Egyptian Journal of Orthopaedic Research "EJOR"
An international peer-reviewed journal published bi-annually

Volume 5, Issue 2, Sep. - 2025: pp: 71-77 www.ejor.sohag-univ.edu.eg

Doi: 10.21608/ejor.2025.455184

Original Article

MANAGEMENT OF SPINE FRACTURES ACCORDING TO THE THORACOLUMBAR AO SPINE INJURY SCORE

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Received 26/1/2025 Accepted 7/4/2025

Abstract

Objective: *This study aims to assess the effectiveness of the Thoracolumbar AO Spine Injury Score (TLAOSIS) in guiding the management of thoracolumbar spine fractures and predicting clinical, radiological, and functional outcomes.* ***Methods:*** *A prospective observational study was conducted on 25 adult patients with thoracolumbar fractures treated at Sohag University Hospitals between September 2023 and September 2024. Patients were categorized into two groups based on their TLAOSIS score: Group A (<4) managed conservatively and Group B (>4) managed operatively.* ***Results:*** *Group A demonstrated significantly better outcomes at arrival, including lower kyphotic angles (11 ± 3.2° vs. 18.8 ± 5.9°, p = 0.001), less vertebral height loss (10.11% ± 2.4 vs. 21.5% ± 6.3%, p < 0.001), and lower pain scores (VAS: 24.2 ± 8.9 vs. 40.9 ± 11.2, p < 0.001). Group B showed more severe initial injuries but exhibited marked improvement over time. By 9 months, both groups achieved comparable outcomes in neurological function (ASIA E: 80%), disability (MODI minimal: 96%), pain (VAS 0–4: 64%), and deformity reduction. The association between TLAOSIS and vertebral height loss (p = 0.002) and kyphotic angle (p = 0.016) was statistically significant at baseline but not at follow-up.* ***Conclusion:*** *TLAOSIS is a reliable prognostic tool that correlates with injury severity and guides treatment decisions. Conservative management is effective for patients with low scores, while surgical intervention benefits those with high scores. Incorporating TLAOSIS into clinical decision-making supports personalized care and improved recovery outcomes. Further validation in larger, multicenter studies is recommended.*

Keywords: *Thoracolumbar fractures, TLAOSIS, Spine injury classification, Conservative vs. operative management.*

1. Introduction

Spinal fractures are a significant global health issue, with around 5 million new cases annually [1]. The lumbar and thoracolumbar regions are commonly affected due to their structural and biomechanical characteristics, including the lack of rib support, lordotic curvature, and transitional mechanical role between spinal regions [2]. Burst fractures typically result from high-energy trauma, such as road traffic accidents or falls [3]. Proper classification is essential for managing these injuries effectively. Systems have been developed based on injury mechanism, morphology, stability, and neurological involvement [4]. The AO Spine Classification categorizes thoracolumbar fractures into compression (Type A), distraction (Type B), and translational (Type C) injuries, with further subdivisions reflecting severity [5]. The Thoracolumbar AO Spine Injury Score (TL AOSIS) complements these systems by integrating injury morphology, posterior ligamentous complex (PLC) integrity, and neurological status, offering a structured approach to guide treatment planning and evaluate spinal stability [5]. Initial management includes spinal immobilization and ABC stabilization before neurological assessment, which involves motor, sensory, and reflex testing, along with rectal examination [6]. Radiological evaluation begins with plain radiographs (AP and lateral) [6], followed by CT for detailed bone assessment and MRI to evaluate soft tissue and neurological structures [7]. Treatment depends on the TL AOSIS score: scores <4 favor conservative treatment like bed rest and orthosis [8], scores >4 indicate surgical intervention, and a score of 4 requires clinical judgment to determine the best approach [9]. The purpose of this study is to validate the effectiveness of the TL AOSIS in guiding the management of spinal trauma cases presenting to the orthopedic emergency department at Sohag Univ. Hospitals.

2. Patients and Methods

2.1. *Study design and setting*

This was a prospective study of patients admitted to the Sohag University Hospitals' orthopedic and traumatology departments.

