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Short Segment with Index Vertebra Fixation versus Long Segment Fixation in the Management of Thoracolumbar Fractures

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ABSTRACT
Introduction: The majority of musculoskeletal injuries around the globe are spine fractures. The thoracic and lumbar spine account for 75–90% of fractures of the spine.
Aim of study: To compare the radiological and clinical results of short segment with index vertebra fixation with those of long segment fixation, in the cases of thoracolumbar fractures.
Patients and methods: This interventional comparative study included 40 patients with traumatic thoracolumbar fractures, of these 20 patients underwent short segment open transpedicular posterior with index vertebral fixation and 20 patients underwent long segment open transpedicular posterior fixation.
Results: The **operative time** in Short Segment with Index Vertebra Fixation (**SSIVF**) was 149 minutes taking considerably less time than Long Segment Fixation (LSF) (195 minutes). **Blood loss** was significantly less in SSIVF (290.5 ± 94.88 mL.) than in **LSF** (495.5 ± 110.76 mL). Regarding postoperative visual analogue scale (**PVAS)** pain was significantly lower in **SSIVF** (2.25 ± 1.45) group than in **LSF** group (4.6 ± 1.79) and Oswestry Disability Index (**ODI)** was significantly lower in **SSIVF** group (20.4 ± 12.1) than in **LSF** group (26.05 ± 13.45) follow-up after 12 weeks postoperatively. Angl of **Kyphosis** measured by **Cobb angle** in **LSF** group (7.7 ± 2.030) correction was significantly best than in **SSIVF** group (9.3 ± 2.25) Follow-up after 12 weeks postoperatively.
Conclusion: In comparison with LSF technique, the SSIVF technique yielded significantly better clinical and functional outcomes for PVAS and ODI. Compared to the SSIVF procedure, the LSF technique greatly outperformed of radiological correction of Cobb's angle at the most recent follow-up.
Keywords: Spine, Short Segment, Long Segment Fixation, Thoracolumbar Fractures.

INTRODUCTION

A frequent type of spinal injury is thoracolumbar vertebral body fractures, with "burst type" fractures accounting for between 21% and 58% of all fractures of the thoracolumbar spine. Thoracolumbar burst fractures are particularly common in younger patients and may significantly affect their everyday physical activity. They are commonly accompanied by neurological deficiencies and kyphotic deformities. However, there is still disagreement over the best way to treat this injury [1, 2].

One of the therapeutic goals of the most effective technique to treat thoracolumbar burst fractures is to open up the spinal canal. Other treatment goals include correcting the kyphotic deformity, restoring spinal stability and alignment, and correcting the kyphotic deformity. The majority of authors feel that surgical intervention is necessary to accomplish these desired objectives in cases of burst fractures; nonetheless, there is ongoing debate about the best course of action [2-4].

Roy-Camille *et al.* **[5]** first used pedicle screws to treat thoracolumbar fractures. Transpedicular Short Segment fixation was first described in 1963 and further developed by **Dick *et al.*** **[6]** **in 1985.** Since then, other surgical approaches have emerged. Straight anterior decompression through corpectomy and thoracolumbar burst fractures can be treated with posterior short segment or long segment pedicle screw fixation, as well as combination therapy using anterior and posterior spinal techniques [7-9].

Fixation with a long segment pedicle screw was historically the most popular technique, encouraging early ambulation and reducing kyphosis (a damaged vertebra and at least two levels above and below it). SSF increasingly took its place because to concerns voiced regarding the loss of motion segments with long-term fixation of segments (the broken vertebra and one level above and below it) **[10]**.

Many publications[9–15] did, however, observe substantial rates of early implant failure and corrective loss when using this fixation technique. Some authors [12, 13] made the claim that installing pedicle screws at the fracture location would improve load distribution and, consequently, construct stability. Therefore, this study's objective was to examine the radiological evaluation and clinical results contrasted with long segment fixing in patients with such broken thoracolumbar vertebrae. The use of short segment fixation in patients with such fractures has been shown to be more effective in treating the fractures.

PATIENTS AND METHODS

The study was performed in the Neurosurgery Department, Zagazig University Hospital during the period from November 2021 to August 2022. This interventional comparative study was conducted on 40

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patients with traumatic thoracolumbar fractures. All patients were operated upon by open transpedicular posterior fixation in such cases of traumatic thoracolumbar fractures.

Inclusion criteria:

The age range was from 18 to 70 years old. Both sexes were represented. General fitness for surgery was considered. Patients who are conscious, cooperative, and willing to consent. Single level fracture vertebra between the 3rd thoracic vertebra and the 4th lumbar vertebra (T3-L4).

