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Computed Tomography Fracture Patterns, Treatment Approaches, and AO Spine Thoracolumbar Injury Classification Concordance in Thoracolumbar Spine Trauma at Kilimanjaro Christian Medical Center

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ABSTRACT

Aim: This study evaluated computed tomography (CT) fracture patterns, treatment approaches, and the association between fracture patterns and management, while assessing concordance between AO thoracolumbar Injury severity score (AOSTSIC) recommendations and actual management among thoracolumbar trauma patients at Kilimanjaro Christian Medical Centre (KCMC) from 2022 to 2024.

Methodology: A hospital-based retrospective cross-sectional study was conducted on patients with thoracolumbar spine trauma treated at Kilimanjaro Christian Medical Centre (KCMC) between January 2022 and December 2024. Data were collected and analyzed using SPSS version 25. Descriptive statistics summarized social demographics, computed tomography (CT) fracture patterns and management approaches, while logistic regression generated odds ratios (OR), 95% confidence intervals, and p-values of 0.05 as cut off level of statistical significance for associations between fracture patterns and treatment.

Results: A total of 166 patients were reviewed, median age 36 years (IQR: 28–52), predominantly male (87.9%), mostly from rural areas (57.8%) and self-employed (71.1%). Falls were the leading mechanism of injury (56.6%), and 76.5% had associated injuries. The thoracolumbar junction, particularly L1 (22.5%), was most frequently affected. AO Spine classification revealed Type A1 (27.7%) and Type C (18.7%) as most common. Overall, 53.1% received conservative management, and 46.9% underwent surgery. Complex fractures (A2: OR=48.0, 95% CI: 3.65–631.76, p=0.003; A3, A4, B, C) were significantly associated with surgical intervention. Substantial agreement existed between AOSTSIC recommendations and actual management (Kappa = 71.1%, p<0.001).

Conclusions: Thoracolumbar trauma at Kilimanjaro Christian Medical Centre predominantly affects young adult males, with falls being the leading cause. Type A fractures, particularly A1, were the most common injury pattern, with L1 as the most frequently involved level. Severe fracture patterns were more likely to require surgical management, although access to surgery was sometimes limited. The AO Spine Thoracolumbar Injury Classification showed strong concordance with the treatment provided, supporting its usefulness in guiding management in resource-limited settings. Integration of the AO Spine Thoracolumbar Injury Classification and Severity Score into routine trauma care may help standardize

clinical decision-making, while improving access to spinal implants through strengthened national health insurance coverage could reduce financial barriers to surgical management.

Keywords: Thoracolumbar trauma; Computed tomography; AOSTSIC; Fracture patterns; Conservative management; surgical treatment; Tanzania

Introduction

Spinal fractures are a major cause of long-term disability and impose a substantial socioeconomic burden. Their incidence increases with advancing age, reduced bone mineral density, and a higher risk of falls. Injuries may involve the vertebrae and surrounding ligamentous structures, and spinal cord involvement can result in severe, life-altering consequences[1].

Globally, the annual incidence of traumatic spinal injuries (TSI) ranges from 3.6 to 246.0 cases per million population[2]. Trauma accounts for up to 90% of spinal cord injuries, with road traffic accidents (RTAs) identified as the leading cause worldwide, particularly in high-income countries and heavily trafficked regions of low- and middle-income countries[3]. Falls also contribute significantly, with RTAs and high-energy falls predominating among younger individuals, while low-energy and osteoporosis-related fractures are more common in the elderly. Spinal fractures are frequently associated with poly-trauma, with 30%–55% of patients sustaining additional injuries, and spinal cord injury complicating approximately 10%–20% of cases[3].

Thoracolumbar injuries account for the majority of spinal trauma. Management strategies include conservative and surgical approaches and are guided by fracture morphology, neurological status, patient factors, and available resources[4].The AO thoracolumbar classification system categorizes injuries into compression (Type A), distraction (Type B), and translation (Type C) injuries, with Type A fractures, particularly wedge compression (A1) and complete burst fractures (A4), being most common [5].

CT plays a critical role in acute trauma by enabling rapid diagnosis and detailed fracture characterization, thereby supporting timely and appropriate management decisions[6]. Several classification systems exist; however, the AO Spine Thoracolumbar Injury Classification and Severity Score (AOSTSIC) has demonstrated superior reliability and clinical utility[7].