2.2. *Participants*

The scientific and ethical committees of the Sohag Faculty of Medicine gave their approval to the study. 25 patients with thoracolumbar fractures who were seen at the orthopedics and traumatology department between September 2023 and September 2024 participated in the study.

2.3. *Selection criteria*

This prospective observational study included skeletally mature patients (aged ≥18 years) presenting with thoracolumbar fractures. Patients were enrolled upon admission to the orthopedic department. Exclusion criteria included patients with skeletal immaturity or pathological fractures.

2.4. *Interventions*

Patients were treated either non-operatively or operatively based on their Thoracolumbar AO Spine Injury Score (TL AOSIS).

- *Non-operative management* was applied for patients with a TL AOSIS score of less than 4 (Group A) and consisted of thoracolumbosacral orthosis (TLSO), adjusted according to pain tolerance.
- *Operative management* was indicated for patients with a TL AOSIS score greater than 4 (Group B) and involved spinal fixation, with or without neural canal decompression. The need for decompression was determined based on the presence of neurological compression as assessed clinically and via imaging.
- *Patients* with a TL AOSIS score of 4 were managed based on surgeon preference, as this score represents an indeterminate category requiring individualized clinical judgment.

2.5. *Clinical and radiological assessment*

Upon admission and after initial stabilization, each patient underwent a comprehensive clinical evaluation, including neurological assessment using the ASIA classification system [10]. Key clinical data such as age, sex, injury mechanism, fracture level, associated injuries, neurological status, pain (VAS), and disability (ODI) were recorded. Radiological assessment included AP and lateral X-rays to evaluate spinal alignment and detect signs of PLC injury, such as widened interspinous or facet spaces and facet dislocation. The kyphotic angle was measured using the Cobb method [11] to assess spinal deformity, along with vertebral height loss quantification. Vertebral height loss was calculated using the formula:

$$\left\{1-\frac{B}{\left[(A+C)/2\right]}\right\}\times100\%$$

Where A and C represent the heights of the adjacent vertebrae, and B is the height of the fractured vertebra. All measurements were performed using the Surgimap application, version 2.3.2.1. CT scans were utilized to assess fracture configuration, including lamina, pedicle integrity, and spinal canal compromise. MRI was performed to evaluate the integrity of the PLC and identify neural canal compression.

2.6. *Follow-up protocol*

Patients were followed up at 1, 3, 6 & 9 months post-injury. At each visit, AP and lateral spinal radiographs were obtained to evaluate kyphotic deformity and vertebral height loss. Clinical follow-up included assessment of:

- Neurological status (ASIA)
- Pain (VAS)
- Functional disability (ODI) At 3, 6, and 9 months, kyphotic angle and vertebral height loss were re-measured using the Surgimap software.

2.7. *Statistical analysis*

Statistical analysis was performed using SPSS version 27. Frequency analysis was used to summarize categorical variables, including fracture type and intervention method. Descriptive statistics (means and standard deviations) were calculated for continuous variables such as age and radiological findings. Chi-square tests assessed associations between categorical variables, while independent samples t-tests compared mean values between operative and non-operative groups for outcomes like kyphotic angle, VAS, and ODI scores. A p-value of less than 0.05 was considered statistically significant.

