracture.

	Minor fracture only	Wedge fracture	Incomplete burst fracture	Complete burst fracture
Cervical	24	3	8	4
Thoracic	11	3	6	8
Thoracolumbar	17	9	16	22
Lumbar	15	1	0	3
Multiple level	6	0	0	0

Ninety-two patients (55.1 %) have no neurologic deficit on presentation while 46 (27.5%) patients exhibited incomplete neurologic deficit and the remaining 29 (17.4%) patients have complete motor and sensory deficit (Figure 3). The highest number of the complete motor and sensory neurological deficit was diagnosed in patients with thoracolumbar spine level injury (58.62%). Most patients with incomplete neurologic deficit were seen in thoracolumbar (43.5%) and cervical (41.3%) spine level injuries.

Analyzing each group of the AO classification for the incidence of a neurological deficit revealed the lowest incidence of neurologic deficit for type A with 32 (28.8%) patients, followed by type B with a neurological deficit in 14 (70.0%) of the patients. Type C injuries were associated with the highest incidence of neurologic deficit, 29 (82.9%) (Table 5).

Table 5: Relationship between the type of fracture and neurologic deficit

	No neurologic deficit		Complete neurologic deficit		Incomplete neurologic deficit	
	N	%	N	%	N	%
Compression	80	87.0	11	37.9	21	45.7
Distraction	6	6.5	6	20.7	8	17.4
Rotational	6	6.5	12	41.4	17	37.0

To see the significance of the relationship between neurologic difficulty and the AO type of the spinal fracture we run the chi-square test which showed a significant relationship exists with p = 0.001, Chi^2 = 38.030 (Table 6). We also try to see if there is an association between neurologic deficit and demographic factors, mechanism of injury, or level of trauma using fisher's exact test but there was no statistically significant association seen.

Discussion

This study reviewed one hundred sixty-seven cases with spine injury and similar to other previous studies we found males are more commonly subjected to spine injury than females (3,4,8). The difference between the incidence in males and females in our study is 4.76:1 which is comparable with the report mentioned by Hagos Biluts and Luis Muñiz Luna 5.6:1 and 5.3:1 respectively (3,4). The study also showed the commonest age range involved by Spine injury was in between 21-30 years (44.3%) with a mean age of 31.8 years. Most of the accidents occurred in the productive age groups (21- 50 years) accounting for 80.9% of the total spine injury. This result is consistent with the study done in Tikur Anbessa Specialized Teaching Hospital (TASH) (32.5 years) (8) and 32.4 years from the largest systematic review of 65 studies from 28 developing countries all over the world (24).

Road traffic accident (63.5%) is found to be the most common cause of spine injury in this study followed by falling down accidents (28.1%). This was noted in previous studies reviewed (8,20,25,26). In the largest systemic review of 65 studies, it was reported that road traffic accidents and falling accidents equally contribute to spine injury (24).

We also found RTA as a major cause of injury in all types of fracture in our study similar to the study done by Esayas Adefris in TASH (8). But Leucht et al. from Germany, on the other hand found high falls as major causes of injury in type A fractures and RTA was the major cause in type

B and C fractures. This goes with different epidemiology of causes of an accident between developed and developing countries, this study found falling down accidents as the commonest mechanism for spine injury (39%) (27).

When we see the level of the spine affected by traumatic injury thoracolumbar level (T10-L2) (35.3%) was the commonest involved followed by cervical (C2-C7) level (31.5%). This has similarity with two separate studies done in Ethiopia by Esayas Adefris and Martin Andreas Lehre and the study done by Leucht et al. from Germany and Shahrokh Yousefzadeh Chabok from Iran (8,25–27). The thoracolumbar level is more vulnerable to injury because of its unique anatomic and biomechanical properties this includes the absence of rib or sternal attachment, facet joint transition from the coronal to the sagittal plane, and biomechanical transition between the kyphotic thoracic and lordotic lumbar spine.

Leucht et al also found an association between the cause of the accident and the fracture distribution. His study showed that fall-related fractures (high energy falls and simple falls) occurred predominantly at the thoracolumbar junction. However, patients that sustained traffic accidents exhibited a significant increase in fractures in the cervical and thoracic spine. Furthermore, sports-related injuries occurred more often at the junctions between the spine sections, cervicothoracic and thoracolumbar (27). Unlike Leucht et al our study found RTA to be the major cause in all levels this difference is due to the high incidence of RTA as a mechanism in our study.