Management is influenced by injury severity, neurological status, comorbidities, and access to specialized spinal services[4].Treatment aims to preserve life, prevent neurological deterioration, restore spinal stability, and promote early mobilization [8]. Surgical management focuses on stabilization and decompression, while conservative treatment includes immobilization, bracing, pharmacotherapy, and rehabilitation [9].

Limited data exist in Tanzania regarding computed tomography fracture patterns and the role of the AO Spine Thoracolumbar Injury Classification and Severity Score in guiding the management of thoracolumbar spine trauma. Therefore, the present study aimed to evaluate computed tomography fracture patterns, treatment approaches, and the concordance between AO Spine Thoracolumbar Injury Classification and Severity Score–based recommendations and the actual management of thoracolumbar spine trauma patients at Kilimanjaro Christian Medical Centre in Northern Tanzania.

Materials and Methods

Methodology

Study Design and Population

This was a hospital-based retrospective cross-sectional study conducted at Kilimanjaro Christian Medical Centre. Computed tomography scans and clinical records of patients with traumatic thoracolumbar spine injuries managed between January 2022 and December 2024 were reviewed. Patients were included if complete computed tomography imaging and clinical documentation were available.

Data Collection

Patient information was retrieved from the Electronic Hospital Management System (EHMS), radiology imaging archives, and physical medical records. Data were entered into SPSS version 25 for cleaning analysis and storage.

Eligibility criteria

Patients were included if they had traumatic thoracolumbar spine injuries, underwent CT imaging at KCMC during the study period, and had complete medical records available. Patients with non-traumatic spinal conditions such as infections, tumors, degenerative diseases, or pathological fractures, as well as those with a prior history of spinal surgery, were excluded.

Ethical approval

Ethical approval was obtained from the KCMC University Research Ethics Committee (Certificate No. PG.57/2024). Institutional permission to access patient records was granted by the relevant departments at KCMC. All data were handled confidentially, with no patient identifiers used in the analysis.

Statistical Analysis

Descriptive statistics were used to summarize the study variables. Categorical variables were presented as frequencies and proportions, while continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate. Data were analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Logistic regression analysis was performed to evaluate associations between CT fracture patterns, AOSTSIC, and treatment approach. Odds ratios (ORs) with 95% confidence intervals were reported, and a p-value <0.05 was considered statistically significant.

Study Setting

The study was conducted at KCMC, a university teaching hospital affiliated with KCM University and KCRI, where the Radiology and Orthopedics departments manage approximately 300 and 415 spine trauma cases annually, respectively. KCMC is located in Moshi town in Northern Tanzania

Sampling Method and Sample Size

All eligible patients meeting the inclusion criteria during the study period were consecutively enrolled. The minimum sample size was calculated using the formula $n = Z^2 \times p(1–p) / d^2$, where $Z = 1.96$ (95% confidence level), $p = 10.9\%$ (prevalence of spine trauma) [2]. and $d = 0.05$ (margin of error). This yielded a required sample size of 166 patients.

Results

Socio-demographic Characteristics of the study participants

A total of 166 patients with thoracolumbar spine trauma who underwent CT at KCMC between 2022 and 2024 were included. The median age was 36 years (IQR 28–51), 87.9% were male, 57.2% resided in rural areas, and 70.5% were self-employed. Falls were the most common cause of injury (56.6%) summarized in Tables 1.

Table 1: Demographic characteristics of the study participants (N=166)

Characteristic	Frequency (n)	Percentage (%)
Median age (IQR) in years	36.0 (28.0–51.0)	
Age (years)		
< 18	5	3.0
18–29	40	24.1
30–39	52	31.3
40–49	23	13.8
> 49	46	27.7
Sex		
Male	146	87.9
Female	20	12.1
Residence		
Rural	95	57.2
Urban	71	42.8
Occupation		
Employed	49	29.5
Self-employed	117	70.5
Insurance		
No	147	88.5
Yes	19	11.5
Injury Mechanism		
Work-related injuries	9	5.5
Road traffic crash	58	34.9
Falls	94	56.6
Assaults	5	3.0

CT Fracture Patterns among Thoracolumbar Trauma Patients

Vertebral injuries were most frequent at L1 (22.5%), followed by T12 (14.8%) and L2 (9.3%). Other affected levels included T11 (7.6%), L3 (7.2%), and T10 (7.2%), with lower frequencies observed at T1–T9, T4–T8, L4, and L5. Injuries were predominantly clustered at the thoracolumbar junction (T10–L2), the most vulnerable region for trauma-related fractures (Figure 1).

