RESEARCH ARTICLE

An evaluation of treatment recommendations: A comparative analysis between tlicss and tlaosis in thoracolumbar spine injuries

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Abstract

Objective: To compare the treatment recommendations of the thoracolumbar injury classification and severity score system and the thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen spine injury score in case of thoracolumbar spine injury.

Method: The cross-sectional study was conducted at the Shaheed Mohtarma Benazir Bhutto Institute of Trauma, Karachi, from July to December 2023, and comprised patients aged at least 18 irrespective of gender, who had traumatic thoracic and lumbar vertebral spine fractures. Data regarding age, gender, mode of trauma, findings of neurological examination and imaging was collected. All cases were independently scored by an experienced spine surgeon, and a radiologist provided standardised imaging interpretation. The scorers were blinded to clinical outcomes and treatment decisions. Inter-rater agreement between thoracolumbar injury classification and severity score system and the thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen spine injury score was assessed using Cohen's kappa coefficient. Data was analysed using SPSS 23.

Results: Of the 335 patients with mean age 32.24±13.32 years, 279(83.3%) were males. The most common mode of trauma was fall from height 189(56.4%), and the most common site of fracture was L1 vertebrae 109(32.5%). Based on the thoracolumbar injury classification and severity score system, the most common fracture morphology was burst fracture 257(76.7%). The most common fracture type based on the thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen spine injury score was Type A compression injuries 300(89.6%). The thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen spine injury score had more patients in the grey zone 30(9%) compared to thoracolumbar injury classification and severity score system 22(6.6%). Treatment recommendations were the same in both the classification systems for 306(91.3%) patients (Cohen's kappa = 0.812, *p*<0.001).

Conclusion: There was no significant difference between the treatment recommendations suggested by the thoracolumbar injury classification and severity score system and the thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen spine injury score. The differences in grey zone classification highlighted the complexity of thoracolumbar injury assessment.

Keywords: TLICSS, TLAOSIS, Thoracolumbar spine, Fracture. (JPMA 75: 1696; 2025)

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Introduction

Thoracolumbar fractures are the most common type of injuries seen in the emergency department in patients with spinal trauma. The global incidence of spinal fractures due to trauma is estimated to be 10.5 per 100,000 cases, with an annual worldwide incidence of 768,473 new cases.[1] Spinal fractures are the cause of increased morbidity and mortality along with socioeconomic burden. This is due to the association of fractures with neurological deficits, osteoporosis and aging.

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Over the years, various classification systems have been developed for thoracolumbar fractures using different injury characteristics, including mechanism of injury, fracture morphology, fracture anatomic stability, and neurological status. In 1930, the concept of classifying the thoracolumbar injuries was first proposed.[2] A classification system based on the mechanism of injury and a two-column spine construct was presented in 1970.[3] This was followed by the use of computed tomography (CT) imaging-based classification correlating with spinal stability.[3] In 1983, a three-column model for spinal injuries was proposed[4] and in 1994, a classification of thoracolumbar injuries was developed using fracture morphology, known as the Arbeitsgemeinschaft für Osteosynthesefragen (AO) Spine System.[5] However, it did not consider the neurological status or guided in deciding the clinical management, limiting its use in clinical practice. In 2005, the Thoracolumbar Injury Classification System Score (TLICSS) was proposed, incorporating the posterior ligamentous complex (PLC) and the neurological status along with fracture morphology to calculate a severity score that helps in guiding the course of treatment.[6] In 2013, the AO Spine Thoracolumbar Spine Injury Classification System was developed by incorporating the Magerl AO system with TLICSS.[7] This development addressed specific limitations of TLICSS by enhanced morphology classification, expanding the neurological assessment categories, and adding formal modifiers, like indeterminate PLC status and patient-specific surgical factors. This was further developed later to establish a treatment algorithm called the Thoracolumbar AO Spine Injury Score (TLAOSIS).[8,9]

Despite the theoretical advantages of TLAOSIS over TLICSS, several clinical questions remain unanswered. First, the incorporation of TLICSS principles into TLAOSIS with additional morphological complexity raises the question of whether enhanced granularity improves treatment decision accuracy or introduces unnecessary complexity. The clinical impact of this enhanced discrimination remains unclear in independent validation studies.[2]

Second, the expanded grey zone in TLAOSIS (4-5 points) compared to TLICSS (4 points) may either improve nuanced decision-making or create additional clinical uncertainty. Third, given that many trauma centres continue to use TLICSS due to familiarity and training investments, understanding the practical differences between systems is essential for evidence-based protocol selection.

