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Comparison Clinical Outcomes of Posterior Short Segment Transpedicular Fixation with or without Injured Vertebra Fixation in Thoracolumbar Burst Fracture: A Retrospective Study

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ABSTRACT

AIM: To evaluate and compare clinical outcomes between the posterior short-segment pedicle fixation with injured vertebra fixation (PSPFI) and fixation without injured vertebra fixation (PSPF) for thoracolumbar burst fracture (TLBF).

MATERIAL and METHODS: In this retrospective study, a total of 78 patients with TLBF were included and assigned to PSPFI (n=46) and PSPF (n=32) groups. The operative time, blood loss, perioperative complications, Oswestry disability index (ODI), and visual analog pain score (VAS) were examined immediately after surgery, 1 month, 3 months, and 1 year after surgery. Moreover, the postoperative vertebral height correction rate and postoperative Cobb angle correction rate were examined immediately and 1 year after surgery, as well as the corrected vertebral height loss rate and Cobb angle correction loss rate.

RESULTS: No significant difference was identified in terms of operative time, blood loss, perioperative complications, ODI, and VAS after surgery ($p>0.05$) between the PSPFI and PSPF groups. Moreover, the postoperative vertebral height correction rate and postoperative Cobb angle correction rate showed no difference between the groups as well. However, the PSPFI group had a significantly lower loss rate in terms of corrected vertebral height loss rate and Cobb angle correction loss rate than the PSPF group 1 year after surgery ($p<0.05$).

CONCLUSION: PSPFI and PSPF achieve similar clinical outcomes. However, posterior short-segment pedicle fixation with injured vertebra significantly maintains vertebral height correction rate and Cobb angle correction rate, which serve as a better choice for the treatment of TLBF.

KEYWORDS: Thoracolumbar burst fractures, Injured vertebral fixation, Pedicle screw internal fixation, Spinal surgery, Retrospective study

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INTRODUCTION

Thoracolumbar burst fracture (TLBF) refers to a common clinical spinal fracture, and it takes up over 50% of all thoracolumbar trauma (11). The aims of TLBF treatment comprise corrected spinal deformities, restored spinal stability, and early landing activities (4,13), which minimizes the number of vertebrae involved in fusion. Surgical treatment has been frequently adopted for TLBF, including anterior plate fixation, posterior pedicle screw fixation, and anterior and posterior combined treatment methods (16).

Posterior short-segment pedicle fixation (PSPF) has been the most used for TLBF (23). However, because of its fixation across the injured vertebrae, there may be risks of failure of internal fixation, poor recovery of vertebral body height, and loss of Cobb angle after surgery. Some scholars believe that, based on the posterior short-segment internal fixation, the injured vertebrae fixation is capable of reducing the internal fixation loosening and fracture after the operation and restoring the height of the injured vertebrae (6). Likewise, relevant evidence has been obtained through biomechanical research (5). Increasing the fixation of the injured vertebral body will facilitate the reduction of the injured vertebral height during the operation, the biomechanical stability is better, and the injured vertebral height can be more significantly maintained.

Patients who performed posterior short-segment pedicle fixation in TLBF were retrospectively collected to further evaluate the clinical efficacy of short-segment pedicle screws with or without injured vertebrae fixation in the treatment of TLBF. This study aimed to compare the postoperative clinical outcomes of posterior short-segment pedicle fixation injury vertebrae placement (PSPFI) or posterior short-segment pedicle fixation without injury vertebrae placement (PSPF).

MATERIAL and METHODS

The General Information

A retrospective review was conducted for a total of seventy-eight patients of TLBF between January 2017 and December 2019 in our institution. This study gained approval from our institution's institutional review board and the ethics committee (Date: 2022-02-14, No: MR-36-22-006138). Posterior short-segment pedicular fixation with injured vertebra fixation (PSPFI, n=46) and posterior short-segment pedicular fixation without injured vertebra fixation (PSPF, n=32) were performed for all the patients.

Inclusion criteria of this study included a single-segment thoracolumbar burst fracture, no neurological defect and operative fixation. Moreover, the thoracolumbar burst fracture was confirmed through radiographs, computed tomography, and magnetic resonance imaging. The follow-up time was at least 1 year. The exclusion criteria included pathological fractures, multiple-segment thoracolumbar fractures, and having neurological defects which needed operative decompression.

