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ORIGINAL ARTICLE

Prognostic Factors for Surgical Treatment of Adult Post-Traumatic Lumbar Fractures

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ABSTRACT

Background: The field of spinal surgery is very rapidly advancing. Post-traumatic lumbar fractures represent a leading cause of morbidity and mortality. Understanding the role of different surgical treatments in survival, complications, and other outcomes of interest is imperative in order to determine optimum treatment modalities. With increasing evidence supporting surgical intervention for these patients, numerous studies have sought to compare outcomes among different treatment paradigms. So we aimed to predict the outcomes of surgical treatment for post-traumatic lumbar fractures.

Methods: This prospective cohort study was conducted in the Neurosurgery department of Zagazig University Hospitals. The sample consisted of 30 patients with traumatic lumbar spine fractures, divided into two groups: Group (I) 15 patients treated with surgical fixation who had neurological deficits, and Group (II) 15 patients treated surgically without neurological deficits.

Results: There were highly statistically significant difference between PVAS preoperative, PVAS after 2 day, PVAS After 12 week and PVAS After 6 month. There were highly statistically significant difference between ODI preoperative, ODI After 2 day, ODI After 12 week and ODI After 6 month

Conclusion: Decompressive laminectomy and transpedicular short-segment screw fixation improve clinical outcomes, including pain and functional impairment, for post-traumatic lumbar fractures, according to our study. Kyphotic angles, PVAS scores, and ODI scores improved postoperatively, with early surgery correcting kyphosis better.

Keywords: Post-Traumatic Lumbar Fractures, Surgical Treatment, Adult.

INTRODUCTION

Traumatic injuries like spinal fractures have major medical and social effects. Due to biomechanical differences, lumbar fractures are a subclass. The shift from the thoracic spine fixed kyphosis to the lumbar spine dynamic lordosis leaves this region vulnerable. This level of injury can cause motor impairments, local discomfort, and kyphosis **[1].**

Most spinal fractures occur in the thoracolumbar region, roughly 90% of the time. Adult males are more likely to suffer these fractures. Trauma, especially falls from heights, is the main cause, but osteoporosis and cancer-related pathologic fractures also contribute, especially in the elderly **[2].**

Traumatic lumbar spine fractures can be treated surgically or conservatively depending on clinical criteria. Surgical treatment seeks to straighten the spine, minimize neurological injury, and avoid post-traumatic abnormalities while doing neural decompression when needed **[3].**

The most common lumbar fracture surgery is posterior pedicle screw implantation. It stabilises bones till they recover. After surgery, vertebral body re-collapse or progressive kyphosis can cause neurological impairments, implant failure, and revision operations. Numerous clinical and radiological factors make these problems difficult to predict **[4].**

The aim of our study is to predict the outcomes of surgical treatment for post-traumatic lumbar fractures.

METHODS

This prospective cohort study was conducted in the Neurosurgery department of Zagazig University Hospitals. The sample consisted of 30 patients with traumatic lumbar spine fractures, divided into two groups: Group (I) 15 patients treated with surgical fixation who had neurological deficits, and Group (II) 15 patients treated surgically without neurological deficits. The Neurosurgery Department of Zagazig University Hospital and the Zagazig Medical Institutional Review Board (IRB number 9399-16-3-2022) gave their approval to this study. Every patient gave their informed consent.

The inclusion criteria:

required participants to have a confirmed diagnosis of lumbar fracture, be over 18 years old, mentally competent, and capable of undergoing surgery. Both males and females were included.

Exclusion criteria:

included patients unable to tolerate surgery, medically unfit for surgery, or diagnosed with severe diabetes, serious anemia, or significant lung or heart disease. Additionally, patients under the age of 18 were excluded from the study.

Pre-operative assessment was conducted for all 30 patients in the study, and their data was recorded comprehensively.

History Taking:

Each patient personal details, including name, age, sex, address, occupation, and smoking status, were documented. Additionally, information regarding the method of transfer, type of trauma, time from trauma to hospital admission, type and location of lumbar fracture, and their medical history was collected.

General and Neurological Examination:

All patients underwent both general and neurological examinations. This included assessments of motor power, sensation, reflexes, and sphincter function. Full neurological assessments were performed to identify any neurological deficits. Pain levels were measured using the Visual Analog Scale **(VAS)** and Oswestry Disability Index **(ODI),** both before and after surgery.

Systemic and Radiological Examinations:

Systemic examinations were completed, and patients underwent radiological investigations, including plain X-rays (AP and lateral views) to measure Cobb angle and classify fractures using the AO Spine classification, A final score based on the AO Spine Thoracolumbar Classification System (0-3) indicated non-operative treatment, while a score of 5 or more suggested surgical intervention (Table 1S, 2S). CT scans of the dorsolumbar spine were performed to assess the three-column fracture theory (Denis classification), and MRI scans were done to evaluate neural tissue and disco-ligamentous complex injuries.