The limitations necessitating the update from TLICS to TLAOSIS include poor inter-observer reliability in PLC assessment, oversimplified burst fracture classification that does not distinguish stability patterns, limited guidance for neurologically intact patients with significant morphological injury, and inadequate consideration of patient-specific factors that influence surgical candidacy.

The current study was planned to compare the treatment recommendations of the TLICSS and TLAOSIS scores in case of thoracolumbar spine injury.

Patients and Methods

The cross-sectional study was conducted at the Shaheed Mohtarma Benazir Bhutto Institute of Trauma, Karachi, from July to December 2023. After approval from the institutional ethics review committee, the sample was raised using consecutive non-probability sampling technique. The sample size was calculated using the formula for Cohen's kappa comparison: $n = 2(Z_{\alpha/2} + Z_\beta)^2 \times (1-P_e)^2 / (\kappa_1-\kappa_0)^2$.[10] The significance level (α) of 0.05 yielded $Z_{\alpha/2}=1.96$, and power (1-β) 80% yielded $Z_\beta= 0.84$, expected baseline agreement between TLICSS and TLAOSIS (κ_0) 0.68, target kappa (κ_1) 0.80 for detecting a clinically meaningful difference, and expected chance agreement (P_e) 0.54 that were calculated from treatment recommendation proportions in thoracolumbar spine injury literature.[1] A minimum sample size of 230 patients was required to detect a difference of 0.12 in Cohen's kappa coefficient between the two classification systems with 80% power at 5% significance level. The sample size was inflated by >40% for additional statistical power.

After obtaining informed consent, patients aged 18-80 years irrespective of gender and with traumatic thoracic and lumbar vertebral spine fractures were included. Patients with non-traumatic thoracolumbar vertebral spine fractures were excluded. Data was collected using Google Forms and included age, gender, mode of trauma, findings of neurological examination and imaging, like X-rays, CT scans and magnetic resonance imaging (MRI).

All cases were independently scored by an experienced spine surgeon with minimum 5 years post-fellowship experience in spine trauma. A radiologist provided standardised imaging interpretation to ensure consistent morphological assessment. The scorers were blinded to clinical outcomes and treatment decisions. Inter-rater agreement between TLICSS and TLAOSIS classification systems was assessed using Cohen's kappa (κ) coefficient, revealing substantial agreement (κ=0.774, 95% confidence interval [CI]: 0.68-0.85, $p<0.001$), which indicated good concordance between the two classification systems and disagreements, if any, were resolved through consensus discussion.

The TLAOSIS divides fractures into three major types, including type A (compression injuries), type B (tension band injuries) and type C (translational injuries). Types A and B are further divided into subtypes. The neurological status of the patient is evaluated and classified from NX, N0 to N4. The patient-specific modifiers include M1 and M2 (Table 1). Non-surgical treatment is recommended if the score is <4 points, non-surgical or surgical treatment is considered for score 4-5, and surgical treatment is recommended for scores >5.

The TLICSS is divided into three categories, including fracture morphology, the integrity of PLC, and neurological status (Table 2). Non-surgical treatment is recommended at score ≤3, non-surgical or surgical treatment is considered for score 4, and surgical treatment is recommended for scores ≥5.[6]

The bias mitigation strategies included consecutive sampling of all eligible patients during the study period, standardised imaging protocols with identical CT and MRI sequences, and independent scoring by multiple experts

Table-1: The Thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen Spine Injury Score (TLAOSIS).

Type	Points	Description
Type A Compression injuries		
A0	0	Minimal injuries such as transverse process fractures
A1	1	Wedge compression
A2	2	Pincer compression injury
A3	3	Incomplete burst fracture: fracture that only involves a single endplate
A4	5	Complete burst fracture: fracture that involves both endplates
Type B Tension band injuries		
B1	5	Osseous disruption of the tension band
B2	6	Posterior tension band injury including ligamentous injury
B3	7	Anterior tension band injury
Type C Translational injuries		
C	8	Translation injuries
Neurological status		
N0	0	Neurologically intact
N1	1	Transient neurological deficit
N2	2	Symptoms or signs of radiculopathy
N3	4	Incomplete spinal cord injury or cauda equina injury
N4	4	Complete spinal cord injury
NX	3	Neurologic exam is unobtainable
Patient-specific modifiers		
M1	1	Fractures with an indeterminate injury to the tension band based on spinal imaging such as MRI or clinical examination
M2	0	A patient-specific comorbidity, which might argue either for or against surgery for those patients with relative indications for surgery

Table-2: The Thoracolumbar Injury Classification System Score (TLICSS).