Exclusion criteria:

The patient must not be under the age of 18 or over the age of 70. Pathological fractures (susceptibility to infection or tumor). Osteoporotic patient. Multiple level fractures of the vertebrae in the thoracolumbar region. Uncooperative patient. severe systemic illness and unfitness for surgery. Dislocation of a fracture with severe kyphotic or scoliotic angles. All patients undergo conservative management with injury categorization and severity rating for the thoracolumbar region (TLICS score ≤ 4).

40 patients suffering from thoracolumbar fractures were included in the study. The patients were classified into 2 groups: **Group A** included 20 patients who were operated upon by open short segment posterior transpedicular screws fixation with index level. **Group B** included 20 patients were operated upon by with open long segment posterior transpedicular screws fixation, two or more levels above and below a fractured vertebrae.

All patients underwent a thorough history taking and clinical examination. Laboratory investigations were done for all patients prior to surgery. Plain X-ray AP view and calculation of the Cobb's angle from the side (local kyphotic angle prior to surgery), as well as classification based on the type of fracture to the AO spine classification. In light of the recent AO spine classification, a CT scan of the dorsolumbar spine axial view and sagittal reconstruction was performed to access 3 column fracture theory (Denis classification) and fracture morphology. To access neural tissue injury and disco-ligmatous complex injury, an MRI of the dorsal lumbar spine was performed with an axial view and sagittal recontraction.

Preoperative preparation:

After clinical examination, neurological assessment, and radiological investigation were done, the patient was placed on a firm mattress wearing a thoracolumbar brace. Catheterization was done under aseptic conditions. Broad-spectrum antibiotics were given before surgery and repeated during surgery.

Operative procedure:

General anesthesia was used in all our patients to reduce blood loss and facilitate hemostasis intraoperatively.

Steps of pedicular screw insertion Figure (1)

1. After identification of the entry site, a pedicle awl and using a pedicle probe, a route through the pedicle cancellous bone to vertebral body was created for the screw.
2. To check for disruptions in the medial, lateral, caudal, or cephalic planes and to ensure that the bottom of the vertebral body was not penetrated, the pedicle sound probe was inserted into the pedicle and palpated from within.
3. The permanent screws were placed with adequate width and length.
4. During surgery, the depth and location of the screws were confirmed using fluoroscopy.
5. After pedicular screw placement, screws were connected to a rod of suitable length, and a spherical nut was loosely applied. After ensuring that the rod was in the desired anatomical alignment by using the rod holder, tightening of the nuts was done.

Reduction and decompression:

Indirect decompression was done by countering the rod that corrects kyphosis and recreates normal lordosis, distraction and reduction movements can be used to help reduce compression caused by ligamentotaxis.

Wound closure:

After copious irrigation and debridement, a suction drain was placed deep in the wound. Then, the wound was closed in layers: muscles, fascia, subcutaneous tissue, and skin.