Surgical Technique

All the surgeries were performed by the same senior doctor. Under general anesthesia, open, posterior approach surgery was performed for the patients. After anesthesia, patients were positioned prone and the posterior spinal approach was made one level above and below the fracture. With the use of a conventional approach, a posterior median incision was created, and pedicle screws were inserted into the vertebrae above and below the fracture level with or without pedicle fixation at the fracture level. Then, the reduction and fixation of the fracture were performed. All the patients wore a brace for 3 months.

Follow-up and Parameters Collection

All patients were reexamined for radiographs once a month for up to 1 year. The demographic characteristics of the patients were evaluated and are listed in Table I. Clinical and radiologic parameters were evaluated immediately after surgery and at 1 month, 3 months, and 1 year postoperatively. The operation time, intraoperative blood loss, perioperative complications (including superficial infection of the incision, internal fixation loosing, and deep vein thrombosis), Oswestry disability index score (ODI), and visual analog scale (VAS). The effect of low back pain on daily activities was assessed using ODI and VAS. The higher the value, the greater the effect of dysfunction and daily activities.

The correction rate of the injured vertebral height, the loss rate of the injured vertebral height correction, the correction rate of Cobb angle, and the loss rate of Cobb angle correction were examined following the X-rays of the patients before operation, immediately after the operation and at 1 year. The specific measurement is shown in Figure 1. The correction rate of the injured vertebral height = A×2/(B+C)×100%, the loss rate of the injured vertebral height correction = (correction rate of injured vertebral height immediately after the operation – correction rate of injured vertebral height at 1 year after the operation)/correction rate of injured vertebral height immediately after the operation. The correction rate of Cobb angle represents the angle between the upper (D) and lower (E) endplates of adjacent vertebrae, and the loss rate of Cobb angle correction = (correction rate of Cobb angle immediately after operation - correction rate of Cobb angle at 1 year after the operation)/ correction rate of Cobb angle immediately after the operation.

Statistical Analysis

Analysis was conducted using SPPS 22.0 statistical software. Measurement data have the expression of mean ± standard deviation. The independent-sample t-test was performed to compare the data of the two groups if normality is met; otherwise, the Chi-square test is performed. Count data has the expression of rate, and comparison between groups is performed by $\chi 2$ test or Fisher's exact probability approach. $P<0.05$ indicated a difference with statistical significance.

RESULTS

All the patients were followed up satisfactorily, and there was no neurological damage during or after the operation. No statistical difference was identified in gender, BMI, weight,

Table I: Preoperative Baseline Information of Patients and the Postoperative Parameters Between Groups

Parameters	PSPFI group (n=46)	PSPF group (n=32)	p-value
Gender	Male (n=28)	Male (n=23)	0.344
	Female (n=18)	Female (n=9)	
Age (years)	41.97 ± 12.71	42.75 ± 12.01	0.788
Weight (kg)	61.02 ± 8.23	60.31 ± 8.65	0.715
BMI	24.77 ± 1.41	25.99 ± 2.39	0.339
Diabetes mellitus	2 (4.8%)	2 (6.3%)	0.710
Osteoporosis	6 (13.0%)	2 (6.3%)	0.331
Smoker	5 (10.9%)	3 (9.4%)	0.831
Operation time (min)	63.83 ± 9.12	60.37 ± 5.70	0.428
Blood loss (ml)	277.39 ± 35.33	271.71 ± 27.19	0.447
Complications	5 (10.9%)	3 (9.4%)	
Incision infection	2	1	
internal fixation loosing	1	1	
deep vein thrombosis	2	1	

PSPFI: *Posterior short-segment pedicle fixation with injured vertebra fixation;* ***PSPF:*** *Posterior short-segment pedicle fixation without injured vertebra fixation.*