3. Results

Table (1) presents the sociodemographic characteristics of 25 patients, highlighting their age distribution and gender proportions. Patients are categorized into four age groups: 18–25 years and 26–35 years, each comprising 7 individuals (28% each), 36–45 years, representing the largest group with 9 individuals (36%), and those older than 45 years, with only 2 individuals (8%). The mean age is 33.3 years, with a range from 18 to 60 years, and a standard deviation of 10.5 years. Gender distribution shows a higher proportion of females (60%) compared to males (40%). Among the 25 patients, the majority (64%) sustained trauma from falls from height, followed by motor car accidents (24%), heavy object falls (8%), and slippage downstairs (4%). Over half (56%) had no associated injuries, while lower limb fractures were the most common among those injured (24%). Complete burst fractures and flexion distraction injuries were the most frequent fracture types (32% each), and the PLC was intact in 68% of cases. Fracture patterns A4N0 and B2N3 were the most common (28% each), with several rarer patterns (4% each). Most patients (64%) had TLAOSIS scores above 4 (mean: 5.56 ± 3.33; range: 1–10), and the same percentage underwent surgical intervention. Complications were rare (8%), limited to one superficial infection and one case of bed sores. Neurologically, 68% were classified as ASIA E, while ASIA A, B, and C accounted for 4%, 12%, and 8%, respectively, tab. (2). Over a nine-month follow-up, patients showed significant neurological and functional improvement. The proportion of ASIA E patients increased from 17 (68%) at arrival to 20 (80%), while ASIA B cases decreased from 3 (12%) to 1 (4%), with changes statistically significant ($p < 0.001$). Vertebral height loss improved markedly: patients with 30–40% loss (12%) at arrival were fully resolved, and the 10–19% category rose to 68%, while the 20–29% group declined to 4% by nine months ($p < 0.001$). Kyphotic angle correction also showed progress: severe cases (21–25°) were eliminated, and the 0–5° category appeared by nine months, with the 6–15° range comprising 72% of patients ($p = 0.011$). Disability levels improved significantly—severe disability (48%) was fully resolved by six months, and by nine months, 96% of patients had only minimal disability ($p < 0.001$). Pain levels also declined: while 88% initially scored 5–44 on the pain scale, by nine months, 64% were in the 0–4 range ($p < 0.001$), indicating substantial and statistically significant recovery across all measures, tab. (3). At arrival, patients in Group A had significantly better outcomes compared to Group B across vertebral height loss ($p = 0.002$), dis-ability index ($p < 0.001$), and kyphotic angle ($p = 0.016$). Group A mostly presented with mild vertebral height loss (10–19%) and no severe disability, while Group B had more severe height loss (56.3% with 20–29%) and 75% presented with severe disability. Kyphotic angles were also milder in Group A, with no cases above 20°, unlike Group B which had 31.3% in the 21–25° range. After 9 months, both groups showed marked improvement: the majority had 10–19% height loss (77.8% in Group A, 62.5% in Group B), 96–100% achieved minimal disability, and kyphotic angles improved with most cases under 20°. However, the differences between groups were no longer statistically significant at follow-up, indicating that both groups benefitted from treatment over time, tab. (4). Patients managed conservatively demonstrated better results with lower mean TLAOSIS scores (2.11 ± 0.9 vs. 7.5 ± 2.5, $p < 0.001$). Additionally, the kyphotic angle was significantly lower in the conservative group ($11 \pm 3.2°$) compared to the operative group ($18.8 \pm 5.9°$, $p = 0.001$). Pain levels, measured by the VAS score, were also notably lower in the conservative group (24.2 ± 8.9 vs. 40.9 ± 11.2, $p < 0.001$). Furthermore, vertebral height loss was significantly less in the conservative group ($10.11 \pm 2.4\%$) than in the operative group ($21.5 \pm 6.3\%$, $p < 0.001$), tab. (5).

Table (1) Sociodemographic characteristics of the patients (n=25).

Parameter		Frequency (%)	Group A (n=9)	Group B (n=16)
Age (years)	▪ ***18-25***	7 (28%)	2 (22.5%)	5 (31.3%)
	▪ ***26-35***	7 (28%)	4 (44.5%)	3 (18.8%)
	▪ ***36-45***	9 (36%)	2 (22.5%)	7 (43.8%)
	▪ ***>45***	2 (8%)	1 (11.1%)	1 (6.3%)
Mean age (Min-max)		33.3 ± 10.5 (18-60)		
Gender	▪ ***Male***	10 (40%)	4 (44.4%)	6 (37.5%)
	▪ ***Female***	15 (60%)	5 (55.6%)	10 (62.5%)

***Group A:** Conservative approach* ***Group B:** Operative approach*

Table (2) Clinical and postoperative outcomes (n=25).