Radiological data included the level of spinal fractures, the number of fractured levels, the type of spinal fracture, fracture dislocation, presence of kyphotic deformity, spinal instability, and the percentage of canal compression by retro-pulsed bone segments.

Preoperative Preparation:

Following clinical, neurological, and radiological evaluations, all patients were placed on a firm mattress and fitted with a thoracolumbar brace. Catheterization was performed under aseptic conditions. Broad-spectrum antibiotics were administered before and during surgery to minimize the risk of infection.

Operative Procedure:

The surgical fixation involved the use of bilateral titanium alloy trans-pedicular screws and a two-rod system via a posterior approach. Decompression of the spinal cord and nerve roots was achieved through spino-laminectomy of the fractured vertebra. The main objectives were to stabilize the spine and relieve spinal cord compression. All procedures were performed under hypotensive general anesthesia to reduce blood loss and ensure adequate hemostasis.

Patient Positioning:

Patients were placed in a prone position on a radiolucent frame, allowing the abdomen to hang free with the hips and knees moderately flexed to maintain lumbar lordosis.

Surgical Approach:

A posterior midline incision was made, centered over the spinous processes, from one level above to one level below the fracture. Paraspinal muscles were detached subperiosteally to expose the bony structures fully and allow access for pedicle screw insertion. Hemostasis was maintained throughout the procedure to minimize blood loss.

Pedicle Screw Insertion:

For the lumbar spine, pedicle screws were inserted at the intersection of a vertical line tangential to the lateral border of the superior articular process and a horizontal line bisecting the transverse process. The screws were angled to converge by 5° at the thoracolumbar junction and by 10°-30° between L2 and L5. After identifying the entry site, a pedicle awl and probe were used to create a path for the screws, which were then inserted under fluoroscopic guidance. Screws were connected to rods of suitable length, and the system was securely aligned and tightened.

Reduction and Decompression:

Partial reduction of the fracture was typically achieved by positioning the patient in a way that restored normal dorsal kyphotic and lumbar lordotic curves. Indirect decompression was facilitated by distraction and reduction maneuvers, often utilizing ligamentotaxis to reduce compression.

Wound Closure:

The wound was irrigated and debrided, followed by the placement of a suction drain. The wound was closed in layers: muscle, fascia, subcutaneous tissue, and skin.

Postoperative Care:

Postoperatively, all patients wore a thoracolumbar belt for six months. Pain was assessed using the Visual Analog Scale **(VAS),** and functional outcomes were measured with the Oswestry Disability Index **(ODI),** which is regarded as the gold standard for low back functional assessment. Neurological assessments , and surgical wounds were evaluated for signs of infection and cerebrospinal fluid **(CSF)** leakage.

Radiological Evaluation:

Radiological assessments were conducted using lateral **X-rays** of the dorsolumbar spine immediately after surgery to evaluate spinal alignment. **CT** scans were performed to assess pedicle screw placement, while MRI scans were reserved for cases requiring further evaluation of neural tissue injuries.

Follow-Up:

Routine clinical and radiological follow-ups were performed at 2, 6, and 12 weeks, and at 6 months postoperatively. Pain was assessed using the **VAS,** and functional outcomes were measured with the **ODI**. Radiologically, lateral **X-rays** were taken at 12 weeks and 6 months to monitor spinal alignment and check for system failure**. CT** scans were used to evaluate for hardware-related complications such as screw breakage, pullout, or rod failure, while **MRI** scans were conducted when clinically indicated

Statistical analysis:

Data were analyzed using IBM SPSS version 20. Qualitative data were presented as numbers and percentages, while quantitative data were expressed as means, standard deviations, and ranges for parametric distributions. Chi-square tests were used to compare qualitative data across groups, with Fisher exact test applied when cell counts were less than five. Paired t-tests were used for quantitative data comparisons in two paired groups with parametric distributions. A 95% confidence interval was applied, with a 5% margin of error. Statistical significance was set as $p > 0.05$ (non-significant), $p < 0.05$ (significant).

RESULTS

There were no statistically significant difference between Group I and Group II regarding Age, Sex and Martial status **(Table 1).**

there were 15 (50.0%) Cases suffering from Back pain & no neurological deficit, 8 cases suffering from Back pain & motor &sensory deficit, 5 cases suffering from Back pain & motor & sensory deficit & urine retention and 2 cases suffering from Back pain & motor & sensory deficit & urine incontinence **(Table 3S)**.