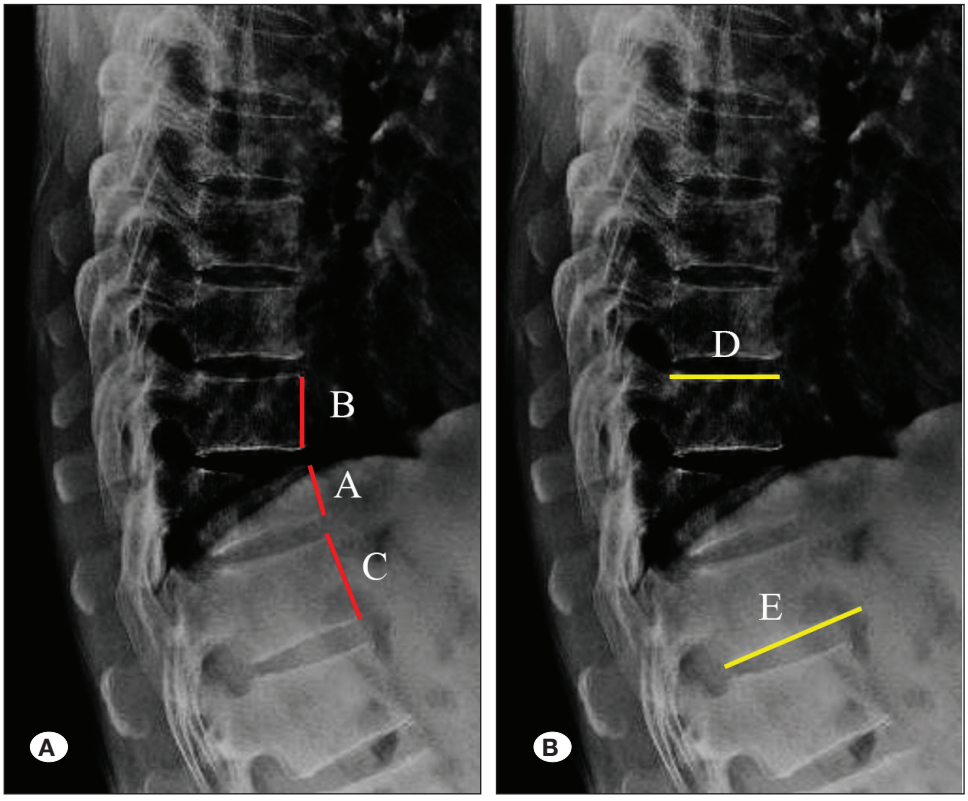

Figure 1: The measurement of the correction rate of the injured vertebral height and the loss rate of the injured vertebral height correction **(A)**, and the correction rate of Cobb angle and the loss rate of Cobb angle correction **(B)**.

age, Diabetes mellitus, Osteoporosis, smoking, perioperative complications, intraoperative blood loss, and operation time between the two groups of patients. There were 2 cases of incision necrosis and poor healing that occurred in the experimental group and 1 case in the control group. All incisions were cured after debridement, dressing change, and related antibiotic treatment. Deep venous thrombosis of lower limbs occurred in both groups of patients. There were 2 cases in the PSPFI group and 1 case in the PSPF group. No serious complications were reported after the subcutaneous injection of low-molecular-weight heparin sodium for anticoagulation. Details are listed in Table I.

The PSPFI group comprised 28 males and 18 females with the average age of 42.97 ± 12.71 years old (from 18 to 60 years old) and the average weight of 61.02 ± 8.23 kg (from 45 to 80 kg). The fractures were classified in accordance with Denis as follows: 10 cases of type A, 16 cases of type B, 16 cases of type C, and four cases of type D. Figure 2 illustrates the typical cases. There are 23 males and 9 females with the average age of 42.75 ± 12.01 years old (from 19 to 65 years old) and the average weight of 61.31±8.65 kg (from 47 to 78 kg) in the PSPF group. The fractures were classified in accordance with Denis as follows: six cases of type A, 18 cases of type B, five cases of type C, and three cases of type D. Figure 3 illustrates the typical cases.

No significant difference was identified in the postoperative correction rate of injured vertebral height and postoperative Cobb angle correction rate between short-segment pedicle screws with or without injured vertebrae fixation (Figure 4A and 4B, $p>0.05$). However, the loss rate of the injured vertebral height correction and the loss rate of Cobb angle correction decreased significantly in the fixation of injured vertebrae than those without fixation in the injured vertebrae at 1 year after the operation (Figure 4C and 4D, $p<0.05$). The above results indicated that short-segment pedicle screws with injured vertebrae fixation is better in terms of the recovery of injured vertebral height and Cobb angle in long-term outcomes than those in the short-segment pedicle screws with injured vertebrae fixation.

No significant difference was identified between the two groups in VAS and ODI scores immediately, 1 month, 3 months and 1 year after the operation ($p>0.05$) (Figure 5). The postoperative clinical outcomes of the two surgical procedures were similar, as indicated by the results.

