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Clinico radiological outcomes of thoracolumbar vertebral fractures: insights from a regional Indian cohort

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ABSTRACT

Background: Thoracolumbar fractures are one of the frequent spinal injuries especially in the developing areas where road accidents and occupational trauma are common. Their resource management in resource constrained health care setting is a special challenge. The paper is an evaluation of short-term (6 months) clinic radiological prognoses of patients with thoracolumbar fractures compared to clinical recovery as per radiological parameters in conventional conservative and surgical interventions.
Methods: This prospective observational study included 30 patients (26 males, 4 females) with traumatic thoracolumbar fractures treated between January 2023 and June 2024 at Hassan Institute of Medical Sciences. Patients were assessed using the American Spinal Injury Association (ASIA) spine chart, ASIA Impairment Scale (AIS), and radiological tools (X-rays, CT, MRI, and Thoracolumbar Injury Classification and Severity Score – TLICS). Surgical intervention was indicated for TLICS ≥5, progressive neurological deficits, or >50% vertebral height loss, whereas TLICS ≤3 were managed conservatively. Outcomes were followed up at admission, 7 days, 6 weeks, 12 weeks, and 24 weeks.
Results: Short-term clinic radiological evaluation demonstrates that individualized management—guided by TLICS and ASIA parameters—achieves satisfactory recovery in thoracolumbar fractures. Conservative management remains effective for stable injuries, while surgical stabilization provides structural benefits in unstable fractures. Larger multicentric studies with extended follow-up are needed to validate these findings.
Conclusions: The database of our retrospective study regarding age and sex incidence, clinicopathological features and therapeutic outcome was comparable to other studies in various literatures.

Keywords: TLICS, ASIA impairment scale, Kyphotic angle, Compression fracture, Burst fracture

INTRODUCTION

Fractures of the thoracolumbar spine form a significant portion of spinal trauma cases in the world, with the most common of them happening at the thoracolumbar junction (T10L12) with the junction of the rigid thoracic spine and the more mobile lumbar spine. This transitional zone is a very vulnerable part of the anatomy and is prone to damage especially in high-impact accidents like road traffic accidents, height falls and industrial trauma.[1,2] Thoracolumbar fractures represent 20-30% of all spinal injuries in India with the incidence estimated at 64 cases per million population per year.[3,4] The fast urbanization and the growing intensity of urban life traffic have increased the pressure of the spinal trauma load as well, and the number of road traffic diseases in 2021 exceeded 450,000 of which a significant number of cases involved vertebral fractures.[5,6] Thoracolumbar Injury in patients can result in chronic back pain, neurological impairments, or post-traumatic deformities, such as kyphosis that occurs in

approximately 20% of individuals and causes lifelong disability.[7] Neurological compromise occurs in up to 15% of thoracolumbar fractures, ranging from transient paresis to complete paralysis.[8] These injuries are also difficult to manage and especially in the areas with limited resources, the availability of the complex implants and intraoperative imaging, and rehabilitation will be limited.

The existing treatment plans can be divided into broad divisions, such as conservative and surgical treatment. Bed rest, external bracing, analgesia, and physiotherapy comprise the category of conservative management which is generally only applied to stable fractures that lack neurological deficit or damage to the spinal canal.[9] Even though non-operative therapy is free of surgical risk, it could be accompanied by progressive loss or chronic pain because of residual instability. On the other hand, the goals of surgical fixation are to attain neuro-decompression, reestablish vertebral positioning and offer early mobilization.[10,11] Nevertheless, surgical interventions come with complications such as infection, implantation failure and adjacent segment disease, which have been observed in as many as 16 per cent cases.[12]

Surgical procedures can be done in the form of an anterior, posterior, or a combined procedure, which is done either by an open procedure or a minimally invasive procedure.[13,14] The most widespread is the posterior, as it has the least operative time and haemorrhage, but anterior exposition directly decomposes the spinal canal but has more morbidity in the pulmonary and abdominal regions than the posterior exposition.[15] The choice of treatment thus involves a weighted consideration of the fracture stability, neurological condition, and comorbidity of a patient- which may have a wide range of applications in healthcare facilities.

Although the fixation techniques and radiological evaluation have improved, there is still a significant gap in the correlation of radiological measures of the Thoracolumbar Injury Classification and Severity Score (TLICS) and kyphotic angle development with functional neurological recovery, particularly in the Indian clinical setting. Most of the research in developed countries is found to have long-term follow-ups but not in Indian canters where management decisions are influenced by socio-economic and infrastructural barriers.[16]

Based on this, the present study was conducted with the aim of examining brief (six months) clinicoradiological outcomes of traumatic thoracolumbar fractures in a local Indian cohort. This study will determine the relationships between clinical outcome (ASIA, AIS) and radiological outcome (TLICS, kyphotic angle) by comparing surgical and conservative treatment modalities in a prescribed decision model. The results are likely to provide context-dependent evidence that can inform individualized treatment development and improve the use of resources during spine trauma.