Parameter		Frequency (%)	Group A (n=9)	Group B (n=16)
Mode of trauma	▪ ***FFH***	16 (64%)	4 (44.5%)	12 (75%)
	▪ ***MCA***	6 (24%)	4 (44.5%)	2 (12.5%)
	▪ ***Assault***	2 (8%)	1 (11.1%)	1 (6.3%)
	▪ ***Heavy object fallen on him***	1 (4%)	0	1 (6.3%)
Associated injuries	▪ ***No***	14 (56%)	5 (55.6%)	9 (56.3%)
	▪ ***Lower limb fracture***	6 (24%)	1 (11.1%)	5 (31.3%)
	▪ ***Upper limb fracture***	2 (8%)	1 (11.1%)	1 (6.3%)
	▪ ***Pelvic fracture***	3 (12%)	2 (22.2%)	1 (6.3%)
Morphology	▪ ***Complete burst***	8 (32%)	0	8 (50%)
	▪ ***Incomplete burst***	4 (16%)	4 (44.4%)	0
	▪ ***Wedge fracture***	4 (16%)	4 (44.4%)	0
	▪ ***Compression***	1 (4%)	1 (11.1%)	0
	▪ ***Flexion distraction***	8 (32%)	0	8 (50%)
PLC integrity	▪ ***Intact***	17 (68%)	9 (100%)	8 (50%)
	▪ ***Injured***	8 (32%)	0	8 (50%)
AO classification	▪ ***A4N3***	1 (4%)	0	1 (6.3%)
	▪ ***A4N0***	7 (28%)	0	7 (43.8%)
	▪ ***A3N0***	4 (16%)	4 (44.5%)	0
	▪ ***A2N0***	3 (12%)	3 (33.3%)	0
	▪ ***B2N4***	1 (4%)	0	1 (6.3%)
	▪ ***B2N3***	7 (28%)	0	7 (43.8%)
	▪ ***B2N0***	1 (4%)	0	1 (11.1%)
	▪ ***A1N0***	1 (4%)	1 (11.1%)	0
TLAOSIS	▪ ***<4***	9 (36%)	9 (100%)	0
	▪ ***>4***	16 (64%)	0	(16%)
Management	▪ ***Conservative***	9 (36%)	▪ ***Conservative***	9 (36%)
	▪ ***Operative***	16 (64%)	▪ ***Operative***	16 (64%)
Postoperative complications	▪ ***Yes***	2 (8%)	0	2 (12.6%)
	▪ ***No***	23 (92%)	9 (100%)	14 (87.5%)
If yes, the complications are	▪ ***Infection***	1 (4%)	0	1 (6.3%)
	▪ ***Bed sores***	1 (4%)	0	1 (6.3%)
Neurological status	▪ ***ASIA A***	1 (4%)	0	1 (11.1%)
	▪ ***ASIA B***	3 (12%)	0	3 (33.3%)
	▪ ***ASIA C***	2 (8%)	0	2 (22.2%)
	▪ ***ASIA D***	2 (8%)	0	2 (22.2%)
	▪ ***ASIA E***	17 (68%)	9	8

***Group A:** Conservative approach* ***Group B:** Operative approach*

Table (3): Functional outcomes before and after management.