There were highly statistically significant difference between Group I and Group II regarding Canal compression, and there were statistically significant difference between Group I and Group II regarding Kyphotic angle and Time from trauma to between Group I and Group II regarding Kyphotic angle and time from trauma to surgery (Days), and there were no statistically significant difference between Group I and Group II regarding Level of fracture, Type of fracture and compression or not and Associated injury **(Table 2).**

There were no statistically significant difference between Group I and Group II regarding Preoperative AO spine, Preoperative ODI and there were statistically significant difference between Group I and Group II regarding Preoperative PVAS **(Table 3).**

There were highly statistically significant difference between Angle of kyphosis Pre Operative and Angle of kyphosis Post Operative **(Table 4).**

There were highly statistically significant difference between PVAS preoperative, PVAS after 2 day, PVAS After 12 week and PVAS After 6 month **(Table 5).**

There were highly statistically significant difference between ODI preoperative, ODI After 2 day, ODI After 12 week and ODI After 6 month **(Table 5).**

Cases:

Case 1:

Male patient, 35 years old, married , worker ,address urban area ,with **L1** fracture due to Motor bicycle accident, assiocated with lift calcaneous fracture, Neurologically of motor power less than antigravity (Grade 3) , the patient has developed urine retention and catherazied , PVAS (Severe 8/10) ,full laboratory investigations are accepted.

Case 2:

Male patient, 25 years old, with **L1** fracture due to fall from height, **no** associated injuries, Neurologically intact, PVAS (moderate **6/10**), full laboratory investigations are accepted.

Table 1: Comparison between Group I (no. =15) and Group II (no.=15) regarding Age, Sex and Martial status

		Group I	Group II	Test value	P-value	Sig.
		No. = 15	No. = 15			
Age	**Mean ± SD**	27.53±8.18	25.47 ± 6.65	0.759•	0.454	NS
	Range	18 – 45	18 – 41			
Sex	**Female**	8 (53.3%)	6 (40.0%)	0.536*	0.464	NS
	Male	7 (46.7%)	9 (60.0%)			
Marital status	**Married**	9 (60.0%)	8 (53.3%)	0.136*	0.713	NS
	Single	6 (40.0%)	7 (46.7%)			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), *: Chi-square test, •: Independent t-test

Table 2: Comparison between Group I (no. =15) and Group II (no. =15) regarding Level of fracture, Type of fracture and compression or not, Canal compression, Kyphotic angle, Associated injury and Time from trauma to surgery (Days)

		Group I	Group II	Test value	P value	Sig.
		No. = 15	No. = 15			
Level of fracture	L1	6 (40.0%)	6 (40.0%)	1.010*	0.799	NS
	L2	3 (20.0%)	4 (26.7%)			
	L3	2 (13.3%)	3 (20.0%)			
	L4	4 (26.7%)	2 (13.3%)			
Type of fracture and compression or not	Brust fracture	14 (93.3%)	14 (93.3%)	0.000*	1.000	NS
	Fracture and dislocation	1 (6.7%)	1 (6.7%)			
Canal compression	Mean ± SD	42.00% ± 9.41%	63.33%±4.88%	-7.794•	0.000	HS
	Range	20% – 50%	60% – 70%			
Kyphotic angle	Mean ± SD	27.40 ± 10.18	41.67 ± 12.20	-3.478•	0.002	S
	Range	10 – 45	20 – 60			
Associated injury	Belvic fracture	١ (٦.٧%)	1 (6.7%)	7.556*	0.478	NS
	Fracture calcaneous	1 (6.7%)	2 (13.3%)			
	Fracture clavical	0 (0.0%)	1 (6.7%)			
	Fracture Humerous	0 (0.0%)	1 (6.7%)			
	Fracture tibia	1 (6.7%)	2 (13.3%)			
	Head trauma	0 (0.0%)	1 (6.7%)			
	Lung contusion	1 (6.7%)	0 (0.0%)			
	No	11 (73.3%)	7 (46.7%)			
Time from trauma to surgery (Days)	Mean ± SD	5.47 ± 3.48	2.67 ± 1.88	2.741•	0.011	S
	Range	1 – 14	1 – 7			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), *: Chi-square test, •: Independent t-test

Table 3: Comparison between Group I (no.=15) and Group II (no.=15) regarding Preoperative AO spine, Preoperative PVAS, Preoperative ODI .

Preoperative		Group I	Group II	Test value	P value	Sig.
		No. = 15	No. = 15			
AO spine	A3	9 (60.0%)	5 (33.3%)	3.476*	0.324	NS
	A4	5 (33.3%)	7 (46.7%)			
	B1	0 (0.0%)	2 (13.3%)			
	C	1 (6.7%)	1 (6.7%)			
PVAS	Moderate	11 (73.3%)	5 (33.3%)	4.821*	0.028	S
	Severe	4 (26.7%)	10 (66.7%)			
ODI	Moderate	9 (60.0%)	4 (26.7%)	3.394*	0.065	NS
	Severe	6 (40.0%)	11 (73.3%)			

P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS), *: Chi-square test, •: Independent t-test

Table 4: Comparison Between Angle of kyphosis Pre Operative and Angle of kyphosis Post Operative :

Angle of kyphosis	Pre Operative	Post operative	Test value	P value	Sig.
Mean ± SD	34.53 ± 13.21	9.13 ± 7.86	9.858•	0.000	HS
Range	10 – 60	4 – 50			

