

Short Segment Fixation With Transpedicular Screws in Traumatic Thoracolumbar Spine Fractures

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ABSTRACT

AIM: The “gold standard” surgical treatment for an unstable thoracolumbar fracture is transpedicular screw fixation. Although traditional treatment supports long-segment posterior fixation (LSPF), more recent studies suggest short-segment posterior fixation (SSPF) with transpedicular screws, but incur higher failure rates. Thus, this study aimed to evaluate the effectiveness of SSPF in the management of traumatic unstable thoracolumbar injuries in terms of stability, deformation correction, neurological recovery, and pain relief.

METHODS: This prospective and observational hospital-based study was carried out in the Orthopedics Department of Universal College of medical Sciences-Teaching Hospital (UCMS-TH)

from August 2020 to July 2021. After Ethical clearance (UCMS/IRC/047/20) from the Institutional Review Committee (IRC) and informed written consent, all patients with a traumatic thoracolumbar fracture who fulfilled the inclusion criteria were enrolled in this study and were treated with SSPF. The fracture was classified according to Thoracolumbar injury classification and severity score (TLICS) and AO classification. Functional outcome was assessed according to neurological status, patient satisfaction, and pain assessment which was assessed by Frankel grading, Macnab grading, and Denis pain scale respectively. Post-operatively patients were regularly followed at 6 weeks, 3 months, and 6 months. The data was analyzed in SPSS 20 and descriptive statistics like frequency, percentage, mean and standard deviation were used to analyze the data. Chi-Square test, Independent sample t-test, and ANOVA tests were used as inferential statistics.

RESULTS: Thirty-one patients (16 females and 15 males) with traumatic thoracolumbar fracture were surgically managed with SSPF with a mean age of 38.61 ± 11.54 years. Twenty-seven patients (87.1 %) had fall injuries. The majority of cases (14 patients: 45.2%) had L1 vertebral fracture with a majority of the cases being wedge compression type (24 patients: 77.4%) and A1 type (24 patients: 77.4%). Posterior ligamentous complex (PLC) was injured in 23 patients (74.2%) and 7 cases (22.6%) had neurological involvement. The majority of cases had a TLICS score of 4 (12 patients). The mean interval between trauma and surgery was 2.13 ± 0.71 days. The average duration of hospital stay was 13.10 ± 2.95 days and intraoperative average blood loss was 460 ± 58.2 ml. In 16 cases, an additional screw was fixed through the intact pedicle of the fractured vertebra. Screw failure was the only complication seen in 2 cases (6.5%). Preoperatively, 20 cases (64.5%) had Frankel type E injury, mean Denis pain scale was 4.16 ± 0.93 , and mean preoperative kyphotic angle was 16.77 ± 6.82 degree which improved to 26 cases (83.9%), 1.42 ± 0.62 , and 1.35 ± 0.48 degrees at 6 months respectively. The mean loss of kyphotic correction angle was 0.58 ± 0.88 (range 1-4) degrees. The majority of compression fracture cases had excellent to good patient satisfaction scores where 12(50%) and 10(41.7%) cases had excellent and good scores respectively (P 0.02). Concerning patient satisfaction score, a statistically significant difference was observed in mean TLICS score (P 0.101) and AO fracture type (P 0.034) while no difference was observed in PLC status (P 0.101) and additional screws (P 0.909). There was a statistically significant difference between the fracture type and

improvement of Frankel grading at the end of six months follow up ($p < 0.001$) where compression fracture managed with SSPF showed remarkable neurological recovery than burst fracture in terms of improvement of Frankel grading.

CONCLUSIONS: Short segment transpedicular screw fixation is an effective treatment procedure for achieving better neurological recovery and good pain control in traumatic unstable thoracolumbar fractures.

