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Original Article (SPINE)

Comparison of Short Segment Percutaneous Transpedicular Fixation With and Without Inclusion of Fractured Vertebrae in Thoracolumbar Fractures

Syed Ahmad Faizan, Naeem-ul-Hassan, Zubair Mustafa Khan, Tariq Imran, Abdul Majid
Department of Neurosurgery, Unit-III, Punjab Institute of Neurosciences, Lahore, Pakistan.

ABSTRACT

Objective: The study aimed to compare the outcome of SSPF (Short Segment Posterior Fixation) with and without the inclusion of fractured vertebrae in thoracolumbar fractures in terms of visual analog score and vertebral column stability.

Materials and Methods: The study enrolled 96 patients who were divided into two groups. Group A treated by SSPF (four screws: one level above and below the fracture), and Group B was treated by PSFFV (six screws: including fractured vertebrae). Assessment of parameters related to clinical and radiological aspects was recorded at 3 – 6 months.

Results: Mean ages of patients were 36.96 and 37.41 years with an M:F ratio of 1.8:1 and 1.4:1 in groups A (SSPF) and B (PSFFV), respectively. Mean VAS preoperatively, and postoperatively, at 3 and 6 months were 8.78 vs. 9.01, 4.98 vs. 5.01, 2.08 vs. 2.11, and 0.47 vs. 0.67 in groups A and B, respectively. Mean Kyphotic angle preoperatively, postoperatively, at 3 and 6 months were 21.76 vs. 22.91, 11.13 vs. 10.16, 13.59vs. 11.16 and 14.88 vs. 12.87 in groups A and B respectively. Mean AVH preoperatively, and postoperatively, at 3 and 6 months were 19.11 vs. 18.72, 20.01 vs. 22.71, 20.61 vs. 22.87, and 20.02 vs. 22.67 in groups A and B, respectively. The screw pullout, screw head dislodgement, and breakage of implants were less common in the PSFFV group compared to the SSPF group of patients.

Conclusion: The results of this study favor PSFFV (Group B) over SSPF (Group A) in terms of vertebral column stability which was better achieved in PSFFV. PSFFV was also found superior with no implant failure which declares it safer and more effective than SSPF. None of the techniques was found superior in terms of pain. Radiologically, PSFFV, showed significant improvement in achieving anterior vertebral height, while there was no important distinction in kyphotic angle between the two.

Keywords: Transpedicular, Fractured Vertebrae, Thoracolumbar, Anterior Vertebral Height, Posterior short-segment fixation including the fractured vertebra, short-segment pedicle fixation.

Corresponding Author: Syed Ahmad Faizan
Department of Neurosurgery, Unit-III,
Punjab Institute of Neurosciences (PINS), Lahore
Email: drfaizan122@hotmail.com

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INTRODUCTION

Many studies are available in Pakistan for thoracolumbar fracture fixation but most of these are for open fixation or analytical study and no study is available to compare the short segment percutaneous transpedicular fixation (SSPF) with and without the inclusion of fractured vertebrae in thoracolumbar fractures. The objective of the study was to compare the outcome of short segment percutaneous transpedicular fixation with and without the inclusion of fractured vertebrae in thoracolumbar fractures in terms of Visual analog score and vertebral column stability. Thoracolumbar fractures are frequent and cause important spinal malformation as well as a neurological deficit. There are still disagreements on the management and timing of surgery, as well as the technique and kind of surgery. Thoracolumbar joint fractures are a common (50 – 74%) kind of spinal injury.[1] Transitional zone is most susceptible to fractures (junction of thoracic and mobile lumbar vertebrae).[2] Polytrauma patients are usually associated with spinal injuries.[3] Patients with thoracolumbar fractures and cord injuries have a poor quality of life and socioeconomic level.[4] The thoracolumbar junction is the most common location for a spine fracture. Thoracolumbar fracture treatment aims include early mobilization, rehabilitation through mechanical stability, and improvement of neurologic impairment, allowing the patient to return to work. Thoracolumbar fractures are treated by posterior spinal fixation.[5] Posterior spinal fixation is commonly used for thoracolumbar fractures with excellent results and few complications like loss of vertebral height and implant failure. Among all operative procedures, posterior short-segment pedicle instrumentations are most commonly utilized for thoracolumbar fractures due to their three-column fixation.[6] Hu et al.[7] reported that yearly spinal injury incidence was 64 per 100,000 populations in Canada. Thoracolumbar fractures among men are more common between 20 and 40 years.[8]