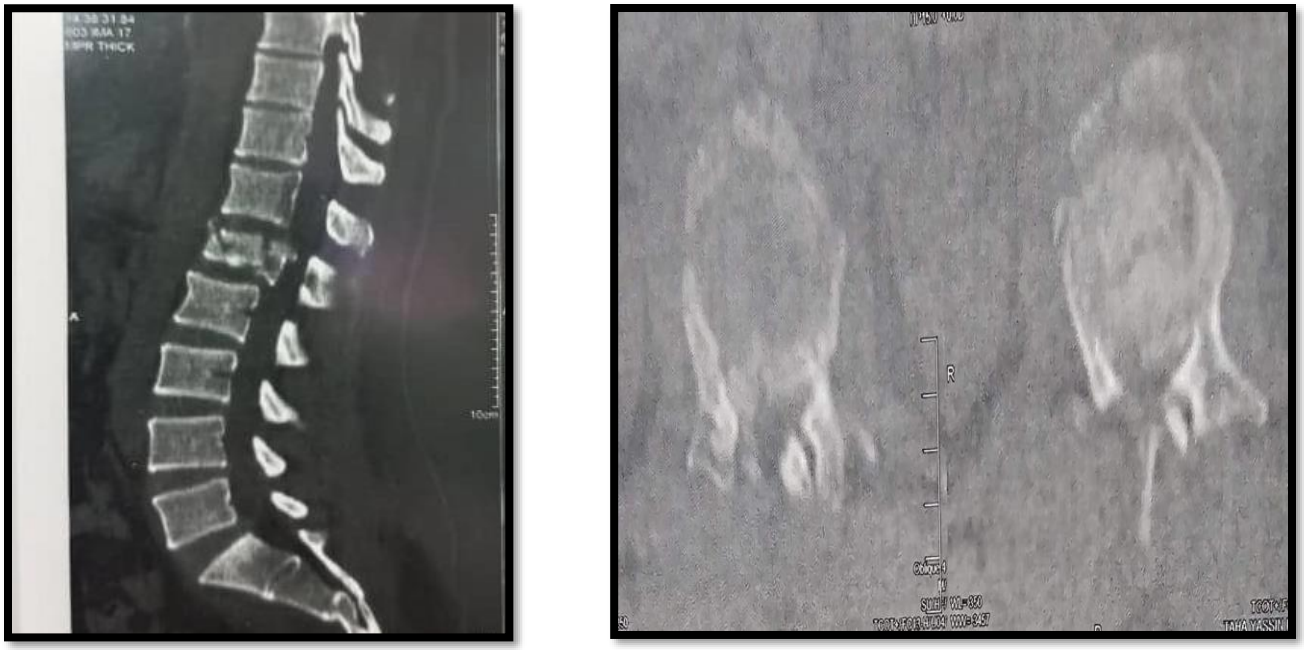
P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS), *: Chi-square test, •: Paired t-test

Table 5: Comparison Between PVAS Pre Operative, PVAS After 2 day, PVAS After 12 week and PVAS After 6 month:

	Pre Operative	After 2 day	After 12 week	After 6 month	Test value	P-value	Sig.
PVAS							
Mild	0 (0.0%)	8(26.7%)	16(53.3%)	18(60.0%)	83.568*	0.000	HS
Moderate	16(53.3%)	16(53.3%)	9 (30.0%)	0 (0.0%)			
Severe	14(46.7%)	6 (20.0%)	1 (3.3%)	0 (0.0%)			
No Pain	0 (0.0%)	0 (0.0%)	4 (13.3%)	12(40.0%)			
ODI							
Minimal	0 (0.0%)	9(30.0%)	17(56.7%)	29(96.7%)	64.361*	0.000	HS
Moderate	13(43.3%)	12(40.0%)	9 (30.0%)	0 (0.0%)			
Severe	17(56.7%)	9 (30.0%)	4 (13.3%)	1 (3.3%)			

P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS), *: Chi-square test, •: Paired t-test

Case (1):