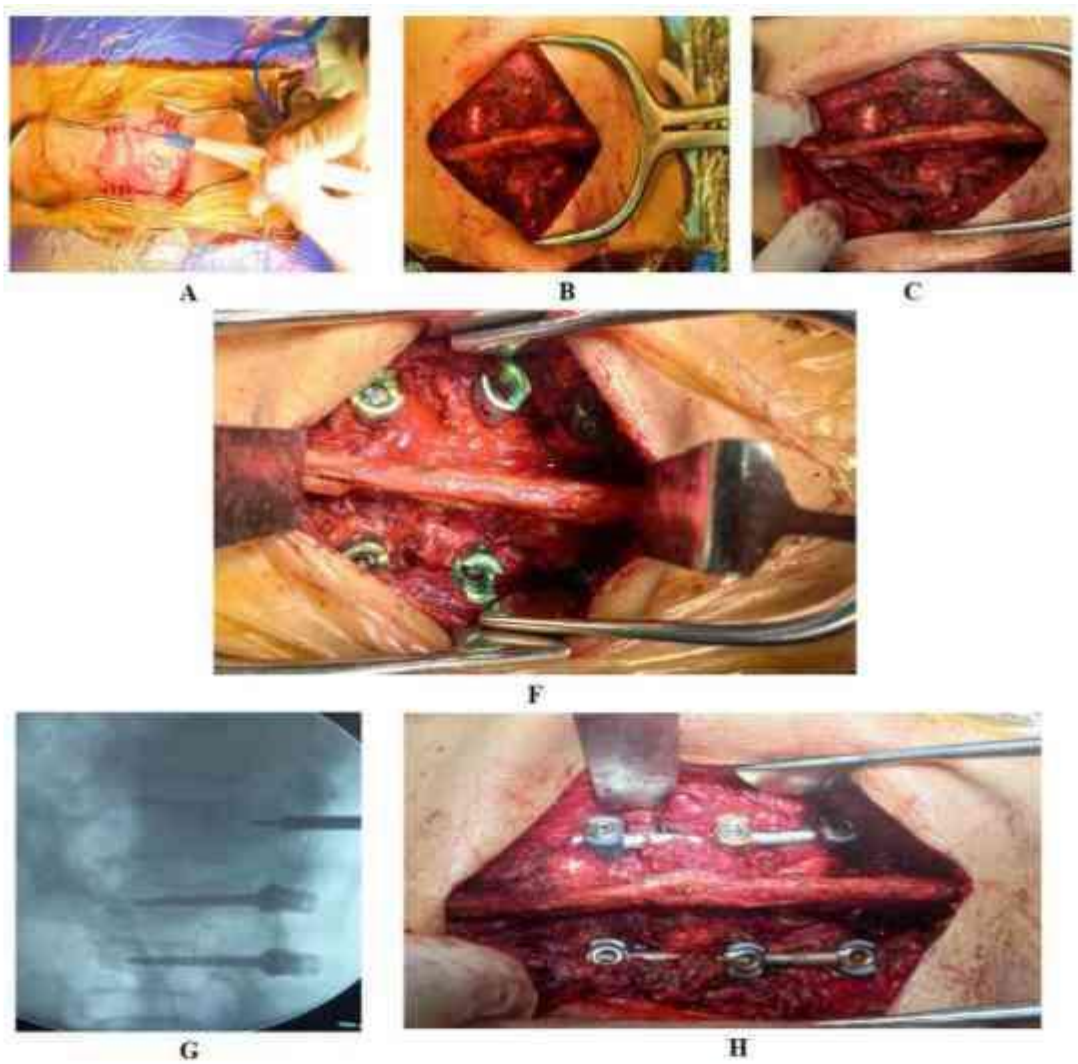

Figure (1): Pictures showing incision (A) and deep dissection (B & C). Screw entry (F). Fluoroscopy is used to determine the position and depth of the screws (G). Rod application (H).

Postoperative care and follow-up:
All patients had a thoracolumbar belt for three months postoperatively.
Routine clinical and radiological examinations were performed to all patients after 2 weeks, 6 weeks, and 12 weeks.

Ethical consent: This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Zagazig University. Written informed consents were taken from all participants. The study was conducted according to the Declaration of Helsinki.

Statistical Analysis
The IBM SPSS statistics software (version 23) was utilised to collect, present, and analyse the data. Comparisons of measurements (mean ± SD) between two groups were performed using the student t-test for unpaired data and the paired t-test for paired data, whereas comparisons of measurements (mean ± SD) between several groups were performed using the one-way ANOVA test. Furthermore, qualitative categories were expressed as a frequency and percentage, and comparisons between qualitative categories were made using the Chi square test. When there was an observation in cell 5, the Fisher exact test was employed. When the P value ≤ 0.05, it meant that the test results were important. The test findings were declared non-significant when the P value exceeded 0.05.

RESULTS

Table (1) showed that there were statistically insignificant differences between the groups under study with respect to age, gender, residence, or marital status

Table (1): Comparison between the studied groups regarding demographic data

	Short Segment with Index Vertebra Fixation (SSIVF) N=20 (%)	Long segment fixation (LSF) N=20 (%)	χ^2	p
Gender				
Female	7 (35%)	12 (60%)	2.506	0.113
Male	13 (65%)	8 (40%)		
Residence:				
Rural	6 (30%)	10 (50%)	1.667	0.197
Urban	14 (70%)	10 (50%)		
Occupation				
House wife	5 (25%)	12 (60%)	2.902	0.088
Worker	11 (60%)	5 (25%)		
Employee	4 (20%)	3 (15%)		
Marital state				
Married	10 (50%)	11 (55%)	0.1	0.752
Single	10 (50%)	9 (45%)		
	Mean ± SD	**Mean ± SD**	**t**	**p**
Age (years)	26.25 ± 6.73	24.0 ± 6.79	-1.053	0.299

χ^2 Chi square test t independent sample t test

Regarding operative time, blood loss, and incision length were all significantly higher in groups with longer segment fixations than in groups with shorter segment fixations.