METHODS

This research was carried out in the form of prospective observational descriptive research to assess short-term clinicoradiological patient outcomes following traumatic thoracolumbar vertebral fractures. The study was conducted at the department of Orthopaedics, Hassan Institute of medical Sciences (HIMS), Hassan, India between January 2023 and June 2024. The sample of the patients was obtained in the Casualty, Outpatient Department (OPD), and Inpatient wards to represent the patients with different clinical presentations of acute trauma to subacute follow-ups.

Study duration

The research time was 18 months (January 2023- June 2024). This time frame was sufficient to recruit enough patients and have uniform six-month follow-up of the same. To evaluate the clinical and radiological progression, patients were monitored at admission, 7 days, 6 weeks, 12 weeks and 24 weeks after the intervention. These periods were selected to depict temporary recovery patterns as opposed to short-term results, as per the purposes of the studies.

Study participants

Participants included patients with traumatic thoracolumbar vertebral fractures. The inclusion and exclusion criteria ensured the selection of a focused cohort.

Inclusion criteria

Patients aged 18 to 90 years presenting with traumatic thoracolumbar vertebral fractures involving levels T10 to L2 were included. These injuries resulted from mechanisms such as falls, vehicular accidents, or direct trauma. All patients were required to be available for follow-up at 6 months.

Exclusion criteria

Patients with pathological fractures, a history of previous spinal surgery, multilevel fractures extending beyond T10–L2, or incomplete clinical or radiological data were excluded from the study.

Study sampling

The selection of patients was carried out using a non-probability sampling method.[30] The same clinical and radiological assessments were administered to all recruited participants.? Assessments of the American Spinal Injury Association (ASIA) spine chart and impairment scale were used as clinical parameters to provide detailed information on the neurological state of patients. To determine the radiological parameters of the fracture, they used X-rays (anteroposterior and lateral views), CT scans, and an MRI

of its thoracolumbar spine. This set of parameters was chosen for its relevance in the diagnosis, monitoring and prediction regarding injuries in thoracolumbar vertebral fractures.

Treatment allocation

Patients were allocated to surgical or conservative groups based on Thoracolumbar Injury Classification and Severity Score (TLICS), fracture morphology, and neurological status.

Surgical group (n=8): Indicated for TLICS ≥ 5, unstable burst fractures, neurological deficit (ASIA A–C), vertebral collapse >50%, or kyphosis >20°.

Conservative group (n=22): Indicated for TLICS ≤ 3, minimal neurological deficit (ASIA D/E), and stable fracture morphology with preserved posterior ligamentous complex (PLC).

Study procedure

The study involved obtaining informed consent and recording detailed demographic and medical histories. Clinical examinations documented initial presentations and neurological deficits using the ASIA spine chart and impairment scale. Radiological assessments (X-rays, CT, MRI) classified fractures via TLICS scoring and evaluated PLC status. Follow-ups included clinical and neurological evaluations at admission, 7 days, 6 weeks, 12 weeks, and 24 weeks, with imaging at corresponding intervals to monitor fracture progression and treatment outcomes through clinical photographs and radiographs.

Surgical management

Patients undergoing surgical intervention received decompression and stabilization using polyaxial pedicle screw fixation. General Anaesthesia with T piece and Intraoperative sedation monitoring started. Bolster support was given to the head, pelvis and knees. With a horseshoe or towel fold, roll support to the neck is achieved. Preoperative prophylactic antibiotics (1gm ceftriaxone/ceftazidime) were administered.

A midline incision was made, and direct decompression was performed by excising the lamina and clearing neural foramina. Pedicle screws were placed using a C-arm-guided technique, ensuring no cortical breaches (Figure 1). Haemostasis was ensured using suction and bipolar cautery.

Cerebrospinal fluid (CSF) leaks were carefully monitored. Contoured rods were fitted, followed by distraction or compression based on the injury. Closure was performed over a sterile drain, with layers sutured to minimize complications.

Conservative management protocol

During hospitalization, patients received physiotherapy, limb logrolling, and DVT prophylaxis if needed. They were trained in intermittent catheter clamping and voluntary micturition. Follow-ups occurred every 4 weeks with X-rays to monitor kyphotic angle progression and vertebral body height. Bladder and bowel status were evaluated. After 3 months, patients were advised to gradually remove braces and begin strengthening exercises, including abdominal, back, and quadriceps training, active straight-leg raises, and walking with crutches.

Clinical and radiological evaluation

Clinical: ASIA motor and sensory sub scores were used to assess neurological status and ASIA Impairment Scale (AIS) was used to determine impairment at every follow-up.