Key words: Short segment; Thoracolumbar spine fracture; Transpedicular screw

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INTRODUCTION

The primary objectives of the treatment of traumatic unstable thoracolumbar fractures are early pain relief, early stability, preventing and/or improving neurological involvement, and good nursing care^[1,2]. The optimum treatment of these fractures remains controversial^[3]. Although both operative and nonoperative treatment have been described for managing these fractures, nonoperative treatment can only be employed in patients with less vertebral body compression (<50%)^[4,5]. In unstable fracture with more than 50% vertebral compression transpedicular screw fixation is the gold standard surgical treatment procedure. The advantages of transpedicular screw fixation are early pain relief, early stability, shorter hospital stay, complete rehabilitation, reduced bedridden complication, reduced morbidity, and mortality^[6]. Although traditional treatment supports LSPF, more recent studies observed SSPF as an equally effective procedure, but incur higher failure rates^[7]. Nowadays SSPF, where pedicle screw is fixed one level cephalad to and one level caudad to the fracture, is being selected more often when operative intervention is chosen. SSPF makes it possible to reduce the fracture over a short segment until the desired alignment is achieved and to simultaneously restore canal dimensions and vertebral body height^[8]. Recently, many authors also observed that short segment fixation is rather more superior to long segment fixation because of its advantages like lesser duration of surgery time, minimal blood loss, lesser duration of back pain, low incidence of stiffness, etc. But still, there is an ongoing debate between SSPF and LSPF regarding better fixation methods for treating a thoracolumbar fracture.

Thus, this study is aimed to assess the effectiveness of short-segment fixation with transpedicular screws in the treatment of traumatic thoracolumbar spine fractures in terms of neurological recovery and pain relief.

MATERIALS AND METHODS

Study Design/ Place and Duration of Study

This prospective hospital-based, longitudinal and observational study was carried out in the Department of Orthopedics of UCMS-TH, Bhairahawa, Nepal from August 2020 to July 2021.

Ethical Approval and Patient Consent

After Ethical clearance (UCMS/IRC/047/20) from the Institutional Review Committee (IRC) of UCMS-TH, all patients with an isolated single-level traumatic thoracolumbar fracture who fulfilled the inclusion criteria were enrolled in the study. Patients were informed about the purpose of the study and written consent was taken. Cases were admitted either via the Outpatient department (OPD) or the Emergency department of UCMS-TH. Data collection was done by the researcher.

Sample Size and Sampling Technique

The targeted sample size after using the sample size formula was 30. So, an approximately convenient sample of 31 patients was selected by using the purposive sampling technique.

$$n = z^2pq/d^2$$

[n=required sample size; p=prevalence of disease (2%); q=100-p; z=1.96 taken at 95% confidence interval; d=allowable error taken as 5%; P= 2%, q=98%]

Inclusion Criteria

Age 15-65 years
Single level traumatic thoracolumbar fracture with or without neurological involvement
Fracture of T10 to L4
Wedging >50%

Exclusion Criteria

Polytrauma patients and head injury patients
Open fractures
Neuromuscular problems
Pathological fractures
Previous fracture of the spine around the same level
Multiple level fractures requiring long segment fixation

Patient Management and Surgical Technique

Detailed history, clinical examination, an x-ray of the thoracolumbar spine, CT scan, or MRI (if required) of the thoracolumbar spine was done in all cases. Neurological status was assessed using the Frankel grading for spinal cord injury. Fractures were classified according to TLICS^[9], and AO Spine classification^[10]. After stabilization of patients, all preoperative investigation was sent. Preoperatively patients were managed by analgesics and intravenous (IV) fluids. All patients were strictly advised for complete bed rest with every 2-hour log rolling position change to prevent bedsores. Deep vein thrombosis (DVT) prophylaxis with low molecular weight heparin (LMWX) and leg stockings was started for those patients with coexisting comorbidities who were likely to require a longer duration for surgery clearance and optimization for surgery.

In the operation theatre, all patients were given IV antibiotics half an hour before surgery. All patients were catheterized and positioned in a prone position in the spinal frame with adequate padding over the pressure areas. The posterior approach was used for all cases. SSPF was performed in all patients with 2 screws cephalad and 2 screws caudad to the fractured vertebra (Figures 1, 2, 3). If the fractured vertebra had an intact pedicle, additional screws were added to the fractured vertebra as well (Figures 4, 5). All fracture was gradually reduced by spinal distractor to restore the vertebral height and correct the angulations. Finally wound was sutured in layers under the suction drain. Postoperatively patients were continued with IV antibiotics for 5-7 days depending upon wound condition. Patients were allowed to sit in bed and weight-bearing walking with the help

of a thoracolumbar corset and walker as patients became comfortable.

The neurological status and improvement of pain were documented at the time of admission, discharge, and every subsequent follow-up visit. The follow up were scheduled at 6 weeks, 3 months, and 6 months. Functional outcome was assessed according to neurological status and patient satisfaction by Frankel grading^[11] and Macnab criteria^[12] respectively. Pain assessment was measured by Denis pain scale^[13]. Kyphotic angle was assessed preoperatively, postoperatively, and on follow-ups in lateral radiograph by Cobbs method^[14]. After clinical and radiological union all implants were planned for removal at 10-12 months to release moving segments, to reduce stress on neighboring vertebrae, and to prevent screw breakage (Table 1).