Parameter	At arrival	After 3 months	After 6 months	After 9 months	P-value
Neurological Affection					
▪ ***ASIA A***	1 (4%)	1 (4%)	1 (4%)	1 (4%)	**<0.001**
▪ ***ASIA B***	3 (12%)	2 (8%)	2 (8%)	1 (4%)	
▪ ***ASIA C***	2 (8%)	3 (12%)	2 (8%)	2 (8%)	
▪ ***ASIA D***	2 (8%)	1 (4%)	2 (8%)	1 (4%)	
▪ ***ASIA E***	17 (68%)	18 (72%)	18 (72%)	20 (80%)	
Vertebral height loss					
▪ ***<10%***	4 (16%)	9 (36%)	8 (32%)	7 (28%)	**<0.001**
▪ ***10-19%***	9 (36%)	14 (56%)	15 (60%)	17 (68%)	
▪ ***20-29%***	9 (36%)	2 (8%)	2 (8%)	1 (4%)	**0.011**
▪ ***30-40%***	3 (12%)	0	0	0	
▪ ***0-5°***	0	0	0	2 (8%)	
▪ ***6-10°***	4 (16%)	11 (44%)	11 (44%)	9 (36%)	
▪ ***11-15°***	8 (32%)	9 (36%)	9 (36%)	9 (36%)	
▪ ***16-20°***	8 (32%)	5 (20%)	5 (20%)	5 (20%)	
▪ ***21-25°***	5 (20%)	0	0	0	

Modified Oswestry Disability Index					
▪ ***Minimal disability*** ▪ ***Moderate disability*** ▪ ***Severe disability***	3 (12%) 10 (40%) 12 (48%)	16 (64%) 8 (32%) 1 (4%)	16 (64%) 9 (36%) 0	24 (96%) 1 (4%) 0	**<0.001**
VAS score					
▪ ***0-4*** ▪ ***5-44*** ▪ ***45-74*** ▪ ***75-100***	0 22 (88%) 3 (12%) 0	0 25 (100%) 0 0	14 (56%) 11 (44%) 0 0	16 (64%) 9 (36%) 0 0	**<0.001**

Table (4) Association between TLAOSIS score and the functional outcomes at arrival and after follow-up.

Parameter		**TLAOSIS score**		**P-value**
		Group A	***Group B***	
Vertebral height loss				
▪ ***At arrival***	<10% 10-19% 20-29% 30-40%	4 (44.4%) 5 (55.6%) 0 0	0 4 (25%) 9 (56.3%) 3 (18.8%)	**0.002**
▪ ***After 9 months***	<10% 10-19% 20-29%	2 (22.2%) 7 (77.8%) 0	5 (31.3%) 10 (62.5%) 1 (6.3%)	0.629
Modified Oswestry Disability Index				
▪ ***At arrival***	Minimal disability Moderate disability Severe disability	3 (33.3%) 6 (66.7%) 0	0 4 (25%) 12 (75%)	**<0.001**
▪ ***After 9 months***	Minimal disability Moderate disability	9 (100%) 0	15 (93.8%) 1 (6.3%)	0.444
Kyphotic angel				
▪ ***At arrival***	0-5 6-10 11-15 16-20 21-25	0 4 (44.4%) 3 (33.3%) 2 (22.2%) 0	0 0 5 (31.3%) 6 (37.5%) 5 (31.3%)	**0.016**
▪ ***After 9 months***	0-5 6-10 11-15 16-20	0 2 (22.2%) 4 (44.4%) 3 (33.3%)	2 (12.5%) 7 (43.8%) 5 (31.3%) 2 (12.5%)	0.335

Table (5) Comparison between management methods and the clinical assessment scores.

Parameter		**No**	**Mean ± SD**	**P-value**
▪ ***TLAOSIS score***	Conservative Operative	9 16	2.11 ± 0.9 7.5 ± 2.5	**<0.001**
▪ ***Kyphotic angle***	Conservative Operative	9 16	11 ± 3.2 18.8 ± 5.9	**<0.001**
▪ ***VAS score***	Conservative Operative	9 16	24.2 ± 8.9 40.9 ± 11.2	**<0.001**
▪ ***Vertebral loss***	Conservative Operative	9 16	10.11 ± 2.4 21.5 ± 6.3	**<0.001**

4. Discussion

This study explores the relationship between thoracolumbar injury severity—classified using the TLAOSIS system—and clinical, radiological, and functional outcomes, while also evaluating how these outcomes vary based on management strategies. The most frequent fracture types were complete burst fractures and flexion-distraction injuries (32% each), followed by incomplete burst and wedge fractures (16% each), and compression fractures (4%). These findings differ from Holmes et al., who noted wedge fractures represent 50–70% of civilian thoracolumbar fractures and burst fractures 14% of blunt trauma cases [12]. Additionally, flexion-distraction injuries account for 10% of thoracolumbar injuries, with