The short-segment percutaneous pedicle instrumentation has problems, like inadequate reduction, instrumentation failure, and pain.[9-10] We did not find any local work which can prove the definite advantage of one method over the other. So, this study would help to plan a better management protocol for thoracolumbar fractures. These facets sustain the vertebral alignment as well as control the motion range.[11] All of the vertebrae except for the sacral and upper two cervical vertebrae articulate together by post lateral facet joint and intervertebral disc. The facet joints are strengthened by the presence of capsule interspinous ligament and supraspinous ligament. These ligaments form a posterior ligamentous complex which is essential for the stability of the spine Murray 1943. During surgical treatment of the thoracic spine, surgeons face unique challenges owing to a narrow canal diameter, and the proximity to vascular structures such as the aorta, azygous vein, and sympathetic chain.[12]

Following ATLS (advanced trauma life support) and clearing ABC (airway, breathing & circulation), spinal immobilization must be the main focus. Stabilization of unstable injured spinal segment and using log roll method for shifting and evaluation of patient plays important role in preventing secondary injury. Neural structure injury can occur both at primary and non-modifiable surgery time and during subsequent phases because of vascular dysfunction, electrolyte shifts, ischemia, edema, production of free radicals, inflammation, and late apoptotic cell death (potentially modifiable and secondary).[13-14] Thoracolumbar Spinal fractures with TLICS (Thoracolumbar Injury Classification and Severity) score < 3 are to be treated conservatively and of > 5 is to be treated surgically.[15] Numerous surgical techniques were reported regarding thoracolumbar fractures such as combined, anterior, and posterior approaches. Posterior short-segment fixation (PSSF) includes the joining

of the normal proximal and distal of the fractured vertebrae. The posterior pedicle screw (PPS) fixation has been demonstrated to be easy, efficient, familiar, safe, and reliable regarding reduction and the stabilization of the majority of fractures and believes a most accepted technique. Bühren et al.[16] analyzed 38 patients, and concluded that when compared with open technique, minimally invasive surgical treatment had the advantage of decreasing pain after surgery, shorter hospital stays, causing early functional recovery, and decreasing morbidity of surgical technique. The pedicle screw insertion technique is performed under general anesthesia.[17]

MATERIALS AND METHODS

Study Design & Setting

Randomized Controlled Trial (RCT) was conducted by following CONSORT Guidelines. The study was carried out at the Department of Neurosurgery Unit 3, Punjab Institute of Neuroscience (PINS), Lahore General Hospital (LGH), Lahore Pakistan, for one year after the approval of the research proposal.

Sample Size

The sample size (n = 48) was calculated by a formula keeping the power of study equal to 90% and the level of significance equal to 5% and taking the expected mean VAS (visual analog score) in both groups i.e., 4.9 ± 0.7 in short-segment percutaneous transpedicular fixation without the inclusion of fractured vertebrae group and 5.4 ± 0.8 in short-segment percutaneous transpedicular fixation with the inclusion of fractured vertebrae group.

Inclusion Criteria

Patients of either gender between 20 to 60 years of age have thoracolumbar vertebral fractures with intact pedicle and PLC on CT and MRI. Patients with TLICS scores > 4 were included in the study.

Exclusion Criteria

Patients with TLICS score < 3, having pathological fractures or associated with other injuries like rib fractures, visceral injuries, and long bone fractures were excluded. Patients requiring anterior decompression for removal of fractured segment following thoracolumbar burst fractures (Figures 1a and 2a), and patients with fractured pedicle or posterior ligament injury on CT or MRI (Figure 1b) were also excluded from the study. Age > 60 years and unfit for surgery due to co-morbidities, pathological fractures, polytrauma including visceral injuries and long bone fractures, and TLICS < 3 were excluded.