Statistical Analysis

All the data was collected using preformed Pro forma that included patients demographic profile, general history, clinical & radiological findings, its management & regular follow up. Data were entered and analyzed by SPSS Vs.20. Descriptive Statistics like frequency, percentage; mean and standard deviation were used to analyze the data. Chi-Square test, Independent sample t-test, and ANOVA tests were used as inferential statistics. A P-value less than 0.05 was considered statistically significant.

RESULTS

In the present study of 31 patients, SSPF was performed in all 31 patients (16 females and 15 males) with a mean age of 38.61 ± 11.54 years (range 20-63). Most of the cases had fall injury (87.1%), the mean interval between trauma and surgery was 2.13 ± 0.71 days, the average duration of hospital stay was 13.10 ± 2.95 days and the intraoperative average blood loss was 460 ± 58.2 ml. The majority of cases (45.2%) had L1 vertebral fracture and wedge compression fracture was the predominant type (77.4%). Posterior ligamental complex (PLC) was injured in 74.2% cases, 7 cases (22.6%) had

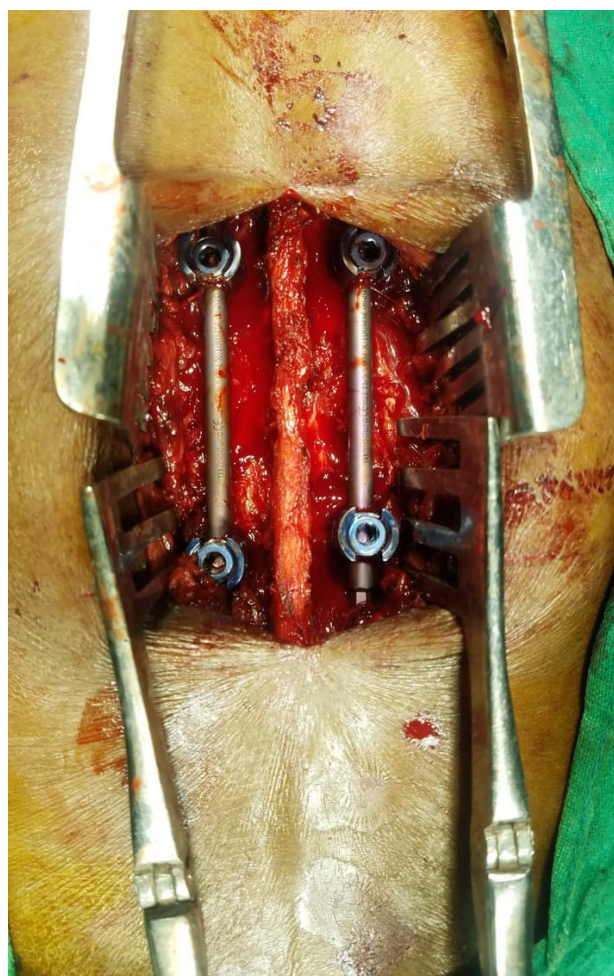


Figure 1 Posterior fixation.

Table 1 Frankel grading, Macnab criteria and Denis pain scale.

FRANKEL GRADING ¹¹
A: Complete (no sensory or motor function is preserved)
B: Incomplete (Sensory, but no motor function is preserved below the neurological level)
C: Incomplete (Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle power grade of <3)
D: Incomplete (Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle power grade of > 3)
E: Normal (sensory & motor function is normal)
MACNAB CRITERIA ¹²
Excellent: No pain; no restriction of activity
Good: Occasional back or leg pain of sufficient severity to interfere with the patient's ability to do his normal work or his capacity to enjoy himself in his leisure hours
Fair: Improved functional capacity, but handicapped by intermittent pain of sufficient severity to curtail or modify work or leisure activities
Poor: No improvement or insufficient improvement to enable an increase in activities; further operative intervention required
DENIS PAIN SCALE ¹³
P1: No pain
P2: Occasional minimal pain; no need for medication
P3: Moderate pain, occasionally medications; no interruption of work or activities of daily living
P4: Moderate to severe pain, occasionally absent from work; significant changes in activities of daily living
P5: Constant, severe pain; chronic pain medications



Figure 2 Preoperative x-ray.