Table (2): Comparison between the studied groups regarding operative data

	SSIVF Mean ± SD	LSF Mean ± SD	t	p
Operative time(min)	149.0 ± 35.08	195.5 ± 38.51	4.421	<0.001**
Blood loss (ml)	290.5 ± 94.88	495.5 ± 110.76	8.862	<0.001**
Incision length (cm)	8.9 ± 1.52	16.25 ± 2.17	12.398	<0.001**

χ^2 Chi square test t independent sample t test

Table (3) showed that in terms of preoperative VAS score, there was no statistically significant difference between the two groups. On the other hand, there was a significant difference between them regarding VAS at 3 days and 12 weeks postoperatively, which was higher in long segment fixation. In each group, there was a statistically significant drop in the VAS score compared between the two points in time.

Table (3): Comparison between the studied groups regarding VAS score pre and postoperatively

VAS	SSIVF Mean ± SD	LSF Mean ± SD	t/Z	p
Preoperative	6.05 ± 1.85	6.95 ± 1.28	1.792	0.081
3 days postop	3.25 ± 2	5.11 ± 2.25	-2.495	0.013*
12 weeks postop	2.25 ± 1.45	4.6 ± 1.79	-3.702	<0.001**
P1	< 0.001**	0.003*		
P2	< 0.001**	< 0.001**		
P3	< 0.001**	< 0.001**		

P1 difference between preoperative and 3 days postoperative p2 difference between preoperative and 12 weeks postoperatively p3 difference between 3 days and 12 weeks postoperatively Z Mann Whitney test p1, 2, 3 for Wilcoxon signed rank test.

Table (4) showed that the two groups had a statistically significant difference in terms of ODI at 3 days and 12 weeks postoperatively, which was higher in long segment fixation. In each group, a statistically significant decline was seen in ODI when comparing the two points in time.

Table (4): Comparison between the studied groups regarding ODI pre and postoperatively

ODI	SSIVF	LSF	Z	p
	Mean ± SD	**Mean ± SD**		
3 days postop	24.8 ± 16.11	39.0 ± 15.71	-3.087	0.002*
12 weeks postop	20.4 ± 12.1	26.05 ± 13.45	-2.225	0.026*
P (Wx)	<0.001**	<0.001**		

P1 difference between preoperative and 3 days postoperative p2 difference between preoperative and 12 weeks postoperatively p3 difference between 3 days and 12 weeks postoperatively Z Mann Whitney test Wx Wilcoxon signed rank test.

Table (5) demonstrated a statistically insignificant change in preoperative Cobb angle 3 days or 12 weeks postoperatively between both groups. In each group, there was a statistically significant change in Cobb's angle when compared at each of the two points in time.

Table (5): Comparison between the studied groups regarding Cobb' angle pre and postoperatively

Cobb angle	SSIVF	LSF	t	p
	Mean ± SD	**Mean ± SD**		
Preoperatively	20.75 ± 6.11	24.85 ± 7.33	1.921	0.062
3 days postop	6.5 ± 1.15	6.8 ± 1.82	0.623	0.538
12 weeks postop	9.3 ± 2.25	7.7± 2.030	-0.063	0.95
P1	<0.001**	<0.001**		
P2	<0.001**	<0.001**		
P3	<0.001**	<0.001**		

P1 difference between preoperative and 3 days postoperative, p2 difference between preoperative and 12 weeks postoperatively, p3 difference between 3 days and 12 weeks postoperatively t independent sample t test.

DISCUSSION

The majority of patients in the group of long segments fixation (60%) were females, while the majority of patients in the short segment with index vertebra fixation group (65%) were males. The mean age in the **SSIVF** group was 26.25 years (22–40 years), whereas it was 24.25 years (18–45 years) in the group of **LSF**. Rural areas, which account for 30% of both groups' residence, were the most common. House wife was the most common occupation in both groups, accounting for 25% of **SSIVF group** and 60% of **LSF** group. Smokers formed 40% of the **LSF** group compared to 35% in the **SSIVF** group. The most frequent trauma in the group of **LSF** was fall from a large height (60%), whereas inside the **SSIVF**, the most frequent trauma was MBA (55%).

A 3 fractures were the two groups' most typical AO spine fractures, making up 75% and 45% of the **LSF** group and the **SSIVF** group respectively. In both groups, L2 fractures were the most common. L2 fractures occurred (35%) of patients in the **SSIVF** group but only in 7% of individuals in the **LSF** group.

In the **SSIVF** Group, The most common fixation level was at D12 and L3, where 120 screws were put in. In the **LSF** Group, with D6 and L2 being the most prevalent levels of fixation, 160 screws were put in.