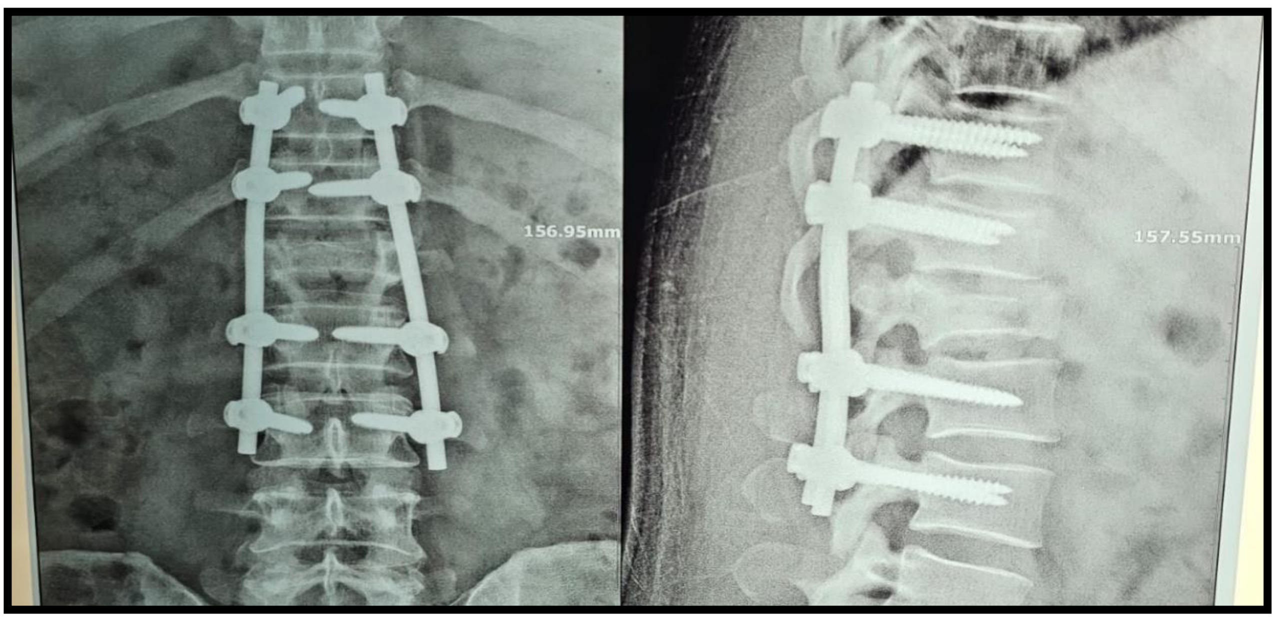
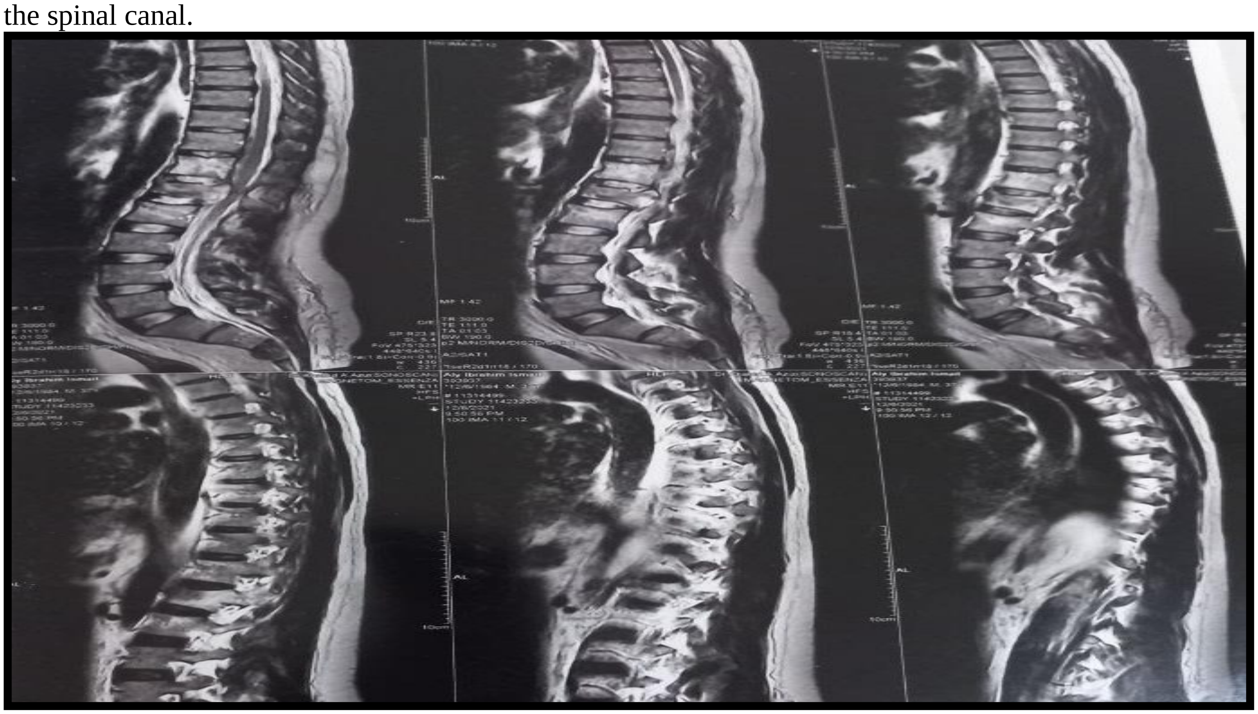


Figure (1A) : Preoperative CT of L.S, Axial and sagittal views, reveal Burst Fracture of L1 body , with retro pulsed bone fragment leading to canal stenosis.

Figure (1B): Postoperative plain x ray AP & lateral views after 3 months Reveal the fixation from D11 to L3, All the transpedicular screws are in proper place, the rods are also in the proer place.

Case (2):

Figure(2A): Preoperative ct scan reveal compressed burst fracture of L1, with retropulsed bone fragment into the spinal canal.