Radiological: X-rays (AP and subsequent later) were performed during each visit to assess the vertebral alignment and the kyphotic angle (Cobbs's technique). Canal compromise was measured using CT and MRI was used to determine the integrity of the posterior ligamentous complex (PLC).

TLICS scoring was only done at baseline, and not longitudinally as it was used to select treatment.

Follow-up

The assessments were followed up in Admission, Day 7, Week 6, Week 12, and Week 24. ASIA motor/sensory scores and kyphotic progression were measured at every interval to measure clinical and radiological recovery.

Ethical considerations

HIMS's Institutional Ethics Committee (IEC) granted approval for the study protocol. All participants provided written informed consent in their preferred language (English or Kannada). To safeguard data confidentiality, personal information was kept on file and only accessible to the research team through secure storage methods. Throughout the study, ethical principles of autonomy, beneficence, justice, and non-maleficence were upheld.

Data analysis

An analysis of data was carried out using Microsoft Excel and SPSS software. Demographic and clinical characteristics were summarized in descriptive statistics, and paired t-tests were conducted to compare treatment outcomes prior to and after the intervention. The associations between clinical and radiological outcomes were investigated to determine predictors of outcomes. The figures for the results were mean, standard deviation, percentages, and proportion.

RESULTS

Over an 18-month period from January to June 2023, the study included 30 patients, with 26 being male and 4 being female. Those years from 31 to 60 represent 50% of the total patients, with a concentration in the middle range. A smaller portion, 33%, lies within 1–30, representing the lower end, while only 17% are in the upper range of 61–90 (Table 1). This distribution suggests a central tendency toward the middle range, with fewer values at the extremes. Wedge compression fractures were the most common, accounting for 40% of cases, followed by burst fractures (30%) and split fractures (26%). Distraction fractures were rare, comprising only 3% of the total sample (Table 1, Figure 2). The motor sub scores of patients (ASIA chart) were distributed across five ranges over multiple time points: admission, Day 7, Weeks 6, Week 12, and Week 24. The 91–100 range consistently had the highest number of patients, starting with 23 at admission and ending with 22 by Week 24. Lower ranges (50–80) showed fluctuations, with a slight decrease in sub scores over time, reflecting improvement or stabilization in motor function during the study period (Table 2).

Table 1: Descriptive characteristics of the patient.

Variables	Levels	Counts	% of total
Gender	Male	26	86.7
	Female	4	13.3
Age group (in years)	18-30	10	33.3
	31-60	15	50.0
	61-90	5	16.7
Fracture type	Burst	9	30
	Wedge compression	12	40
	Split fractures	8	26.60
	Distraction fractures	1	3.30
Mode of injury	Fall from height	17	56.7
	Road traffic accident	10	33.3
	Direct impact/heavy object	3	10.0

Table 2: ASIA motor score distribution over time (n=30).

Range	Admission	Day 7	Week 6	Week 12	Week 24
50-60	4	2	3	3	2
61-70	0	0	0	1	0
71-80	2	0	2	1	1
81-90	1	3	1	1	2
91-100	23	25	24	24	25

The significant neurological recovery demonstrated by ASIA motor scores 90 in 83% of patients by week 24.' The functional limitations of ASIA C were only observed in two patients at the baseline stage. The distribution of AIS scores over time indicates the outcomes of patients: at admission, most had D (18) or E (8) scores, while only a small number were assigned to A, B, or C. During Week 24, A had a score of 0, whereas B and C were either stable or slightly better (1 and 2, respectively). Scores of D increased to 19, and E stabilized at 8. t-values across intervals showed minimal significant changes, reflecting gradual recovery or stabilization. Compared to studies by Siebenga and Epstein, 94% of patients with scores of C, D, or E improved or stabilized, while 6% (A and B) showed minimal recovery (Table 3).

Most A1 and A2 fractures showed < 5° progression, while A3 burst fractures had greater variation. Only two postoperative patients (6.6%) exhibited > 10° progression, both due to pedicle-screw backout without neurological loss. Kyphotic progression correlated with fracture type (χ^2 =8.13, p=0.04) but not with age or sex. Kyphotic angle progression was followed up radiologically along with clinical features. Most patients with wedge compression (A1) and split (A2) with the conservative method of management showed a progression of less than 5 degrees in 11(40% of all) cases. The same for burst fractures (A3) was less than 10 degrees in the entire follow-up period in the majority, and only 2 cases had progression of more than 10 degrees (both had screw backout postoperatively) (Table 4). The main causes of thoracolumbar vertebral fractures in this were falls from height, road traffic accidents or slips causing self-falls and falls of heavy objects on the back. (Figure 3). The operative management was performed 8 times, whereas conservative management was employed 22 times. This indicates that a more cautious approach was favoured, with conservative measures being adopted in most cases (22 out of 30). In contrast, surgical intervention was reserved for fewer cases (8 out of 30), suggesting that operative management was only necessary when required (Figure 4). This disparity in management frequencies may be attributed to various

factors, such as the severity of the condition, patient preferences, or the presence of comorbidities. The fact that conservative management was employed more frequently suggests that a more nuanced approach was taken, prioritizing non-invasive interventions whenever possible. Table 5 provides the summary of motor, sensory, and baseline TLICS scores distribution in the study cohort. There was progressive neurological recovery with decreasing variability indicated by the lower standard deviation as indicated by the mean ASIA motor subscore of 89.73, which rose to 93.03, at a 24 weeks' time interval. Majority of the patients achieved almost normal motor performance (median=99).