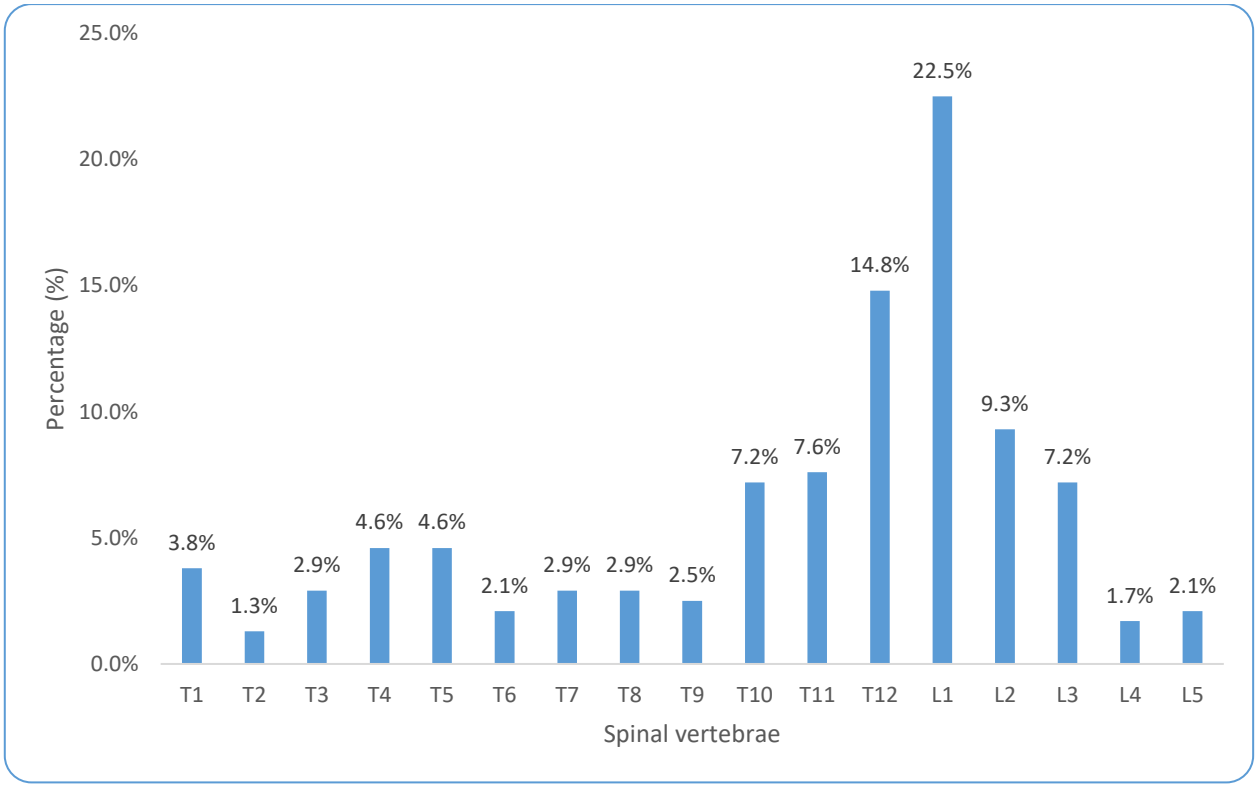

Figure 1: Thoracolumbar injuries showing the CT Fracture Patterns among Thoracolumbar Trauma Patients (n=166)

Fracture Patterns in Thoracolumbar Spine Trauma

Fractures were classified using the AO Spine system. Compression-type fractures predominated, with A1 observed in 33.7% and A3 in 16.9% of patients. C-type and A4 fractures accounted for 12.7% and 10.9%, respectively, while A0 and A2 fractures were less frequent (9.6% and 4.8%). Among B-type injuries, B2 was seen in 7.8%, and B1 and B3 each in 1.8% of patients. The overall distribution of fracture types is shown in Figure 2.