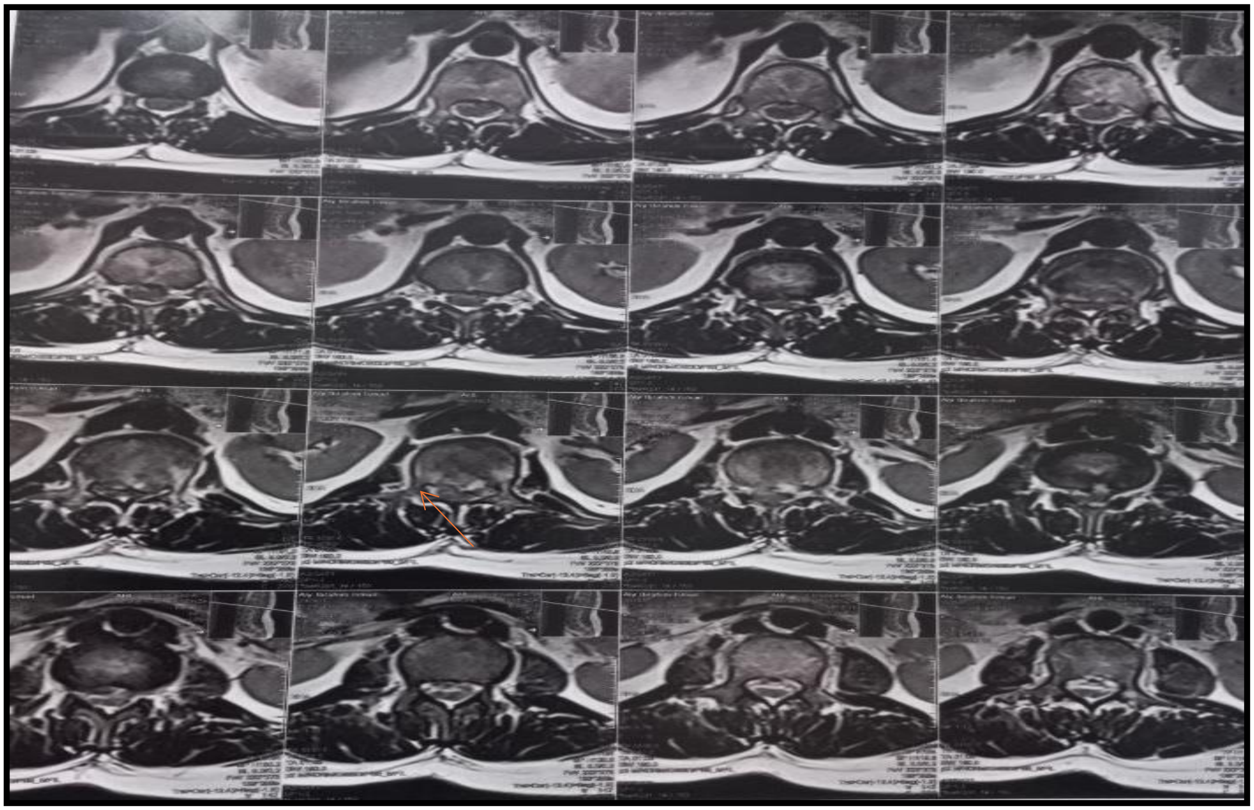


Figure (2B): Preoperative MRI L.S , reveal compressed fracture L1, reveal retropulsed bone fragment with compression to conus medullaris.