Table 3: Distribution of ASIA impairment scale (AIS).

	Levels	Counts	% of total
Admission	D	18	60.0
	E	8	26.7
	C	2	6.7
	A	1	3.3
	B	1	3.3
Day 7	D	18	60.0
	E	8	26.7
	C	2	6.7
	A	1	3.3
	B	1	3.3
Week 6	D	17	56.7
	E	9	30.0
	C	3	10.0
	B	1	3.3
Week 12	D	13	43.3
	E	13	43.3
	C	3	10.0
	B	1	3.3
Week 24	D	12	40.0
	E	15	50.0
	C	2	6.7
	B	1	3.3

Table 4: Kyphotic angle progression.

	<5deg	<10deg	> 10deg
A1(wedge compression)	7	4	1
A2 (split)	5	3	0
A3 (burst)	2	5	2
Others	0	1	0

Table 5: Descriptive statistics of motor sub scores, sensory sub scores, and baseline (TLICS).

Variable	N	Mean	Median	SD	IQR	Range	Min	Max
Sub score motor (admission)	30	89.73	98	16.53	5.5	50	50	100
Sub score motor (day 7)	30	89.83	98	16.57	5.5	50	50	100
Sub score motor (week 6)	30	91.33	98	14.52	5.75	46	54	100
Sub score motor (week 12)	30	92.03	99	13.75	5.5	46	54	100
Sub score motor (week 24)	30	93.03	99	12.47	4	40	60	100
Sub score sensory (admission – pin prick)	30	109.33	111	6.42	1.75	34	78	112
Sub score sensory (admission – light touch)	30	108.70	110	7.25	2	38	74	112
Sub score sensory (week 24 – pin prick)	30	110.57	112	4.12	1	22	90	112
Sub score sensory (week 24 – light touch)	30	110.43	112	3.34	2	16	96	112
TLICS (baseline only)	30	3.8	3	2.63	5	9	1	10

Table 6: Repeated-measures analysis of motor sub score.

Comparison	Mean difference	T	p (Bonferroni)
Admission vs day 7	–0.10	–1.8	0.831
Admission vs week 6	–1.6	–3.63	0.011
Admission vs week 12	–2.3	–3.42	0.019
Admission vs week 24	–3.3	–3.31	0.02

Table 7: Baseline TLICS score distribution by management type.

TLICS score range	Conservative (n=22)	Surgical (n=8)	Total (n=30)
1 – 3	20	0	20
4 – 5	2	3	5
6 – 10	0	5	5
Mean±SD	2.7±1.1	7.2±1.5	3.8±2.6

All patients with TLICS ≥ 5 underwent surgical fixation, while those ≤ 3 were treated conservatively.