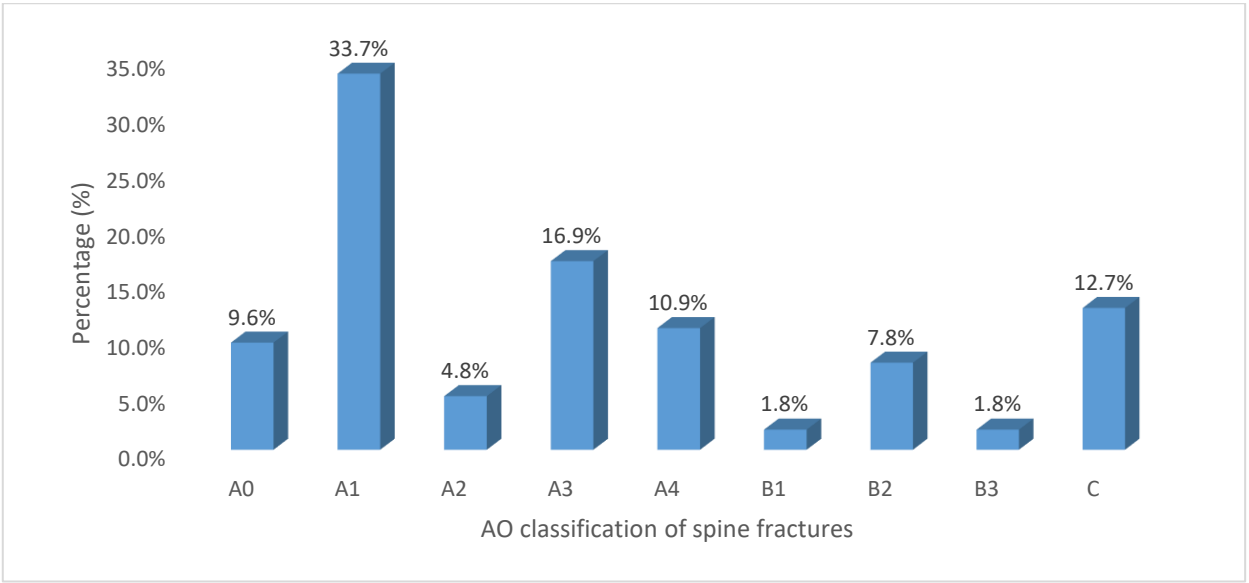

Figure 2: Fracture Patterns in Thoracolumbar Spine Trauma (n=166)

Association between CT Fracture Patterns and Treatment Approaches

Multivariable logistic regression demonstrated significant associations between fracture morphology and treatment approach. Compared with A0 fractures, A2, A3, and A4 fracture types were independently associated with higher odds of surgical management. Similarly, B1, B2, and C-type injuries showed significant associations with operative treatment. The presence of spinal cord compression was also independently associated with surgical intervention. Detailed results of the regression analysis are presented in Table 3.

Table 2: Association between fracture pattern and treatment approach in thoracolumbar spine trauma (N=166)

Factor	Conservative (n = 109, 65.7%)	Surgical (n = 57, 34.3%)	COR (95% CI)	p-value	AOR (95% CI)	p-value
AO Classification						
A0	15 (13.8)	1 (1.7)	1	–	1	–
A1	55 (50.5)	1 (1.7)	0.27 (0.02–4.62)	0.368	0.23 (0.01–4.03)	0.316
A2	2 (1.8)	6 (10.5)	45.00 (3.41–594.12)	0.004	29.02 (1.97–427.41)	0.014
A3	12 (11.0)	16 (28.1)	20.00 (2.31–173.11)	0.007	12.67 (1.27–126.54)	0.031
A4	7 (6.4)	11 (19.3)	23.57 (2.52–220.33)	0.006	12.52 (1.03–151.56)	0.047
B1	1 (0.9)	2 (3.5)	30.00 (1.29–693.13)	0.034	15.93 (1.57–444.75)	0.013
B2	6 (5.5)	7 (12.3)	17.50 (1.76–174.42)	0.015	10.34 (1.86–123.53)	0.025
B3	0 (0.0)	3 (5.3)	–	–	–	–
C	11 (10.1)	10 (17.5)	13.64 (1.51–122.81)	0.020	7.47 (1.65–85.62)	0.016
Insurance						
No	96 (88.1)	51 (89.5)	1	–	–	–
Yes	13 (11.9)	6 (10.5)	0.87 (0.31–2.42)	0.788	–	–
Spinal Cord Compression						