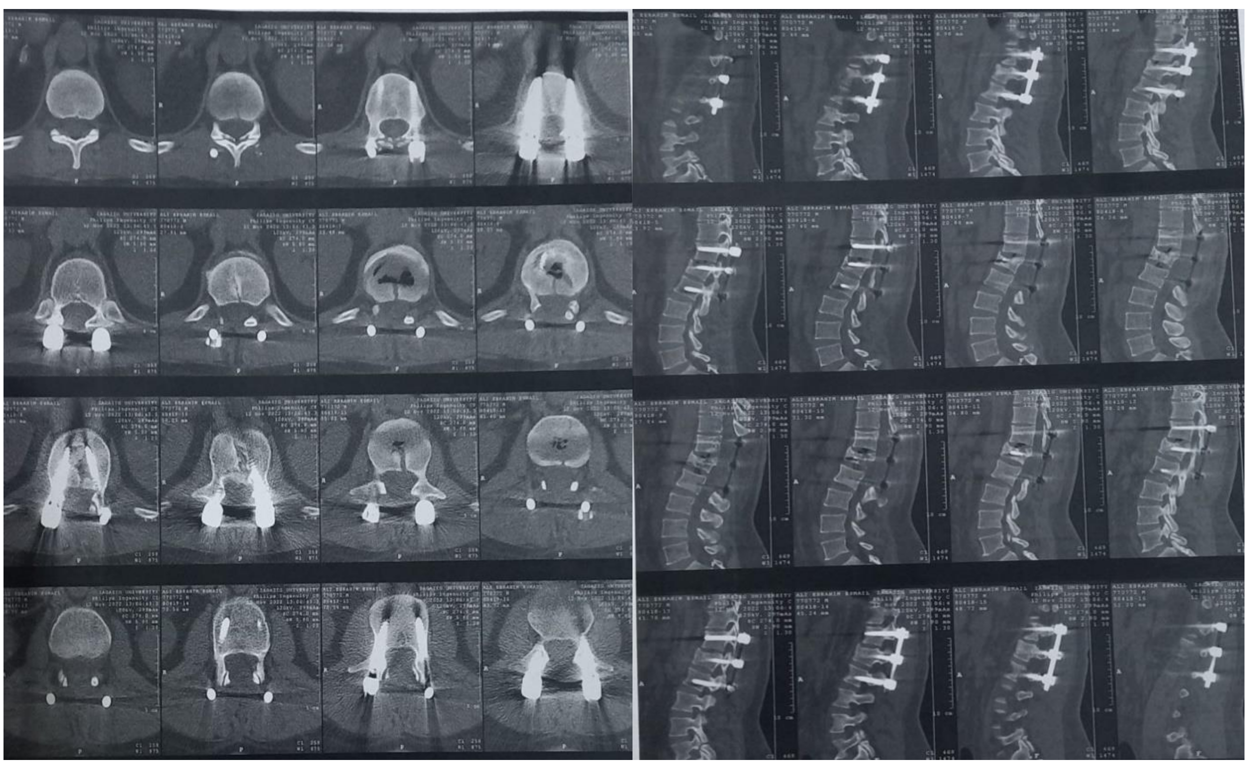


Figure (2C): Post operative CT scan at 3 months ,Axial and Sagittal reveal good decompression to the spinal canal , the all transpedicular screws and both rods are hold in proper place.

DISCUSSION

In our study, 30 people aged 18–45 (16 men and 14 women) had a mean age of 26.50. There were 17 married and 13 single. Groups I (with neurological deficit) and II (without neurological deficit) had similar age, sex, and marital status. This suggests that demography may not affect neurological deficits in thoracolumbar fractures. Trauma severity, including force, angle, and spinal cord involvement, may predict neurological outcomes better than demographics **[6].**

Muratore et al. [7] evaluated vertebral stability in 101 acute traumatic thoracolumbar fracture patients (72 men and 29 women). Our findings match. Mean trauma age was 47.80 ± 15.73 years (16-77 years) with an average follow-up of 44.32 months (24-75 months). Trauma harmed 82 under-65s. Eight patients (6 men, 2 females) had a BMI of 30 kg/m² or above, suggesting severe obesity.

In their study, 15 (50.0%) reported back pain without neurological problems, whereas others had motor and sensory impairments, urine retention, or incontinence. Fracture-caused spinal cord or nerve root involvement determined symptoms. Mild fractures may just affect the vertebrae, producing back pain, while significant nerve compression or spinal cord injuries induce neurological issues.

Like our study**, Kapoor et al. [8]** studied 21 patients with thoracic or lumbar spine injuries, 15 males and 6 females, with an average age of 41.6 years. Their study found 61.91% of spine injuries were from height falls. Overall, 57.14% of patients were workers**. Karim et al. [9]** found motor vehicle accidents to be the main cause, with 16 instances (66.67%) compared to 8 cases (33.33%).

Our investigation found 12 patients (40.0%) with L1 fractures, 7 (23.3%) with L2, 5 (16.7%) with L3, and 6 (20.0%) with L4. Canal compression averaged 52.67%, range 20.0%–70.0%. From trauma until surgery, the mean time was 4.07 days, ranging from 1 to 14. Significant variations were seen in canal compression and kyphotic angle between Groups I (with neurological impairments) and II (without), but not fracture degree, kind, compression, or associated injuries. L1 and L2 fractures (63.3% combined) demonstrate the thoracolumbar junction biomechanical stress susceptibility upon impact **[10].** Canal compression from 20% to 70% linked strongly with neurological outcomes, with more compression associated with severe impairments, distinguishing Groups I and II **[11].** Significant disparities in kyphotic angle and operation duration suggest that spinal deformity and delays might hinder recovery **[12, 13]**.

Kapoor et al. [8] found that 66.66% of injuries damaged the dorso-lumbar junction (D11, D12, L1, and L2). Average injury-to-admission time was 2.5 days. Patients had kyphotic angles of 10° to 60°, averaging 34.53°. A3, A4, B1, and C fractures were found in 14 (46.7%), 12 (40.0%), and 2 (6.7%) instances. According to the PVAS scale, 16 (53.3%) had moderate pain and 14 (46.7%) had severe pain. Patient impairment assessments indicated 13 (43.3%) moderate ODI scores and 17 (56.7%) severe scores. Different degrees of spinal deformity can increase discomfort and impairment, since kyphotic angles average 34.53° **[14]**. The predominance of A3 and A4 fracture types suggests structural instability, which may explain the reported pain and impairment **[15].** The considerable difference in preoperative pain severity (PVAS) between Groups I and II shows that neurological impairment increases with pain intensity. The absence of significant differences in preoperative AO classification and ODI scores suggests that pain severity is a more sensitive indicator of injury impact than fracture type and overall disability **[16].**