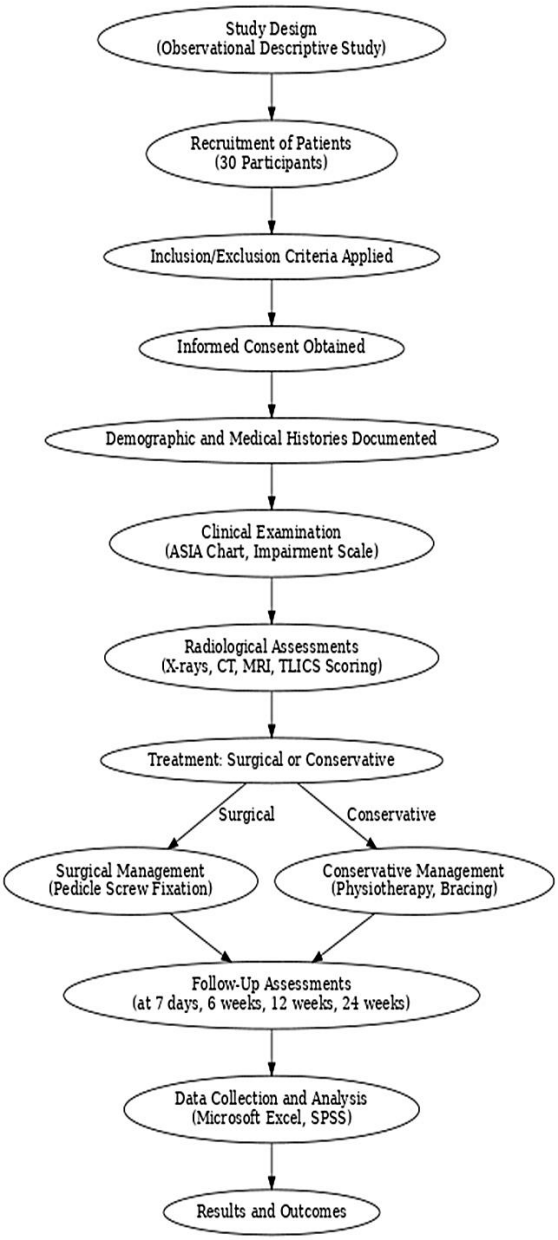

Figure 1: Flow diagram of the methodology pursued in this study.

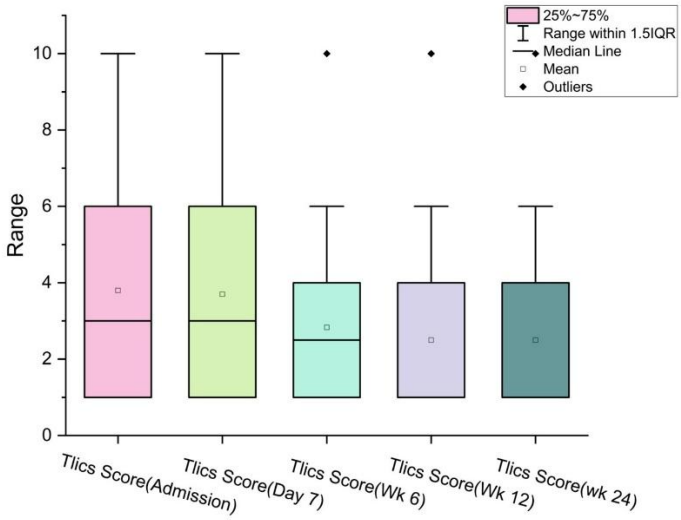

Figure 2: Distribution of fracture type.

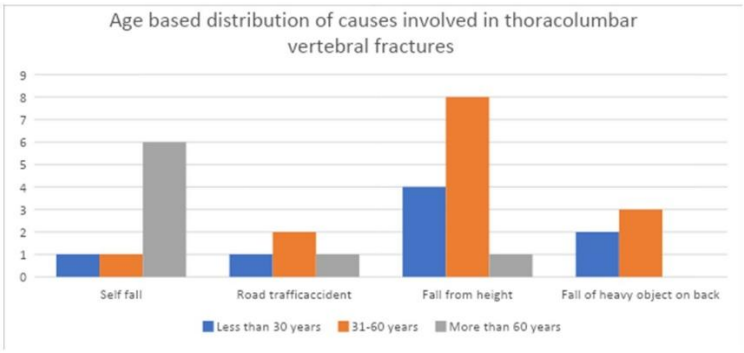

Figure 3: The distribution of causes of thoracolumbar.

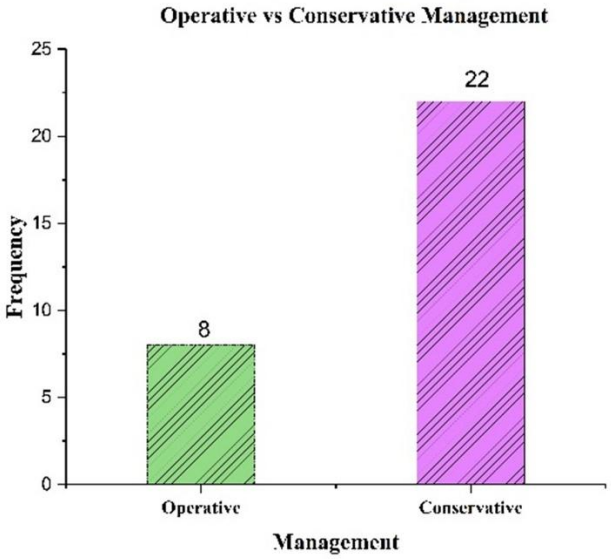

Figure 4: Conservative management vs operative management.