Short segment with index vertebra fixation required considerably less time during surgery than long segment fixation (149.0 ± 35.08 vs 195.5 ± 38.51 minutes, p 0.001). This can be explained by longer periosteal and muscle retraction, hemostasis, and extra time spent determining anatomical landmarks to help determine where to insert the screw in such cases of long segment open posterior transpedicular fixation. It was noted that the operative time gradually decreased from early to late cases due to an increase in the learning curve of the surgeons. **Singh *et al.*** [16] reported an average operating duration of 225 minutes for long segment fixation and 165 minutes for short segment with index level fixation (prospective comparative study, India, 35 patient). **Mittal *et al.*** [17] reported a long segment fixation operation time average of 109 minutes and 90 minutes for short segment fixation (prospective comparative study, India, 26 patient).

The overall amount of postoperative blood loss was significantly less in the SSIVF group compared to that in the LSF group (mean SD: 290.58 ± 93.819 vs. 495 ± 110.75 ml, p 0.001). In such situations of long segment open posterior transpedicular fixation, this may be explained by the huge incisions, lengthy soft tissue dissection, and additional efforts to locate anatomical landmarks for the optimal screw entry point. **Singh *et al.*** **[16]** Long segment fixation caused an average blood loss of 670 mL, while short segment fixation caused a blood loss of 400 mL on average (prospective comparative study, India, 35 patients).

VAS was slightly lower in the **SSIVF** group than in the **LSF** (3.25 vs. 5.11, p = 0.013), and 55% of the **SSIVF** had mild VAS pain. In comparison to 50% of the **LSF** group was suffered from moderate VAS pain (p=0.02).

While 30% of the six cases in the **LSF** group was moderate ODI, the ODI was minimal in the seven cases in the 35% **SSIVF** group. In comparison to the group that **LSF**, ODI was substantially lower in the **SSIVF** group. (Mean SD: 39.0 15.71 vs 24.8 16.11, p=0.002) (p=0167).

Follow-up clinical evaluation (12 week after surgery):

VAS was substantially lower in the short segment with the index vertebra than in the long segment fixation (2.25 ± 1.45 vs 4.6 ± 1.79, p=0.001).

While 60% of the group **LSF** experienced moderate VAS pain, 60% of the short segment fixation experienced mild VAS pain. In comparison with the **LSF** group, the ODI was marginally lower in the **SSIVF** group (20.4 ± 12.1 vs 26.05 ± 13.45, p = 0.026), 70% of the short segment fixation group (14 cases) had minimal ODI, while 45% (9) patients in the long segment fixation group had a moderate ODI. **Biakto *et al.*** **[18]** reported that patients receiving long segment fixation experienced higher levels of patient satisfaction (VAS: 75% vs. 20%) than those receiving short segment fixation. In the intermediate category, there was a significant difference (p 14 0.047). (VAS 3-7). ***Singh et al.*** **[16]** observed that in group SSF group, mean ODI was, 26.7 ± 17.9, while in LSF group, mean ODI at final follow up was 31.5 ± 13.73 with significant difference between the two groups.

Pre-operative assessment of Cobb's angle showed that the angle of kyphosis (Cobb's angle) in the **SSIVF** group was statistically different from the **LSF** group (20.75 ± 6.11 vs. 24.85 ± 7.33, p=0.062), and in terms of statistics, there was difference between the two study groups.

Postoperative assessment of Cobb's angle (0-3 days after surgery) Angle of kyphosis (Cobb's angle) in the **SSIVF** group was lower than in the group of **LSF** (6.5 ± 1.82 vs 6.8 ± 1.15, p=0.538).

In the **LSF** group, the angle of kyphosis was considerably lower than in the **SSIVF** group (7.7 ± 2.030 vs 9.033 ± 2025, p=0.95)**. Çetin & Öner** **[19]** observed that in short segment fixation group, Cobb's angle was mean of 17.4 ± 10.6 preoperatively. It changed to a mean of 8.62 ± 11.9 postoperatively, with the final follow-up showing a mean of 12.07.2. In group long segment fixation group, Cobb's angle was mean of 16.5 ± 5.8 preoperatively and changed to a mean of 6.9 ± 5.6 postoperatively and to a mean of 8.8 ± 5.8 at final follow-up.

Vihar *et al.* **[20]** observed that in short segment fixation group, Cobb's angle was 18-21° (Mean=21.75°) preoperatively and changed to a mean of 6.75° postoperatively and to a mean of 12.5° on the last follow-up. In long segment fixation group, Cobb's angle was 23.58° preoperatively and changed to a mean of 6.16° postoperatively and to a mean of 10.16° at final follow-up.

CONCLUSION

The clinical and functional outcomes for VAS and ODI are much better with the short segment with index vertebral fixation than the long segment fixation**.**

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