Type	Points
Fracture Morphology	
Compression	1
Burst	2
Translational/rotational	3
Distraction	4
Integrity of posterior ligamentous complex (PLC)	
Intact	0
Suspected/indeterminate	2
Disrupted	3
Neurological status	
Neurologically intact	0
Nerve root injury	2
Complete spinal cord injury	2
Incomplete spinal cord injury	3
Cauda equina injury	3

blinded to clinical outcomes. Besides, all classification-based analyses were performed within 2 weeks of injury to minimise status change effects and the raters were provided only imaging studies without clinical history or management information.

Data was managed using Microsoft Excel 2019 and it was analysed using SPSS 23. Mean±standard deviation values were calculated for continuous variables, while categorical variables were presented as frequencies and percentages. The comparison of TLICSS and TLAOSIS treatment recommendation categories was evaluated using the chi-square test. McNemar-Bowker test was used for statistical analysis of systematic differences. P<0.05 was considered significant.

Results

Of the 335 patients with mean age 32.24±13.32 years (range: 18-78 years), 279(83.3%) were males and 56(16.7%) were females. The most common injury mechanism was fall from height 189(56.4%), followed by motor vehicle accidents 105(31.3%), fall of heavy objects 39(11.7%), and firearms-related injuries 2(0.6%) (Table 3).

The thoracolumbar junction was the most frequently affected region, with L1 vertebra involved in 109(32.5%) case, followed by T12 70(20.9%) and L2 41(12.2%). Multiple-level fractures occurred in 40(11.9%) cases, while single-level injuries predominated in 295(88.1%). The remaining fractures were distributed across T11 28(8.4%), L3 22(6.6%) and other thoracolumbar levels 65(19.4%).

Treatment recommendations demonstrated excellent concordance between the two classification systems, with 306(91.3%) patients receiving identical recommendations (Cohen's κ=0.812, standard error [SE]=0.033, p<0.001) (Table 4).

Table-3: Demographic, clinical and radiological parameters.

Factor	n (%)
Gender (n=335)	
Male	279 (83.3)
Female	56 (16.7)
Mode of Trauma (n=335)	
Fall from height	189 (56.4)
Fall of heavy object	39 (11.7)
RTA	105 (31.3)
FAI	2 (0.6)
Fracture Morphology - TLICSS (n=355)	
Compression	43 (12.8)
Burst	257 (76.7)
Translational/rotational	25 (7.5)
Distraction	10 (3.0)
Integrity of PLC - TLICSS	
Intact	90 (26.9)
Suspected/indeterminate	139 (41.5)
Disrupted	106 (31.6)
Neurological status - TLICSS	
Neurologically intact	114 (34)
Nerve root injury	34 (10.3)
Complete spinal cord injury	104 (31)
Incomplete spinal cord injury	42 (12.5)
Cauda equina injury	41 (12.2)
Type of fracture - TLAOSIS	
Type A Compression injuries	300 (89.6)
Type B Tension band injuries	10 (2.9)
Type C Translational injuries	25 (7.5)
Neurological status - TLAOSIS	
N0	114 (34)
N1	0 (0)
N2	34 (10.3)
N3	83 (24.7)
N4	104 (31)
Patient-specific modifiers - TLAOSIS	
M1	139 (41.5)
M2	196 (58.5)

Table-4: Treatment recommendation agreement between TLICS and TLAOSIS.

TLICS Treatment	TLAOSIS Treatment			Total
	Conservative	Grey Zone	Surgery	n (%)
Conservative	67	0	0	67 (20.0)
Grey Zone	0	20	2	22 (6.6)
Surgery	17	10	219	246 (73.4)
Total	**84**	**30**	**221**	**335 (100)**
Percentage	**25.1**	**9.0**	**66.0**	**100.0**

Overall Agreement: 306/335 (91.3%); Cohen's κ=0.812 (SE = 0.033), $p<0.001$; McNemar-Bowker $x^2=22.333$ (df=2), $p<0.001$; TLICSS: Thoracolumbar Injury Classification System Score, TLAOSIS: Thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen Spine Injury Score.

TLICS recommended conservative management in 67(20%) patients, grey zone management in 22(6.6%), and surgical intervention in 246(73.4%). TLAOSIS recommended conservative management in 84(25.1%) patients, grey zone management in 30(9%), and surgical intervention in 221(66%).