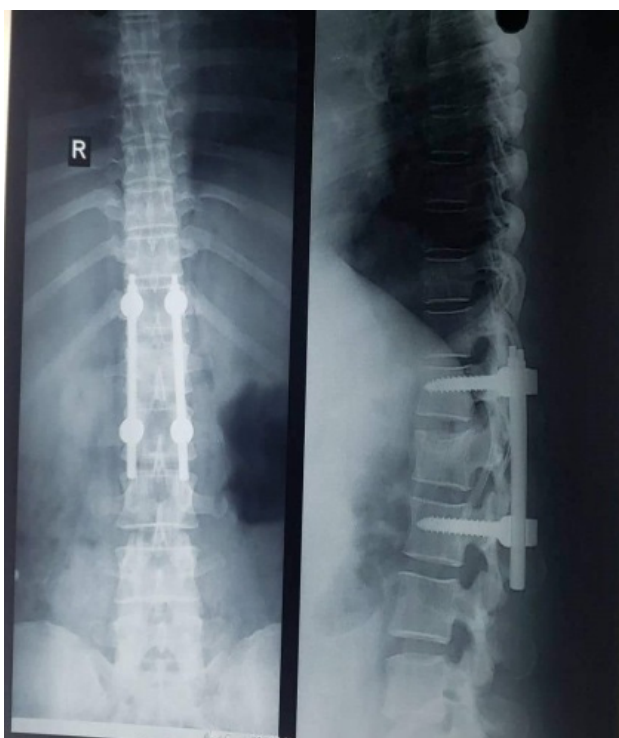


Figure 3 Postoperative x-ray.

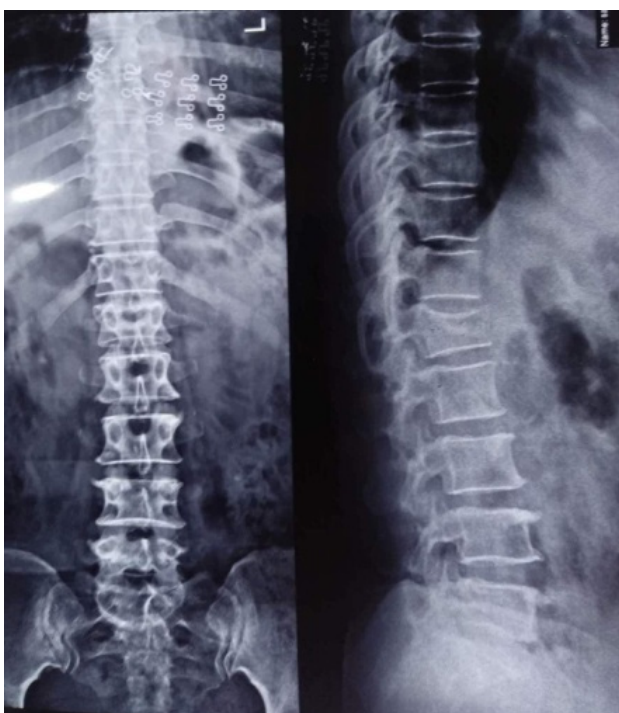


Figure 4 Preoperative x-ray.

neurological involvement and screw failure was seen in only 2 cases (6.5%). The majority of cases had a TLICS score of 4 (12 patients) and were A1 type (77.4%). In 16 cases, an additional screw was fixed through the intact pedicle of the fractured vertebra (Table 2).

Preoperatively 64.5% of cases had Frankel type E injury which improved to 83.9% at 6 months. Preoperatively the mean Denis pain scale was 4.16 ± 0.93 (range 2-5) that also improved to 1.42 ± 0.62 (range 1-3) at 6 months. Preoperatively the mean preoperative kyphotic angle was 16.77 ± 6.82 (range 8-30) degrees which also

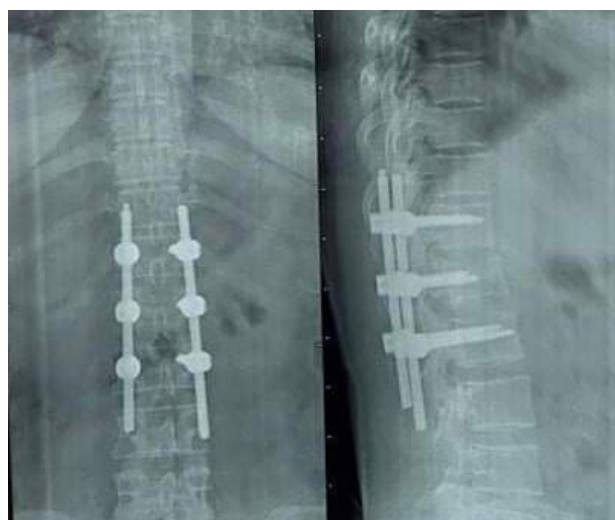


Figure 5 Postoperative x-ray.