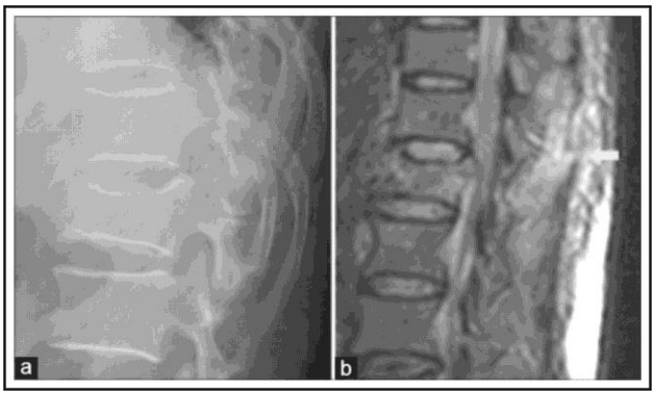

Figure 1: (a) L1 vertebral burst fracture, and **(b)** Hyperintense signal of PLC on MRI (white arrow). (Images used with patient's consent)

Groups of Patients

The 96 patients of both genders (male/female) and aged 20 – 60 years who fulfilled the inclusion criteria were enrolled in my study. Ethical approval was taken from the ethical committee of the hospital and informed consent from the patient. Patients were divided into 2 groups A & B.

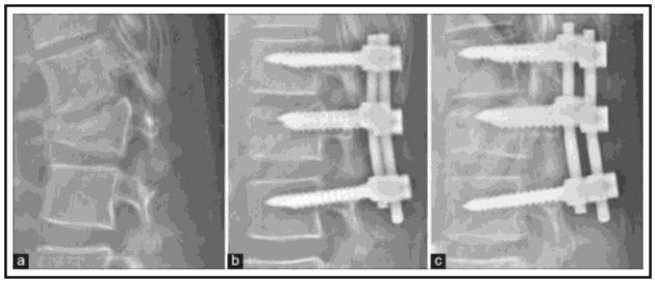

Figure 2: (a) Flexion-distraction injury of L1 vertebra on lateral view (X-rays), **(b)** Screw fixation with PSSF, and **(c)** Healed fracture at one year. (Images used with patient's consent)

Group A: The patient received short segment percutaneous transpedicular fixation without the inclusion of fractured vertebrae in thoracolumbar fractures.

Group B: Patient received short segment per-cutaneous trans-pedicular fixation with the inclusion of fractured vertebrae in thoracolumbar fractures.

Surgical Technique

After full aseptic measures (ASM) under G/A in the prone position pedicles of respective vertebrae were identified with the help of C-ARM. Figure 3 shows multiple 1 – 2 cm skin incisions given over the pedicle and incisions also given in thoracolumbar fascia, Jamshidi needles (Figure 4) were inserted into pedicles with the help of C-ARM and guide wire passed through then Jamshidi needles removed and dilators were passed over the guide wire. Pedicles and vertebrae bodies were tapped and a screw passed under C-ARM guidance and the same procedure was repeated for all screws, (Figures 5 and 6) After placing screws in respective vertebrae on each side rod was placed and the screw distracted under C-arm and the rod fixed (Figure 3). Fascia and skin approximated. The antiseptic dressing is done.

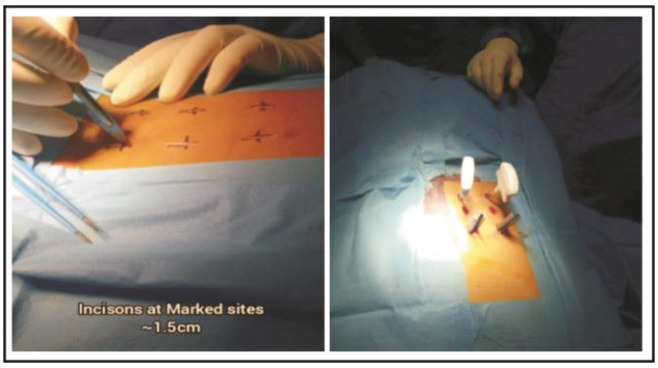

Figure 3 (left): Skin incision marked under C-arm assistance.
Figure 4 (right): Jamshidi needle inserted under c-arm guidance. (Images used with patient's consent)