Perfect concordance was observed for conservative management decisions, with all 67(20%) patients recommended for conservative treatment by TLICSS also receiving conservative recommendations from TLAOSIS, showing 100% agreement. Surgical recommendations showed excellent agreement in 219(89%) of 246 TLICSS surgical cases. Grey zone agreement was substantial, with 20(90.9%) of 22 TLICSS grey zone cases also classified as grey zone by TLAOSIS (Figure).

Treatment recommendation discordance occurred in 29(8.7%) cases, following a consistent pattern favouring more conservative management with TLAOSIS. Specifically, 17(5.1%) patients received surgical recommendations from TLICSS, but conservative recommendations from TLAOSIS, while 10(3%) were recommended for surgery by TLICSS, but fell into the grey zone with TLAOSIS. Only 2(0.6%) patients showed progression from TLICSS grey zone to TLAOSIS surgical recommendations. Notably, there was no reverse pattern of TLICSS recommending conservative management and TLAOSIS recommending surgery.

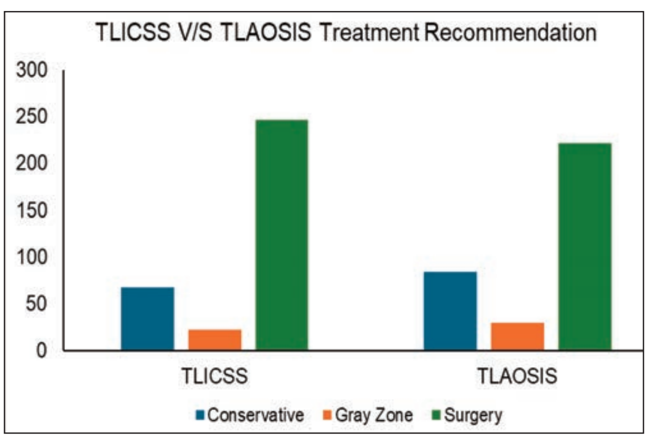

Figure-1: TLICSS and TLAOSIS treatment recommendations.

TLICSS: Thoracolumbar Injury Classification System Score, TLAOSIS: Thoracolumbar Arbeitsgemeinschaft für Osteosynthesefragen Spine Injury Score.

There was a significant systematic difference in treatment recommendations between the classification systems ($p<0.001$). Besides, the high level of agreement between TLICSS and TLAOSIS treatment recommendations (κ=0.812) demonstrated excellent inter-system reliability.

Analysis of individual classification components revealed varying levels of agreement. Neurological status assessment showed the highest concordance between systems, while PLC evaluation demonstrated the greatest variability.

Among the 257(76.7%) patients with burst fractures, agreement between systems remained substantial, though slightly lower than the overall cohort. The systematic conservative bias of TLAOSIS was most pronounced in this subgroup, particularly affecting neurologically intact patients with morphologically complex injuries.

Of the 114(34%) neurologically intact patients, treatment recommendations showed excellent concordance in 98(86%) cases. The discordant cases in this subgroup were exclusively characterised by TLICSS recommending surgery, while TLAOSIS recommending conservative management, highlighting the impact of enhanced morphological discrimination in the TLAOSIS system.

TLAOSIS generated a higher proportion of grey zone recommendations (30[9%] vs 22[6.6%]), reflecting the system's expanded decision-making framework and patient-specific modifiers. This increased sensitivity to borderline cases may provide clinicians with more nuanced guidance for complex decision-making scenarios.

Discussion

Epidemiological data related to thoracolumbar spine fractures is scarce for low- and middle-income countries (LMICs). However, a general trend seen worldwide is similar to the demographic profile in the current study with a greater male-to-female ratio and predominance of young male patients.[11] In a study done in India, an LIMC like Pakistan, a mean age of 37.7±13.2 years was seen in patients with traumatic spinal fractures compared to 32.24±13.32 years in the current study.[12] Fall from height was noted to be the most common mechanism of trauma in patients with thoracolumbar spine fractures, followed by road traffic accidents in the current study. This aligned with previous epidemiological studies.[11,12] The most frequent involvement of L1 vertebra, followed by D12 and L2, mirrored the established biomechanical vulnerability of the thoracolumbar junction with fixed thoracic physiologic kyphosis to mobile lumbar lordosis.[13]

The most common type of fracture in thoracolumbar spine was burst, but the incidence of 17.9% compression fractures in females compared to 11.8% in males highlighted the need to address osteoporosis in females.[14]