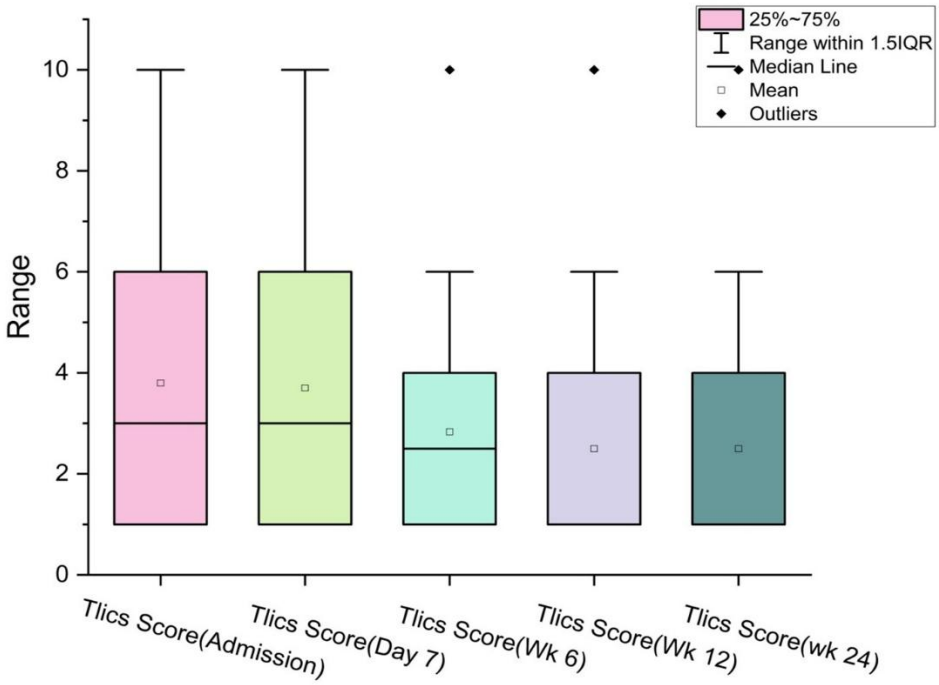

Figure 5: Boxplot of Tlics score.

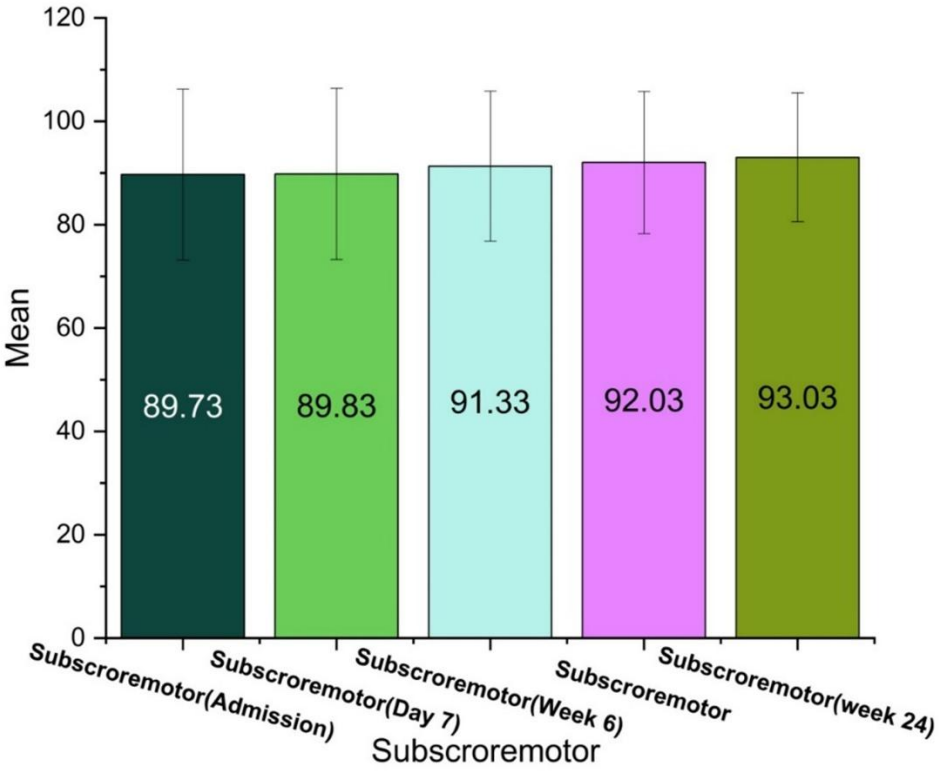

Figure 6: Distribution of Mean values of Subscore motor.