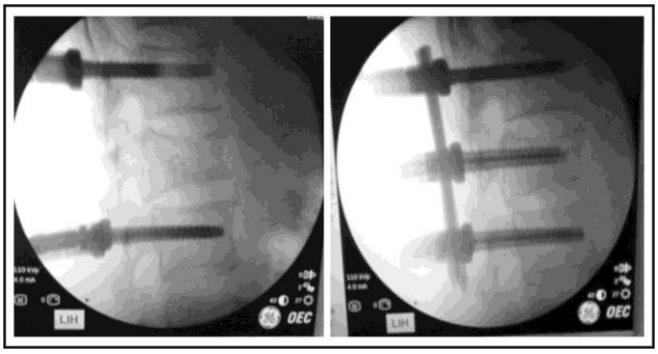

Figure 5 (left): Lateral view of PSFF 4 screw.
Figure 6(right): Lateral view of PSFFV (6 screws) (images taken from PINS). (Images used with patient's consent)

Clinical Management

Per-cutaneous fixation was done in all cases. Patients were discharged on 1st post-op day and followed in 3 months and 6 months. Visual analog score, anterior vertebral height, kyphotic angle, and implant failure (Figure 7) were noted. Spinal X-rays, CTs, and MRIs were conducted on all patients. CT scans were employed to classify the vertebral combination and to see whether the vertebrae of neighboring vertebrae were intact and able to take the screw. MRI was done to see the posterior ligamentous complex. The pre-operative, post-operative, and follow-up radiographs were evaluated for anterior vertebral height (AVH) and implant failure. AVH of the fractured vertebrae (Figure 8) was measured in mm.

X-rays at the end of surgery were recorded

(Figures 9 and 10). Data for preoperative and postoperative radiological analyses were compared. The patient's functional result was evaluated using a visual analog scale (VAS) score for pain after 6 hours following surgery, 3 months, and 6 months after discharge. The information was collected on a pre-designed proforma.

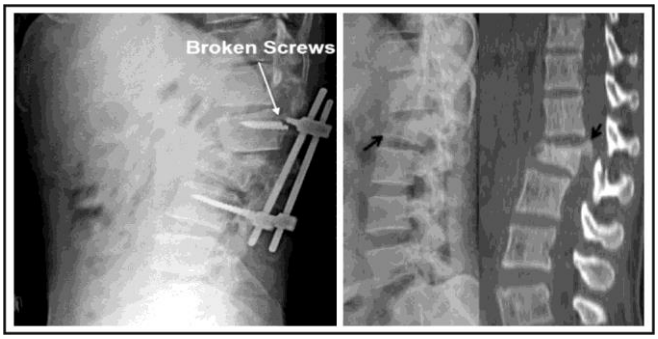

Figure 7 (left): Implant breakage.
Figure 8(right): Computed tomography (CT) scan and x-ray Lateral view of Lumbar spine showing fracture of L1(black arrows).

Data analysis

The statistical analysis was done in IBM SPSS v. 26. The quantitative variables like age and means