A significant difference in preoperative and postoperative kyphotic angles was found. VAS ratings changed significantly from preoperative to two days, 12 weeks, and six months postoperatively. Oswestry Disability Index (ODI) ratings improved considerably from preoperative to two days, 12 weeks, and six months after surgery. Our study found a substantial difference between preoperative and postoperative kyphotic angles, indicating that surgery straightened the spine, reducing discomfort and stabilizing it. Significant pain reductions in PVAS ratings indicate that spine alignment and neural structural decompression reduced nerve compression and instability symptoms **[17].** Surgical correction also improves ODI scores, demonstrating its favorable effects on quality of life and functional capacities. The findings show that surgical therapy for thoracolumbar fractures improves pain alleviation and patient outcomes by correcting structural abnormalities **[18].** Our study corresponds with **Formica et al. [19],** who showed a mean improvement in back and leg pain on the VAS (6.08, $p < 0.01$), 2.77 ($p < 0.01$), and ODI score (38, $p < 0.01$). Postoperatively, lumbar lordosis (32.8°–39.2°, $p < 0.05$) and disc height (3.6–4.8 mm, $p < 0.05$) increased. **Toyone et al. [20]** found that short-segment fixation without fusion improved sagittal alignment from 17° to -2° (lordosis) ten years after surgery, with decreased pain reported by most patients

The fracture features, operating time, and postoperative PVAS ratings six months following post-traumatic lumbar fracture surgery were not substantially associated ($p > 0.05$). Trauma etiology and patient complaints did not alter six-month Oswestry Disability Index (ODI) scores ($p > 0.05$). After surgery, fracture characteristics, operative duration, and trauma origin did not affect kyphosis improvement ($p > 0.05$). Prompt surgery following trauma led to considerable kyphosis improvement ($p < 0.05$).

Fracture characteristics, operative time, and postoperative pain (PVAS) and disability (ODI) scores six months post-surgery did not significantly affect long-term recovery outcomes, suggesting that patient-specific variables like overall health and rehabilitation efforts are more important. We found that immediate surgical intervention significantly improved kyphosis, stressing the necessity of early therapy to prevent structural consequences such bone remodeling and post-traumatic kyphosis. Traumatic lumbar fracture patients with prompt treatment had superior long-term results due to spinal alignment and stability **[21, 22].**

This study main limitations are its small sample size of 30 patients, limiting generalizability, and being conducted at a single institution, which may introduce selection bias. The short follow-up of six months may miss long-term complications, and the lack of randomization could weaken the conclusions due to uncontrolled confounding factors.

Conclusion:

Decompressive laminectomy and transpedicular short-segment screw fixation improve clinical outcomes, including pain and functional impairment, for post-traumatic lumbar fractures, according to our study. Kyphotic angles, PVAS scores, and ODI scores improved postoperatively, with early surgery correcting kyphosis better. However, fracture characteristics, operational duration, and long-term pain or functional results were not significantly related, emphasizing the need of prompt surgery for good healing.

Conflict of Interest: None

Financial Disclosures: None

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Table 1: The AO Spine thoracolumbar spine injury classification system **[5].**

Type A (compression fractures)	
A0	Minimal injuries such as transverse process fractures
A1	Wedge compression
A2	Pincer compression injury
A3	Incomplete burst fracture: fracture that only involves a single endplate
A4	Complete burst fracture: fracture that involves both endplates
Type B (band injuries)	
B1	Osseous disruption of the tension band
B2	Posterior tension band injury including ligamentous
B3	Anterior tension band injury
Type C (displacement or dislocation)	
N (neurological status)	
N0	Neurologically intact
N1	Transient neurological deficit
N2	Radicular symptoms
N3	Incomplete spinal cord injury or any degree of cauda equina
N4	Complete spinal cord injury
Nx	Neurological status is unknown

Table 2S: The thoracolumbar AO Spine injury score (TL AOSIS) **[5].**

Subgroup	**Points**
Type A (compression injuries)	
A0	0
A1	1
A2	2
A3	3
A4	5
Type B (tension band injuries)	
B1	5
B2	6
B3	7
Type C (Translational fracture)	
	8
Neurological status	
N0	0
N1	1
N2	2
N3	4
N4	4
Nx	3
M (patient-specific modifiers	
M1	1
M2	0

A final score of (0-3) suggests nonoperative treatment , Wherease a score of 5 or more suggests surgical intervention.

Table (3S): Distribution of the studied cases according to Clinical presentation on admission:

Clinical presentation on admission	No.	%
Back pain & no neurological deficit	15	50.0%
Back pain & motor &sensory deficit	8	26.7%
Back pain & motor & sensory deficit & urine retention	5	16.7%
Back pain & motor & sensory deficit & urine incontinence	2	6.7%

Citation

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