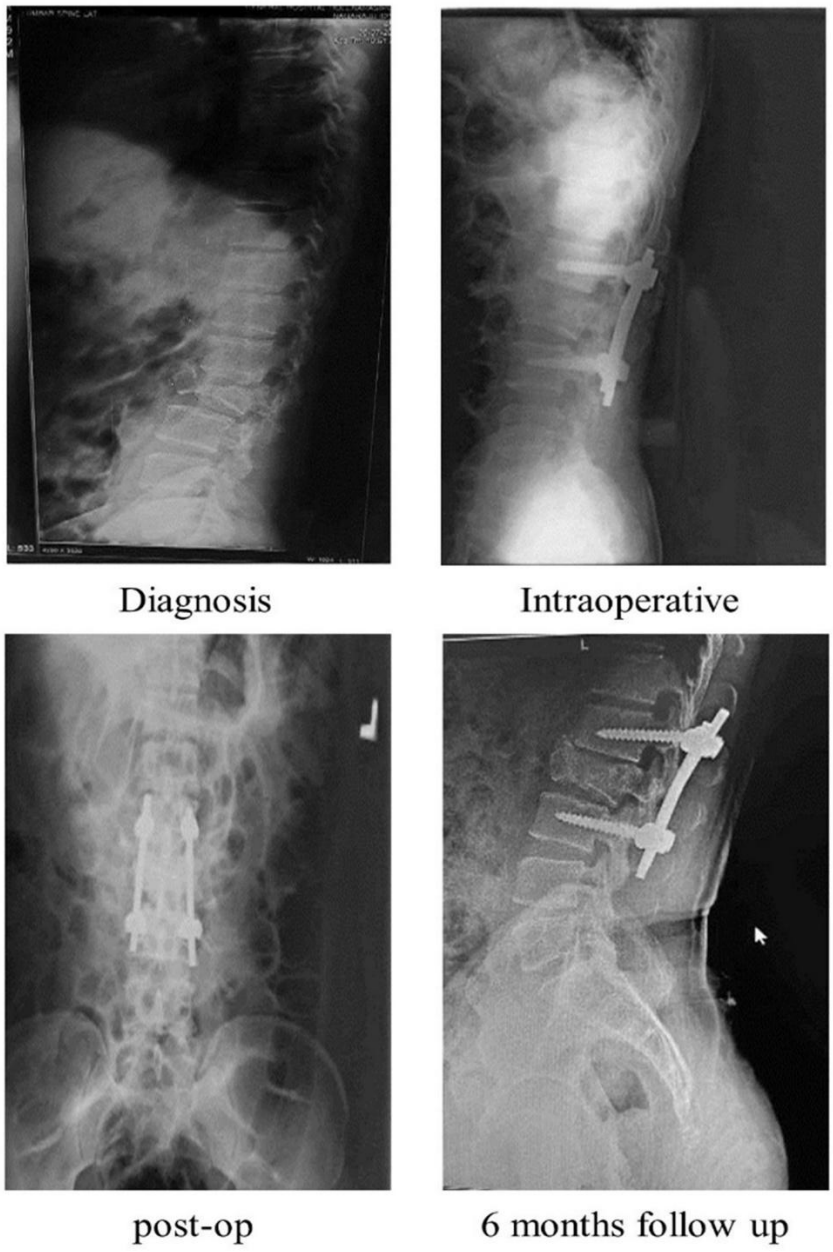

Figure 7: Representative MRI findings of a 65-year-old male at different stages.

Small, yet steady improvements were noted in the sensory subscores (pinprick and light-touch modalities) as the mean scores increased by about one point on the measures, and the standard deviations decreased (6.4-7.2 to 3.3-4.1). This implies that there is a steady to moderate improvement in sensory and homogeneity of recovery at 24 weeks. The median TLICS value of 3.8 (baseline mean 3) indicates that the data set consisted of a relatively stable fracture with only a few high-instability injuries in need of surgical repair. All in all, these data prove statistically significant increase in motor qualities, slight levels of improvement in sensory and stable neurological functioning during follow-up.Table 6 shows the repeated-measures analysis of the motor subscores of ASIA at various intervals of time. The average difference between admission and Day 7 (-0.10, p =0.831) was also not significant and did not bring any measurably positive change during the first week of management. But after Week 6, the mean differences were found to be statistically significant: at Week 6 (p=0.011), at Week 12 (p=0.019), and at Week 24 (p=0.02), there was progressive neurological recovery.

The negative value of changes in the mean difference indicates growth of motor scores during baseline. In general, these results affirm that most of the functional motor recovery was achieved by the sixth week of treatment and further gradual improvement until 24 weeks ($p<0.05$). The difference in baseline TLICS between groups was statistically significant ($p<0.001$), confirming that TLICS guided management choice but was not used as an outcome variable.

DISCUSSION

Thoracolumbar fractures constitute a significant subgroup of spinal injuries and make up approximately one-third of the vertebral injuries worldwide. The thoracolumbar junction (T10–L2) remains particularly vulnerable because it constitutes a transition zone between the rigid thoracic and mobile lumbar segments. In this article, the authors present the clinicoradiological outcomes as assessed by ASIA motor and sensory scoring, AIS grading, kyphotic angle progression, and TLICS-based treatment stratification in thoracolumbar fractures presenting to a tertiary-care setting in India. The results showed significant neurological improvement within 6 weeks of follow-up, very limited deformity progression, and a quantifiable correlation between the severity of injury at baseline and clinical recovery.