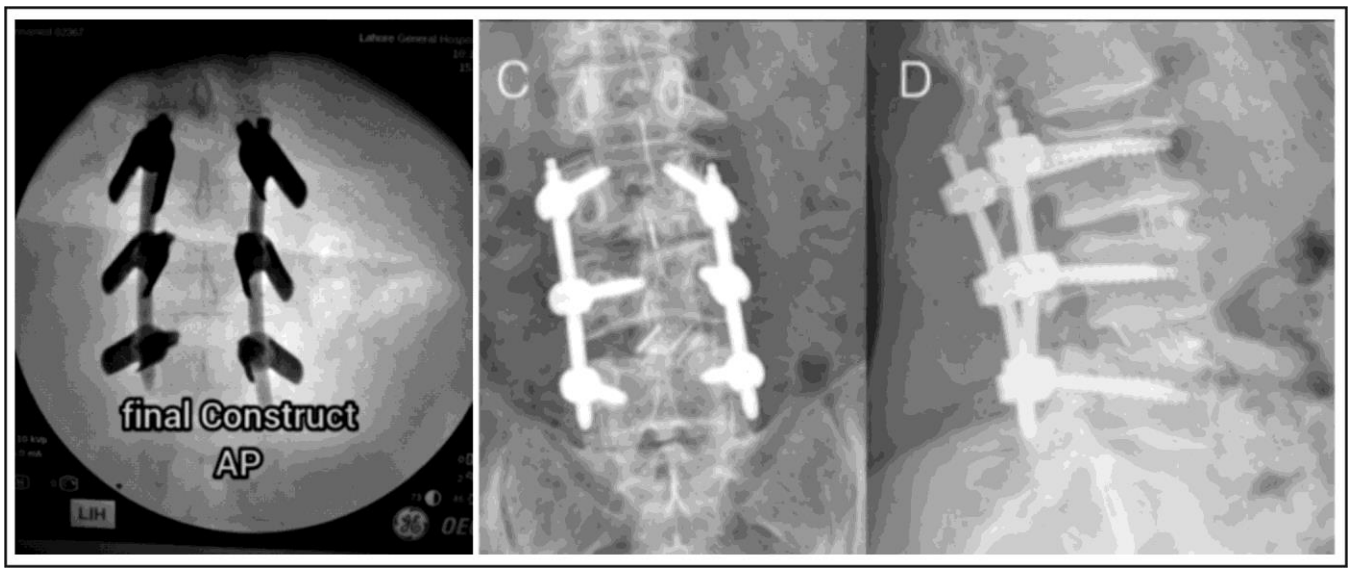

Figure 9 (left): AP view of PSFFV (6 level screws). **Figure 10 (right):** AP (C) and lateral (D) views of PSFFV (6 level screws). (Images used with patient's consent)

VAS, kyphotic angle and anterior vertebral height (AVH) were presented as mean ± SD. The qualitative variables like gender and implant failure were presented by frequency and percentage. The age VAS and anterior vertebral height (AVH) were compared between two groups using the student t-test. A p-value < 0.05 was considered statistically significant.

RESULTS

Distribution of Age

The mean ages of patients who received short segment percutaneous transpedicular fixation in group A (SSPF) and group B (PSFFV) for thoracolumbar fractures were 36.96 ± 6.64 years and 37.41 ± 6.09 years, respectively. Out of 48 patients who underwent short-segment percutaneous transpedicular fixation without the inclusion of fractured vertebrae in thoracolumbar fractures in group A, there were 25 (52.08%) patients in the age group 20 – 30 years, 18 (37.5%) patients in the age group 31 – 40 years, 2 (4.17%) patients in the age group 41 – 50 years and 3 (6.25%) patients in the age group 51 – 60 years. Out of 48 patients who underwent short

segment percutaneous trans-pedicular fixation with the inclusion of fractured vertebrae in thoracolumbar fractures in group B, there were 31 (64.58%) patients in the age group 20 – 30 years, 7 (14.58%) patients in the age group 31 – 40 years, 4 (8.33%) patients in the age group 41 – 50 years and 6 (12.5%) patients in the age group 51 – 60 years. The p-value was 0.731 (**Table 1**).

Table 1: Distribution of Patients by Age (Years).

Age (Years)	Group A (SSPF 4 Screw) (n = 48)		Group B (PSFFV 6 Screw) (n = 48)	
	No. of Patients	Percentage (%)	No. of Patients	Percentage (%)
20 – 30	25	52.08	31	64.58
31 – 40	18	37.5	7	14.58
41 – 50	2	4.17	4	8.33
51 – 60	3	6.25	6	12.5
Mean ± SD	36.96 ± 6.64 years		37.41 ± 6.09 years	
p-value from t-test	0.731 (insignificant result)			

Distribution of Gender

The male to female ratio was 1.8:1 in group A who underwent short-segment percutaneous transpedicular fixation without the inclusion of fractured vertebrae in thoracolumbar fractures and 1.4:1 in group B who underwent short segment per-cutaneous trans-pedicular fixation with the inclusion of fractured vertebrae in thoracolumbar fractures. Out of 48 patients in group A who underwent short-segment percutaneous transpedicular fixation without the inclusion of fractured vertebrae in thoracolumbar fractures, there were 17 females and 31 males. Out of 48 patients in group B who underwent short-segment percutaneous trans-pedicular fixation with the inclusion of fractured vertebrae in thoracolumbar fractures, there were 20 females and 28 males.