Regarding the AO classification of the spine injury, similar to the study findings of Leucht et al the most common type of fracture seen in our study were Compression (type A) injuries (67.1%) followed by rotational (type C) (21.0%) and distraction (type B) (12%) injuries. Again similar to Leucht et al type A injuries tends to occur more commonly at the thoracolumbar level and type B is mostly seen at the cervical level, but in our study type C injuries are commonly seen at the thoracolumbar level, unlike Leucht et al finding which is at the cervical level (27). The high incidence of type c injury in our case at the thoracolumbar level can be explained by facet joint transition from the coronal to the sagittal plane at this level and which makes facet joint vulnerable to injury during high energy trauma and that leads to translational injury.

Neurological deficits are found in about 14–38% of all vertebral fractures (28) and represent the most devastating consequence of spinal fractures. In our study neurological deficits were found in 49.1% of patients. This is higher than found by Leucht et al (24.7%) which can be explained by the much better prehospital and hospital care for trauma patients in developed countries. But when we compare our finding with the study done by Esayas Adefris and Hagos Biluts neurologic deficits were seen in 78.3% and 79% of patients respectively. The higher number of neurologic deficits in these studies may be due to the fact that both studies were done at a referral hospital by the neurosurgery department and patients with neurologic deficit is more likely to go to neurosurgeons than patients with traumatic spine injury without neurologic deficit ,this can lead to over-representation of patients with neurologic deficit in the studies (4,8).

We also found a statistically significant ($p = 0.001$, $Chi^2 = 38.030$) association between neurologic deficit and AO classification type of the spine fracture. The lowest number of neurological deficits was seen in the type A fracture group because by definition only burst fractures have a dorsal wall fragment that can protrude into the spinal canal and induce compression of the spinal cord. With type B and C fractures, the incidence of neurological impairment increased further, as has been previously reported (8,27)

To the best of our knowledge, this is the first study in AaBET hospital and we included all trauma patients in the study period. However, being an institutional based cross-sectional study in a single hospital and utilization of secondary data.

Conclusion

This study shows that males are more commonly subjected to spine injuries than females, with a ratio of 4.76:1, and most accidents occurred in the productive age group (21-50 years). Road traffic accidents were the most common mechanism of injury, and the thoracolumbar spine level was the most frequently affected area. Compression (type A) injuries were the most common type of spine injury according to the AO classification, which also predicts the likelihood of neurologic deficits. Therefore, it is recommended that the Ministry of Transport and policymakers place greater emphasis on and implement effective strategies to reduce the rate of road traffic accidents. Additionally, radiologists should use the AO classification system when reporting spine injury cases, as it can predict the likelihood of neurologic deficits and facilitate clear communication between radiologists and treating physicians. Further similar studies in other centers are recommended to gain a better understanding of the problem at a national level.

Abbreviations

AaBET: Addis Ababa Burn Emergency and Trauma; ASIA: American Spinal Injury Association; AO: Arbeitsgemeinschaft für Osteosynthesefragen; CT: Computed Tomography; MRI: Magnetic Resonance Imaging; MDCT: Multidetector Computed Tomography; RTA: Road Traffic Accident; SPHMMC: St. Paul Hospital Millennium Medical College; SPSS: Statistical Package for Social Science; TASH: Tikur Anbessa Specialized Teaching Hospital; TL: Thoracolumbar; TSI: Traumatic Spine Injury; WHO: World Health Organization

Declarations

Consent for publication

Participants consented for unanimous sharing of compiled data as approved by the IRB of the college at SPHMMC.

Ethical declaration

The St. Paul Hospital Millennium Medical College- institutional review committee has given its approval for the ethical use of the data. All-study methods, and protocols, were carried out in accordance with SPHMMC, Ethiopian national and regional regulations and Guidelines. This is not experimental study and stating experiments on humans and/or the use of human tissue samples is not applicable to this study. Since we used secondary data having consent of participant was not applicable to our study.

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Authors' contributions

Both authors conceptualized the research problem, designed the study, conducted fieldwork, collected and data analyzed, and drafted the manuscript, revising the final manuscript. All authors of the manuscript have read and agreed to its content.

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Competing interest

All authors read and approved the final manuscript. The authors declare that they have no competing interests.

Availability of data and materials

The datasets used in the current study or data collection tool are available from the corresponding author with a reasonable request.

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