Table 2 Demographic profile, a general characteristic of fracture and complication.

Variables	Frequency (n)	Percentage (%)	
Gender	Male	15	48.4
	Female	16	51.6
Age(years)	38.61 ± 11.54 ; range (20-63) years		
Mode of Injury	RTA	4	12.9
	Fall Injury	27	87.1
Interval between trauma and surgery(days)	2.13 ± 0.71 ; range (1-4) days		
Duration of Hospital stay(days)	13.10 ± 2.95 ; range (7-18)days		
Intraoperative blood loss(ml)	460 ± 58.2 ml; range (410-520 ml)		
Fractured Vertebral level	T11	2	6.5
	T12	7	22.6
	L1	14	45.2
	L2	6	19.4
	L3	1	3.2
Fracture Type	Burst	7	22.6
	Wedge Compression	24	77.4
Posterior Ligament Complex (PLC)	Intact	8	25.8
	Injured	23	74.2
Neurological involvement	Intact	24	77.4
	Nerve root	6	19.4
	Incomplete	1	3.2
TLICS	Score 1	8	25.8
	Score 4	12	38.7
	Score 5	4	12.9
	Score 6	2	6.5
	Score 7	4	12.9
	Score 8	1	3.2
AO classification	A1	24	77.4
	A2	2	6.5
	A3	5	16.1
Complication	Back pain	3	9.6
	Screw failure	2	6.5
	Tingling/ Numbness	5	16.1
Supplementary Screw in fractured vertebra	Screw fixation	16	51.6

improved to 1.35 ± 0.48 (range 1-2) degrees during the immediate postoperative period. At 6 months, the mean loss of kyphotic correction angle (kyphotic angle at 6 months minus kyphotic angle at immediate postoperative period) was 0.58 ± 0.88 (range 1-4) degrees (Table 3).

Table 3 Assessment of Frankel grading, Denis pain scale, Kyphotic angle and loss of kyphotic correction angle.

Variables		Preoperative	Immediate Postoperative	6 weeks	3 months	6 months
Frankel Grading	C	4(12.9)		3(9.7)	1(3.2)	1(3.2)
	D	7(22.6)		6(19.4)	5(16.1)	4(12.9)
	E	20(64.5)		22(71)	25(80.6)	26(83.9)
Denis Pain scale		4.16±0.93; range(2-5)				1.42±0.62; range(1-3)
Kyphotic angle (degree)		16.77±6.82; range(8-30)	1.35±0.48; range(1-2)			1.94±0.96; range(1-4)
Loss of kyphotic correction angle (degree)						0.58±0.88; range(0-3)

Table 4 Patient satisfaction according to fracture type, PLL status, TLICS, AO type and additional screws.

Variables		Patient satisfaction score			P-value
		Excellent	Good	Fair	
Fracture type	Burst	1(14.3)	2(28.6)	4(57.1)	0.02*
	Compression	12(50)	10(41.7)	2(8.3)	
PLC	PLC intact	5(62.5)	3(37.5)	0(0)	0.101*
	PLC injured	8(34.8)	9(39.1)	6(26.1)	
TLICS	TLICS system	3.08±1.80; range(1-6)	3.67±1.82; range(1-7)	6.67±1.03; range(5-8)	0.01**
AO Classification	A1	12(50)	10(41.7)	2(8.3)	0.034*
	A2	0(0)	0(0)	2(100)	
	A3	1(20)	2(40)	2(40)	
Additional Screws	Stability according to loss of kyphosis correction angle				0.909***
	SSPF with additional screw	n=16, 0.56± 0.89			
	SSPF without additional screw	n=15, 0.60 ± 0.91			

* Chi-Square test, **ANOVA Test, *** Independent Sample t- test

The majority of cases had excellent to good scores in patient satisfaction score where compression fracture had 12 (50%) and 10 (41.7%) cases with excellent and good scores respectively which was statistically significant (P 0.02). Concerning patient satisfaction score, a statistically significant difference was observed in mean TLICS score (P 0.101) and AO fracture type (P 0.034) while no difference was observed in PLC status (P 0.101) and additional screws (P 0.909) (Table 4).