Comparison of Outcome Parameters (Pre-Operatively)

Preoperatively, the mean Pain (VAS) Scores were 8.78 ± 3.14 and 9.01 ± 2.04 in group A and group B, respectively. The p-value was 0.823 (statistically insignificant). The mean Kyphotic Angles were 21.76 ± 3.01 and 22.91 ± 3.97 in group A and group B, respectively. The p-value was 0.643 (statistically insignificant). The mean Anterior vertebral height (AVH) in group A was 19.11 ± 5.34 mm and in group, B was 18.72 ± 5.17mm. The p-value was 0.731 which was found statistically insignificant (**Table 2**).

Comparison of Outcome Parameters (Post-Operatively):

In the immediate postoperative period, the mean Pain (VAS) Score was 4.98 ± 1.17 in group A and 5.01 ± 1.09 in group B. The p-value was 0.738 which was statistically insignificant. The mean Kyphotic Angle in group A was 11.13 ± 2.01 and in group, B was 10.16 ± 2.11 (p-value 0. 893 which was insignificant statistically). The mean Anterior vertebral height (AVH) postoperatively was 20.01 ± 0.96 mm in group A and 22.71 ± 1.18 mm in group B. The p-value was 0.083 (statistically insignificant) (**Table 3**).

Table 2: Comparison of Group A and B for Outcome Parameters at Pre-Operative Time.

Outcome Parameters	Group A (SSPF 4 Screw)	Group B (PSFFV 6 Screw)	p-value from t-test
Pain (VAS)	8.78 ± 3.14	9.01 ± 2.04	0.823 (insignificant result)
Kyphotic Angle	21.76 ± 3.01	22.91 ± 3.97	0.643 (insignificant result)
AVH (mm)	19.11 ± 5.34	18.72 ±5.17	0.731(insignificant result)

Table 3: Comparison of Group A and B for Outcome Parameters at Post-Operative Time.

Outcome Parameters	Group A (SSPF 4 Screw)	Group B (PSFFV 6 Screw)	p-value from t-test
Pain (VAS)	4.98 ± 1.17	5.01 ± 1.09	0.738 (insignificant result)
Kyphotic Angle	11.13 ± 2.01	10.16 ± 2.11	0.893 (insignificant result)
AVH (mm)	20.01 ± 0.96	22.71 ± 1.18	0.083 (insignificant result)

Comparison of Outcome Parameters at 3 Months

At the time of 3 months follow-up, the mean Pain (VAS) Score was 2.08 ± 1.03 in group A and 2.11 ± 1.29 in group B. The p-value was 0.153 which was statistically not significant. The mean Kyphotic angle postoperatively at 3 months was 13.59 ± 1.32 in group A and 11.16 ± 1.26 in group B. The p-value was 0.177 (statistically insignificant). The mean Anterior vertebral height (AVH) postoperatively at 3 months was 20.61 ± 1.05 mm and 22.87 ± 1.75 mm in group A and group B, respectively. The p-value was 0.386 which was statistically not significant. There was no implant failure observed (**Table 4**).

Comparison of Outcome Parameters at 6 Months

The mean Pain (VAS) Scores postoperatively at 6 months were 0.47 ± 0.10 and 0.67 ± 0.21 in group A and group B, respectively. The mean Kyphotic angle postoperatively at 6 months was 14.88 ± 2.01 and 12.87 ± 1.92 in group A and group B, respectively. The mean Anterior vertebral height (AVH) postoperatively at 6 months was 20.02 ± 1.15mm and 22.67 ± 1.56mm in group A and group B, respectively. Screw pullout was noticed in 3 (6.25%) patients in group A and none in group B. Screw head Dislodgment was noticed in 1 (2.08%) patient in group A and was not reported in any case (0.0%) in group B postoperatively at 6 months. Implant breakage was noticed in 1 (2.08%) patient in group A while no implant failure was reported in any case (0.0%) in group B postoperatively at 6 months (**Table 5**). The comparisons to the implant failure could not be implemented due to zero cell values.