No	62 (56.9)	7 (12.3)	1	–	1	–
Yes	47 (43.1)	50 (87.7)	9.42 (3.92–22.65)	<0.001	1.99 (1.58–6.83)	0.027

Concordance between AO Thoracolumbar Injury Severity Score (AOSTSIC) and Actual Management

Among 166 patients, 44.6% were recommended for conservative management, 48.8% for surgical intervention, and 6.6% for either approach. Clinically, 65.7% were treated conservatively and 34.3% surgically. There was a significant association between AOSTSIC recommendations and actual management ($p < 0.001$), with substantial agreement (Kappa = 0.71) (Table 4; Figures 3 and 4).

Table 3: Comparison between AO thoracolumbar injury severity score and actual management given (N=166)

	Recommended Management Strategy			Actual Management Strategy		p-value	Kappa Value
AO Classification	**Conservative (%)**	**Surgical (%)**	**Conservative/Surgical (%)**	**Conservative (%)**	**Surgical (%)**		
Total	74 (44.6)	81 (48.8)	11 (6.6)	109 (65.7)	57 (34.3)	0.001	0.71
A0	16 (21.6)	0 (0.0)	0 (0.0)	15 (13.8)	1 (1.7)	1.0000	0.11
A1	50 (67.6)	3 (3.7)	3 (27.3)	55 (50.5)	1 (1.7)	1.0000	0.80
A2	3 (4.1)	5 (6.2)	0 (0.0)	2 (1.8)	6 (10.5)	0.0070	0.70
A3	5 (6.8)	19 (23.5)	4 (36.4)	12 (11.0)	16 (28.1)	0.0005	0.55
A4	0 (0.0)	14 (17.3)	4 (36.4)	7 (6.4)	11 (19.3)	0.0001	0.35
B1	0 (0.0)	3 (3.7)	0 (0.0)	1 (0.9)	2 (3.5)	0.4000	0.25
B2	0 (0.0)	13 (16.1)	0 (0.0)	6 (5.5)	7 (12.3)	0.0052	0.11
B3	0 (0.0)	3 (3.7)	0 (0.0)	0 (0.0)	3 (5.3)	0.1000	1.00
C	0 (0.0)	21 (25.9)	0 (0.0)	11 (10.1)	10 (17.5)	0.0005	0.03

DISCUSSION

This study demonstrated that most patients with thoracolumbar trauma were young adult males from rural areas, with falls as the leading mechanism of injury. Spinal cord compression was observed in more than

half of the cases, and vertebral injuries were predominantly located at the thoracolumbar junction, particularly at L1 and T12. According to the AO Spine classification, Type A fractures, especially A1 and A3, were the most common patterns, while Type B and C injuries were less frequent but more likely to require surgical intervention. A significant association was observed between fracture type, spinal cord compression, and treatment approach, with substantial concordance between AOSTSIC recommendations and actual management (Kappa = 0.711, $p < 0.001$) [10].

A1 fractures accounted for 33.7% of cases, followed by A3 fractures (18.1%), while A4 and C-type fractures each represented 11.5%. Most injuries involved the thoracolumbar junction (T10–L2), with L1 being the most frequently affected vertebra (22.5%), followed by T12 (14.8%). This distribution is biomechanically plausible, as the thoracolumbar junction represents a transition zone between the rigid thoracic spine and the more mobile lumbar spine, making it particularly susceptible to traumatic forces [5],[6].

These findings are consistent with studies from Vietnam and Egypt, which reported a predominance of Type A fractures and frequent involvement of L1 [10][11]. In Vietnam, Type A fractures accounted for 89.4% of injuries, with A3 fractures being most common, while Egyptian data similarly showed high proportions of A1 and A3 fractures [10][11]. In contrast, an Indian study reported a higher prevalence of A3 fractures (39.1%) and a greater proportion of B and C injuries, possibly reflecting differences in trauma severity, patient demographics, or access to advanced imaging such as CT [12].