There was a statistically significant difference between the fracture type and improvement of Frankel grading at the end of six months follow up ($p < 0.001$) where compression fracture managed with SSPF showed remarkable neurological recovery than burst fracture in terms of improvement of Frankel grading (Table 5).

DISCUSSION

In the present study, short-segment posterior fixation was performed in 31 patients with a mean age of 38.61 ± 11.54 years (range 20-63 years) which is similar to Azam F et al^[15]. (35±6.75 years; range15-61years).

Most of the cases had fall injuries (27 patients: 87.1 %) and the mean interval between trauma and surgery was 2.13 ± 0.71 days. The average duration of hospital stay was 13.10 ± 2.95 days and intraoperative average blood loss was 460 ± 58.2 ml. Similar results were seen in a study done by Dai et al^[8]. where fall injury was the common mode of fracture, the average duration between trauma and surgery was 3.7 days, the average duration of hospital stay was 13 ± 6.1 days and the average intraoperative blood loss was 423.7 ± 72.8 ml.

The majority of cases (14 patients: 45.2%) had L1 vertebral fracture which is similar to Azam F et al^[15]. (L1fracture: 50%). Most of the cases were wedge compression fracture (24 patients: 77.4%) followed by burst fracture (7 patients: 22.6%) which is similar to Arif M et al^[16]. (wedge: 73.68%, burst: 15.78 %). Posterior ligament complex was injured in 23 patients (74.2%). Only 22.6% of cases had neurological involvement which is similar to Dai et al^[8]. (34.2%).

Table 5 Improvement of Frankel grading according to fracture type.

Fracture types	Frankel grading				P-Value
	Preoperative	6 Months			
	Total	C	D	E	
Burst	C	4	1(25%)	3(75%)	<0.001*
	D	1	0	1(100%)	
	E	2	0	2(100%)	
Compression	C	0	0	0	<0.001*
	D	6	0	1(16.7%)	
	E	18	0	5(83.3%)	

*Chi-Square test

The only major complication was screw failure (2 cases:6.5%) which is similar to Azam F et al^[15] (3.75%).

Preoperatively 64.5% of cases had Frankel type E injury which improved to 83.9% at 6 months which is similar to Dai et al^[8]. (Type E 65%). Khan A et al^[17]. and Javed S et al^[18]. also showed improvement in neurological status after SSPF. The mean Denis pain scale was 4.16 ± 0.93 (range 2-5) which improved to 1.42±0.62 (range 1-3) at 6 months which is similar to Azam F et al^[15]. The mean preoperative kyphotic angle was 16.77 ± 6.82 (range 8-30) degrees which improved to 1.35 ± 0.48 (range 1-2) degrees during the immediate postoperative period which also is similar to Dai et al^[8]. study (preoperative kyphotic angle: 18.7 ± 10.7 (range 2-30) degree and immediate post-operative kyphotic angle: 0.5-1 ± 1 degree). At 6 months, the mean kyphotic angle was 1.94 ± 0.96 (range 1-4) degrees. The mean loss of kyphotic correction angle was 0.58 ± 0.88 (range 1-4) degree which also is similar to Dai et al^[8]. (1.7 ± 1.3 degree).

The majority of cases had excellent to good patient satisfaction scores where 12 (50%) and 10 (41.7%) cases of compression fracture had excellent and good scores respectively (P 0.02). Concerning patient satisfaction score, a statistically significant difference was observed with mean TLICS score (P 0.101) and AO fracture type (P 0.034) while no difference was observed with PLC status (P 0.101) and additional screws (P 0.909). There was a statistically

significant difference between the fracture type and improvement of Frankel grading at the end of six months follow up ($p < 0.001$) where compression fracture managed with SSPF showed remarkable neurological recovery than burst fracture in terms of improvement in Frankel grading. We found no such similar studies where we could compare these results. These results can be used as ground data for future studies to derive a better conclusion in the future.

CONCLUSION

Short segment transpedicular screw fixation is an effective surgical procedure for traumatic unstable thoracolumbar fracture as it provides early pain relief, adequate stability, prevents as well as improves neurological injury, and provides excellent functional outcomes.

LIMITATIONS AND RECOMMENDATIONS

The major limitation of this prospective study is the small sample size and short duration of the study. A further prospective study with a larger number of patients and for a longer duration of time is recommended for a more appropriate result.

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