Table 4: Comparison of Group A and B for Outcome Parameters at 3 Months.

Outcome Parameters	Group A (SSPF 4 Screw)	Group B (PSFFV 6 Screw)	p-value from t-test
Pain (VAS)	2.08±1.03	2.11±1.29	0.153 (insignificant result)
Kyphotic Angle	13.59±1.32	11.16± 1.26	0.177 (insignificant result)
AVH (mm)	20.61±1.05	22.87±1.75	0.386 (insignificant result)

Table 5: Comparison of Group A and B for Outcome Parameters at 6 Months.

Outcome Parameters	Group A (SSPF 4 Screw) Mean Values	Group B (PSFFV 6 Screw) Mean Values
Pain (VAS)	0.47 ± 0.10	0.67 ± 0.21
Kyphotic Angle	14.88 ± 2.01	12.87 ± 1.92
AVH (mm)	20.02 ± 1.15	22.67 ± 1.56
	N(%)	**N(%)**
Implant Failure	5 (10.41%)	0
a). Screw pullout	3 (6.25%)	0
b). Screw head Dislodgment	1 (2.08%)	0
c). Implant breakage	1 (2.08%)	0

DISCUSSION

In this study, the short segment posterior percutaneous transpedicular fixation with and without the inclusion of fractured vertebrae in thoracolumbar fractures were compared. In this study, the Mean ages of patients were 36.96±6.64 and 37.41 ± 6.09 years in groups A and B, respectively. In this study, male to female ratio was 1.8:1 and 1.4:1 in groups A and B, respectively. The results of the study showed a predilection toward the male population as shown by other researchers. This can be due to the reason that male is more prone to accidents and falls. The mean age of the patients reflects that patient of age less than 50 years are prone to the trauma of thoracolumbar vertebrae. This may be due to the reason that trauma caused by road traffic accidents is very common in Pakistan. Cetin et al.[18] also reported the same age ranges and prevalence in male/female patients in their study. We found that the screw pullout, screw head dislodgement, and breakage of implants were less common in the PSFFV group compared to the SSPF group of patients.

Mean VAS preoperatively was very high, i.e., 8.78 ± 3.14 in group A and 9.01 ± 2.04 in group B. which decreased to 4.98and 5.01in both groups and almost negligible at 6-month intervals i.e., 0.47and 0.67in both groups. In a study by Farrokhi et al.[19] the mean VAS in the PSFFV group was 3.6 and in the SSPF group was 2.9, and it was statistically not significant. In another study by Sun C, et al, the mean VAS before surgery was 8.6in the PSFFV group while in the SSPF group, it was 7.7. It decreased to 1.6 + 0.80 and 1.9 in both groups, respectively. The results of our study and other studies also show no significant difference in terms of pain in both techniques. We used VAS in our study which is universally and widely accepted. However, it is a subjective outcome parameter.

The mean Kyphotic angle preoperatively was 21.76 in the SSPF group which improved to 11.13 in the immediate postoperative period. However, at 6 months follow up, it was again dropped to 14.88 So, in this group, an improvement was achieved immediately postoperatively and remained maintained near postoperative at6 months follow up with some loss. The mean kyphotic angle in the PSFFV group preoperatively was 22.91 which improved to 10.16 immediately postoperatively and then dropped to 12.87. This shows that PSFFV fixation showed an improvement in kyphotic angle postoperatively which was maintained at 6 months follow-up with some degree of loss. The results of the study showed that in both the groups, there was immediate postoperative correction was achieved, with dropped at 3 months interval, but was maintained corrected with some drop-in angle at 6 months. So, both the techniques were equally effective in the correction of the kyphotic angle. In another study by Farrokhi et al.[19,] the corrections were worsened in 29% of patients in the SSPF group and improved to 6% in the PSFFV group and this difference was statistically significant. This study also favors the results of our study. In this study, the Mean Anterior vertebral height preoperatively in group A (SSPF group) was 19.11 which was improved to 20.01 and remained static at 20.02 at 6 months follow-up. In patients who received Group B (PSFFV group), preoperatively, AVH was 18.72which improved to 22.71 maintained at 22.67. This shows that PSFFV has shown better stability in vertebral column height at 6 months of follow-up. In a comparison of both groups, Group B has shown better maintenance of vertebral height. In a study by Sun C, et al, the mean vertebral height improved from 20.5 to 25.0 in group A (SSPF group), and in Group B (PSFFV group), it improved from 21.1 to 24.9. This study favored SSPF which is in contradiction to the results of our study. However, in their study, the results were statistically not significant.