Management strategies varied according to fracture type, neurological status, and available resources. In this study, 65.7% of patients were managed conservatively, while 34.3% underwent surgical intervention. Surgery was primarily reserved for unstable fractures, significant vertebral body compromise, and neurological deficits, whereas stable compression fractures without neurological involvement were treated non-operatively [9]. Similar conservative management patterns have been reported in Jordan and Egypt, although the Jordanian cohort largely comprised elderly females with osteoporotic fractures, unlike the younger, trauma-related population in this study [13][11]. Conversely, Indian studies have reported higher surgical rates, particularly for translational and distraction injuries [14].

Notably, surgery was occasionally not performed despite clear indications due to financial and logistical constraints. This mirrors findings from Tanzania, where most non-operated patients had surgical indications but lacked access to implants or specialized care [15]. These challenges highlight the impact of resource limitations on adherence to recommended management pathways in low-resource settings.

A significant association was also observed between CT-defined fracture patterns and treatment approach, with higher-grade fractures (A2–C) being significantly more likely to undergo surgical management. These findings align with Australian data showing higher surgical stabilization rates for complete burst fractures and predominant operative management for Type B and C injuries [16]. Similar conclusions have been reported from Vietnam and East Africa, emphasizing the value of CT imaging and AO classification in guiding treatment decisions [10][17].

Finally, the substantial agreement between AOSTSIC-recommended management and actual treatment at KCMC supports the clinical utility of this scoring system. Comparable findings have been reported in Australia, although moderate agreement in differentiating A3 and A4 injuries has been observed in Brazil despite excellent overall reliability [16][16]. Overall, CT-based fracture classification and AOSTSIC scoring are valuable tools for guiding thoracolumbar trauma management, though resource limitations remain a key determinant of care in low- and middle-income settings.

Limitations of the study

Despite its strengths, this study has limitations. Being a single-center study conducted at KCMC, the findings may not be generalizable to other hospitals with different resource capacities or patient populations. Additionally, as a retrospective study, it is prone to information bias due to reliance on existing clinical records, some of which had incomplete or missing data.

Strengths of the Study

This study has several key strengths. It utilized validated and widely accepted classification systems, including the AO Spine Thoracolumbar Injury Classification and Severity Score (AOSTSIC), improving reliability, reproducibility, and comparability with existing literature. All patients were assessed using CT, ensuring accurate fracture characterization and informed treatment planning. The focus on the thoracolumbar junction, a biomechanically vulnerable and clinically significant transition zone, enhances the study's clinical relevance. Furthermore, the study provides important context-specific data from a low- and middle-income setting, contributing valuable evidence to an under-represented region in the global spine trauma literature.

Conclusions

Thoracolumbar trauma at Kilimanjaro Christian Medical Centre primarily affected young adult males, with falls as the leading cause. Injuries most commonly involved L1, and AO Spine Type A fractures (A1 and A3) predominated. Severe fractures were more likely to require surgery, although access was sometimes limited. CT imaging and AOSTSIC scoring showed strong clinical utility in guiding management in resource-limited settings.

Recommendations

We recommended that CT imaging and the AO Spine classification system be routinely utilized for all patients with thoracolumbar spine trauma to improve diagnostic accuracy and guide appropriate surgical or conservative management. The AOSTSIC should be incorporated into standard clinical workflows, particularly in trauma units, to ensure consistent and evidence-based decision-making. Access to spinal implants and surgical services should be enhanced, including through expanded national health insurance coverage, to reduce financial barriers to operative care. Strengthening documentation and electronic medical record systems is essential for capturing AOSTSIC parameters, treatment rationale, and patient outcomes, thereby supporting continuous quality improvement. Finally, prospective multicenter studies are warranted to validate these findings and enhance their generalizability across diverse healthcare settings.

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Ethics Approval and Consent to Participate

Ethical approval for this study was obtained from the KCMC University. Written informed consent was obtained from all participants prior to data collection, in accordance with the Declaration of Helsinki.