10–25% involving only ligaments [13]. In our cohort, 68% had intact PLC and no neurovascular injuries, whereas Shanke et al. observed that 42% of type B injuries were initially misclassified as type A without PLC evaluation [13]. The most common fracture classifications were A4N0 and B2N3 (28% each), contrasting with Costachescu et al., who noted that A3N0 and A2N0 were managed conservatively, while more complex patterns like A3N1 and A3N2 required surgery [14]. At arrival, TLAOSIS <4 (Group A) patients had less severe vertebral height loss (<10% and 10–19%), whereas TL AOSIS >4 (Group B) patients mostly had 20–29% and 30–40% loss—a statistically significant difference ($p = 0.002$). Over time, this difference diminished, and by 9 months, most patients in both groups fell into the 10–19% range, with no significant difference ($p = 0.629$). These results align with Vaccaro et al., who confirmed TLAOSIS as a valuable prognostic tool, with higher scores indicating more severe injury and poorer outcomes [15]. Our findings support early identification and possible surgical intervention for patients with TLAOSIS >4, consistent with Morrissey et al.'s recommendation that early surgery enhances recovery and reduces deformity risk [16]. Kyphotic angle progression also showed a link with TLAOSIS: at arrival, higher TLAOSIS scores were associated with greater angles ($p = 0.016$), but this association disappeared by 3, 6, and 9 months (p-values > 0.3). A case reported by Mattei et al. supports our findings—conservative treatment of a burst fracture (TLAOSIS = 5) led to progressive kyphosis requiring later surgical stabilization [17]. Finally, pain outcomes and disability correlated with TLAOSIS scores, where patients with lower scores showed better recovery with conservative treatment, while higher scores required more intensive management. This reinforces the TLAOSIS system's clinical relevance in predicting pain and functional recovery, guiding individualized treatment strategies. Patients treated conservatively had significantly lower mean TLAOSIS scores (2.11 ± 0.9) compared to those managed surgically (7.5 ± 2.5, $p < 0.001$), indicating milder injuries were more likely managed without surgery. This supports TLAOSIS's role in guiding treatment, with higher scores associated with operative decisions. Santander & Rodríguez-Boto noted that TLAOSIS placed more patients in the "gray zone" compared to TLICS, with a higher surgical match rate (42.8% vs. 29.9%) but less conservative judgment (57.2% vs. 70.1%, $p < 0.01$), though both systems showed high agreement in conservative cases (98.1%) [18]. Kyphotic angles were significantly lower in conservatively managed patients ($11 \pm 3.2°$) versus those treated surgically ($18.8 \pm 5.9°$, $p = 0.001$), suggesting greater deformity drives the need for surgery. Santander & Rodríguez-Boto emphasized operating on A3/A4 fractures due to the risk of worsening kyphosis in comminuted burst fractures [18]. Pain scores (VAS) were also lower in the conservative group (24.2 ± 8.9 vs. 40.9 ± 11.2, $p < 0.001$), indicating more severe pain influenced surgical decisions. Vertebral height loss was significantly less in the conservative group (10.11% ± 2.4) than in the operative group (21.5% ± 6.3, $p < 0.001$), underscoring height loss as a marker for instability and surgical need. Surgery, in such cases, helps restore height and spinal stability, reducing kyphosis [19, 20]. However, low predictive agreement between TLAOSIS and TLICS in burst fractures reflects ongoing controversy in their management strategies [21].

5. Conclusion

The results demonstrate significant recovery across all patients, regardless of TLAOSIS severity, confirming the effectiveness of both surgical and conservative management. The study reinforces the TLAOSIS score as a reliable prognostic tool linked to pain, deformity, and disability, and advocates for its integration into clinical decision-making to personalize treatment and improve long-term outcomes. Future research should aim to validate its use across larger and more diverse populations.

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