In our study, no implant failure was noticed in the PSFFV group and 5 (10.41%) implant failures were observed in the SSPF group and this

difference was statistically significant. In a study by Zhanga et al.[20] compared with the conventional method across the fracture vertebrae for thoracolumbar fracture, the patients who underwent combined pedicle screw fixation at the fracture vertebrae, had a lower rate of implant failure. The results of this study were a little different from the study by Farroki et al.[19] who showed two implant failures in the PSFFV group, while none was observed in our study. Farroki
et al.[19] documented rod displacement/ breakage as the most common reason in the SSPF group, while in this study, the common reason for implant failure was screw pullout (6.25%) in patients. Head dislodgment and implant breakage in one patient each.

Sun et al. [21]aimed to evaluate the clinical and radiologic outcomes of UPSF (unilateral pedicle screw fixation) against BPSF (bilateral pedicle screw fixation) at the fracture level utilizing SSPI in the treatment of severe TBFs. The UPSF group had a mean follow-up of 18.3 months while the BPSF group had a mean follow-up of 19.0 months. There were no significant variations in age, gender, fracture type, or location between the two groups. There were no significant variations in clinical variables such as VAS and ODI scores. However, the UPSF group appeared to outperform the BPSF group in terms of operational time, blood loss, postoperative drainage, and inpatient time. The BPSF group, in particular, had a 22 percent higher implant cost than the UPSF group. In their study, no significant problems occurred. During follow-up, all fusions healed satisfactorily, and no revision surgery was required for loss of correction or instrumentation failure.[21]

Ren et al.[22] reported that pedicle fixation of the fracture did not increase anterior or posterior vertebral height recovery, nor did it promote AWA repair. There was no significant difference in the incidence of fractured screws or loss of kyphosis angle correction (LAWAC) across groups. Broken screws may become more common as a result of LAWAC. Waqar et al.[23] evaluated clinical and radiological results of short-segment posterior fixation (SSPF) against long-segment posterior fixation (LSPF) for thoracolumbar junction (TLJ) fractures. When compared to the SSPF group, their data revealed a trend toward superior clinical and radiological results in the LSPF group. Despite the support of several types of research, these findings need to be tested in future clinical trials. There is no gold standard for the treatment of thoracolumbar rupture fractures in the current literature. As a result, the choice of therapy should be chosen on an individual basis, taking into account the nature and severity of the fracture, the patient's neurological health, and condition, as well as the surgeon's expertise. Patients in the study of Altay et al.[24] had a worse quality of life regardless of surgical treatment modality. They believe that the Magerl classification, in conjunction with the LSC (load-sharing classification), is accurate for improved fracture therapy and prognosis.

CONCLUSION

This is the first national study to compare the short segment posterior percutaneous transpedicular fixation with and without the inclusion of fractured vertebrae in thoracolumbar fractures. So, the results of this study favor PSFFV over SSPF in terms of vertebral column stability which was better achieved in PSFFV. PSFFV was also found superior with no implant failure which declares it safer and more effective than SSPF. None of the techniques was found superior in terms of pain. Radiologically, PSFFV, showed significant improvement in achieving anterior vertebral height, while there was no important distinction in kyphotic angle between the two.

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AUTHOR CONTRIBUTIONS

Sr. No.	Author's Full Name	Intellectual Contribution to Paper in Terms of
1	Syed Ahmad Faizan	Study Design, Methodology, and Paper Writing
2	Naeem-ul-Hassan	Data Calculation and Data Analysis
3	Zubair Mustafa Khan	Interpretation of Results
4	Tariq Imran	Statistical Analysis
5	Abdul Majid	Literature Review
6	Asif Bashir	Literature Review and Quality Insurer