References

1. A. K. Almigdad, B. Z. Dagher, O. M. Alwaqfi, M. A. Ghabashneh, and H. A. Alfqaha, "Bone tumors distribution in diagnostic and excisional biopsies," *J. Musculoskelet. Surg. Res.*, vol. 5, no. 3, pp. 159–168, 2021, doi: 10.25259/JMSR_49_2021.
2. K. Darko *et al.*, "Presentation, management, and outcome of traumatic spine injuries in Africa: a systematic review and meta-analysis," *J. Neurosurg. Spine*, vol. 42, no. 3, pp. 261–272, Mar. 2025, doi: 10.3171/2024.8.SPINE24614.
3. V. Niemi-Nikkola *et al.*, "Traumatic spinal injuries in northern Finland," *Spine*, vol. 43, no. 1. Lippincott Williams and Wilkins, pp. E45–E51, Jan. 01, 2018. doi: 10.1097/BRS.0000000000002214.
4. K. Khurjekar *et al.*, "Demographics of thoracolumbar fracture in Indian population presenting to a tertiary level trauma centre," *Asian Spine J.*, vol. 9, no. 3, pp. 344–351, 2015, doi: 10.4184/asj.2015.9.3.344.
5. C. Vu and D. Gendelberg, "Classifications in Brief: AO Thoracolumbar Classification System," *Clin. Orthop. Relat. Res.*, vol. 478, no. 2, pp. 434–440, 2020, doi: 10.1097/CORR.0000000000001086.
6. M. Dieckmeyer *et al.*, "Computed Tomography of the Spine: Systematic Review on Acquisition and Reconstruction Techniques to Reduce Radiation Dose," *Clin. Neuroradiol.*, vol. 33, no. 2, pp. 271–291, 2023, doi: 10.1007/s00062-022-01227-1.
7. J. H. Badhiwala and M. G. Fehlings, "Reliability of the AOSpine thoracolumbar spine injury classification system and thoracolumbar injury classification and severity score (TLICS)," *AME Med. J.*, vol. 2, no. Ii, pp. 158–158, 2017, doi: 10.21037/amj.2017.09.16.
8. B. G. Kim, J. M. Dan, and D. E. Shin, "Treatment of thoracolumbar Fracture," *Asian Spine J.*, vol. 9, no. 1, pp. 133–146, 2015, doi: 10.4184/asj.2015.9.1.133.
9. E. E. Karaiković[1], H. O. Pacheco[2], and E. E. Karaiković, "Treatment Options for Thoracolumbar Spine Fractures," 2005.
10. T. D. Pham and N. T. Hoang, "Computed Tomography Findings and Classification of Traumatic Lumbosacral Spine Injuries : Insights from the AOSpine Classification System," no. January, pp. 35–42, 2024.
11. E. M. Zeiada, M. M. Adawi, M. M. Wahdan, R. A. Teama, and M. A. El-Awadi, "AO Spine Injury Classification System; Application on Patients with Traumatic Thoracolumbar Spine Fractures Referred to Benha University Hospitals," *Benha J. Appl. Sci.*, vol. 7, no. 9, pp. 115–130, 2022, doi: 10.21608/bjas.2022.295220.
12. B. Khurana *et al.*, "CT for thoracic and lumbar spine fractures : Can CT findings accurately predict posterior ligament complex injury ?," *Eur. Spine J.*, no. 0123456789, 2018, doi: 10.1007/s00586-018-5712-z.
13. A. Almigdad, S. Alazaydeh, M. B. Mustafa, M. Alshawish, and A. Al Abdallat, "Thoracolumbar spine fracture patterns, etiologies, and treatment modalities in Jordan," *J. Trauma Inj.*, vol. 36, no. 2, pp. 98–104, 2023, doi: 10.20408/jti.2022.0068.
14. D. P. Reddy and K. K. Kiran, "A Comparative Study of Thoracolumbar Spine Fractures Treated by Conservative Management versus Pedicle Screw Fixation," vol. 3389, 2018, doi: 10.21276/sjm.2018.3.12.2.
15. N. L. Lessing *et al.*, "Nonoperative treatment of traumatic spinal injuries in Tanzania: who is not undergoing surgery and why?," *Spinal Cord*, vol. 58, no. 11, pp. 1197–1205, 2020, doi: 10.1038/s41393-020-0474-y.

16. B. T. S. Kweh *et al.*, "The AO Spine Thoracolumbar Injury Classification System and Treatment Algorithm in Decision Making for Thoracolumbar Burst Fractures Without Neurologic Deficit," *Glob. Spine J.*, vol. 14, no. 1_suppl, pp. 32S-40S, 2024, doi: 10.1177/21925682231195764.
17. C. A. Ikwuegbuenyi *et al.*, "Patients with traumatic spinal injuries treated in a low- and middle-income country: what happens after discharge?," *Neurosurg. Focus*, vol. 58, no. 3, 2025, doi: 10.3171/2024.12.FOCUS24826.