In the current study, the comparative analysis of TLICSS and TLAOSIS revealed distinct patterns in treatment recommendations, with notable variations in their classification approaches. The higher proportion of surgical recommendations in TLICSS (73.4%) compared to TLAOSIS (66%) aligned with earlier findings that reported that TLICSS tends to be more aggressive in suggesting operative intervention, particularly in cases with suspected PLC injuries.[7]

The TLAOSIS's higher rate of grey zone cases (9% vs 6.6%) reflects its more nuanced morphological considerations. This observation is supported by studies that found that TLAOSIS's detailed sub-classifications, particularly in type A injuries, provided better morphological characterisation but may lead to more borderline decision-making scenarios.[9] TLAOSIS divides burst fractures into stable and unstable, but there is only a single category for burst fracture in TLICSS. There were 23.2% patients with unstable fracture (A4) based on TLAOSIS compared to 7.8% patients with burst fracture based on TLICSS who fell under the grey zone for treatment recommendation, suggesting TLICSS to be more reliable.

The role of PLC integrity assessment, which is more explicitly weighted in TLICSS, remains a critical differentiating factor between the two systems. Recent studies utilising advanced MRI techniques have demonstrated that TLICSS's emphasis on PLC status correlates well with postoperative outcomes, particularly in burst fractures.[15] However, a study stated that TLAOSIS's more comprehensive morphological assessment might better guide surgical approach selection, despite potentially creating more classification complexity.[16] Both systems showed strong agreement in clear-cut cases (90% concordance for surgical cases), supporting the findings of a systematic review.[17] However, the significant statistical difference between systems ($p<0.001$) in the current study highlighted their fundamental conceptual differences, particularly in cases with intermediate severity scores.

The neurological status consideration, which is integrated differently in both systems, yielded interesting patterns; 21.9% patients with no neurological deficits were suggested surgery based on TLICSS compared to 1.7% based on TLAOSIS. This aligned with a study suggesting higher rates of surgical recommendations in patients with no neurological deficits using TLICSS compared to TLAOSIS.[2]

The economic implications of these classification-based decisions can be noteworthy. TLAOSIS does not require MRI to ascertain the integrity of PLC compared to TLICSS, and conservative approach suggested by both TLAOSIS and TLICSS might reduce healthcare costs without compromising outcomes. However, failure of treatment in patients in the grey zone undergoing delayed intervention in initially conservatively managed patients can led to higher overall healthcare utilisation.[15]

There was a statistically significant systematic difference between the classification systems ($p<0.001$) in the current study, indicating that TLAOSIS consistently recommended more conservative management compared to TLICSS. This systematic difference occurred despite excellent overall agreement ($\kappa=0.812$), suggesting that while the systems were largely concordant, TLAOSIS demonstrated a measurable conservative bias in treatment recommendations.

The systematic conservative bias of TLAOSIS may reflect the system's enhanced morphological discrimination and patient-specific modifiers, which appear to identify cases where less aggressive management may be appropriate. This finding has important clinical implications as it suggests that TLAOSIS may help reduce unnecessary surgical interventions while maintaining appropriate care for patients requiring operative management.

These divergences in classification-based recommendations underscore the importance of integrating multiple factors in clinical decision-making. The ideal approach involves using these classification systems as tools within a broader clinical framework that includes patient-specific factors (age, comorbidities, bone quality), injury-specific characteristics (fracture morphology, neurological status, segmental kyphosis, loss of vertebral height, and degree of canal compromise), healthcare setting capabilities, patient preferences and functional demands.

The current study has several limitations. The cross-sectional, single-centre design has limited the generalisability of the findings and prevented the assessment of long-term clinical outcomes. Most importantly, the study could not validate which classification system's recommendations led to superior clinical outcomes, which is a critical area needing prospective studies. Additionally, the study population was limited to a trauma centre setting, which may not reflect the broader spectrum of thoracolumbar injuries managed in different healthcare environments.

Conclusion

While both TLICSS and TLAOSIS demonstrated good agreement in clear-cut cases, their differences in grey zone classifications and surgical recommendations highlighted the complexity of thoracolumbar injury assessment. While the two classification systems are valuable tools, they should be used in conjunction with clinical expertise rather than as absolute determinants of treatment strategy.

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MN & ASK: Concept, design, data acquisition, analysis, interpretation, drafting, revision and accountability.
MFA: Concept, design, data interpretation, revision, accountability, supervision and proof reading.
MSK, FA & IAK: Concept, design, data interpretation, revision, accountability and proof reading.