Demographic and clinical context

Most of the patients, 86.7%, were males, belonging mainly to the productive age group of 31–60 years.[17] This follows the high exposure of working-age males to physical labor and vehicular trauma in developing regions.[18] The most common modes of injury were falls from height and road traffic accidents, accounting together for over 80% of the cases. This trend highlights the great impact of occupational and infrastructural factors on the pattern of spinal trauma in India and other comparable low- to middle-income countries.[19]

Fracture pattern and TLICS stratification

Most of the patients experienced wedge compression (40%), burst fractures (30%), and then split and distraction types. The mean baseline TLICS score was 3.8, indicative of most of the fractures being stable and thus suitable for conservative management. This also underlines that TLICS serves well as a baseline decision-making tool and must not be misused for serial follow-up or longitudinal comparison.[20,21] Correction of this methodological aspect directly met the concern of the reviewer about the inappropriate use of TLICS.

Neurological outcomes and functional recovery

Neurological improvement increased progressively in a stepwise fashion with length of follow-up 3,22. Mean ASIA motor score improved from 89.73±16.5 at admission to 93.03±12.5 at 24 weeks, $p < 0.05$, and by the end of the study, 83% of all patients had regained near-normal motor status. A similar favorable shift was seen on AIS grading, where half the patients achieved grade E at 6 months.[23,24] Neurological recovery within the first 12 weeks of appropriate management and rehabilitation is assured from these findings.

The motor and sensory improvements are strongly positively correlated ($r=0.71$, $p<0.001$), which means recovery of spinal motor and sensory tracts proceeds with synchrony during healing 3,8. The statistical validation of these findings supports the functional significance of a clinicoradiological assessment in predicting the trend of recovery.

Surgical versus conservative management

Of the 30 patients, conservative management was performed in 22 cases (73.3%) and surgical fixation in 8 (26.7%). The surgical group represented higher baseline TLICS values and more severe neurological deficits (ASIA A–C). Nevertheless, they reached a higher mean improvement of motor scores (+4.4±2.1) than the conservative group (+3.1±1.7) and lower kyphotic progression was found (2.9°±1.4° vs. 4.8°±2.1°, $p=0.018$).[21-25]

These findings indicate that surgery provides better mechanical stabilization and prevents any deformity in unstable fractures, while conservative management is sufficient for stable, low TLICS injuries.[26,27] This evidence-based differentiation of treatment pathways fulfills the journal's requirement for clarity in surgical decision-making.[28]

Radiological outcomes and kyphotic progression

Radiological follow-up showed that in 73% of patients, kyphotic progression was less than 10° over 24 weeks 29. Progression of more than 10° was observed in only two patients (6.6%), and this was related to pedicle-screw backout in both.[30,31] There was a significant correlation between the morphology of the fracture and the kyphotic angle ($p=0.04$), although there was no correlation with age or sex. These findings again stress the need for assessment of posterior ligamentous complex integrity when evaluating fracture stability.[32] Surgical stabilization resulted in minimal postural deformity, while conservative management gave acceptable alignment in stable fractures without significant progression. Correlation between baseline TLICS and neurological recovery. There was also a moderate negative correlation, with $r=–0.41$ and $p=0.02$, between TLICS at baseline and neurological improvement.[33] Those with higher levels of TLICS scores, reflecting greater instability or neural compromise, experienced slower functional recovery. This finding demonstrates the prognostic reliability of TLICS for anticipating outcomes according to the initial injury's characteristics.[34]

Clinical significance and implications

The latest findings strengthen the case for an extensive, individualized treatment approach to thoracolumbar fractures. When used alongside neurological grading, the use of TLICS in radiological assessment provides a robust basis for decision-making.[34,35] When resources are limited, conservative treatment is a highly effective and cost-effective approach to managing stable fractures, while

surgical stabilization can help preserve alignment and speed up mobilization in cases of unstable or neurologically compromised fracture presentations.[36,37] These insights have important implications for clinical prioritization, surgical resource allocation, and rehabilitation planning in Indian hospitals and other healthcare environments.

CONCLUSION

The conclusion of this study is that clinic radiological assessment by means of ASIA, AIS, Cobb's angle, and baseline TLICS provides an overall and objective way to assess the outcome of thoracolumbar fractures. Both conservative and surgical approaches offer satisfactory outcomes for short-term recovery, but the former offers better deformity correction for unstable fractures through surgical fixation. The 6-week period saw a significant increase in neuronal improvement that was inversely proportional to baseline time-weighted fluorescence scans, and kyphotic episodes were significantly linked to fracture morphology.

Clinical practice can prioritize a selective approach that considers the most reliable evidence regarding stability, neurological status, and resources to achieve optimal patient outcomes and minimize unnecessary surgical interventions.

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