DISCUSSION

The thoracolumbar spine is a commonly affected site for spinal fractures, among which burst thoracolumbar fractures are unstable fractures and require surgery intervention (5).

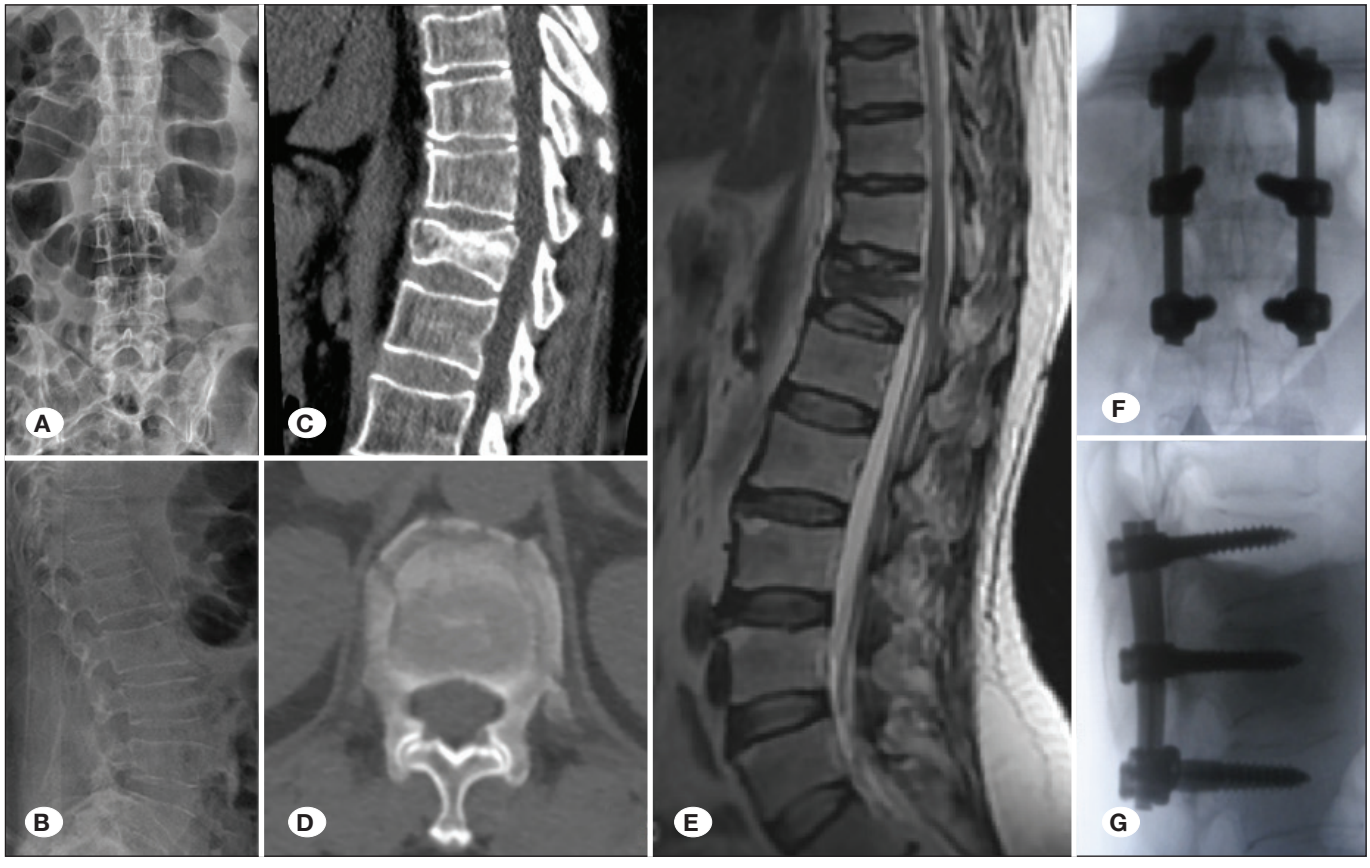

Figure 2: Male, 60 years old, T12 burst fracture caused by falling accident, and performed PSPF. **A, B)** preoperative X-rays, **C, D)** Preoperative CT examination, **E)** preoperative MRI examination, **F, G)** postoperative lateral X-ray.

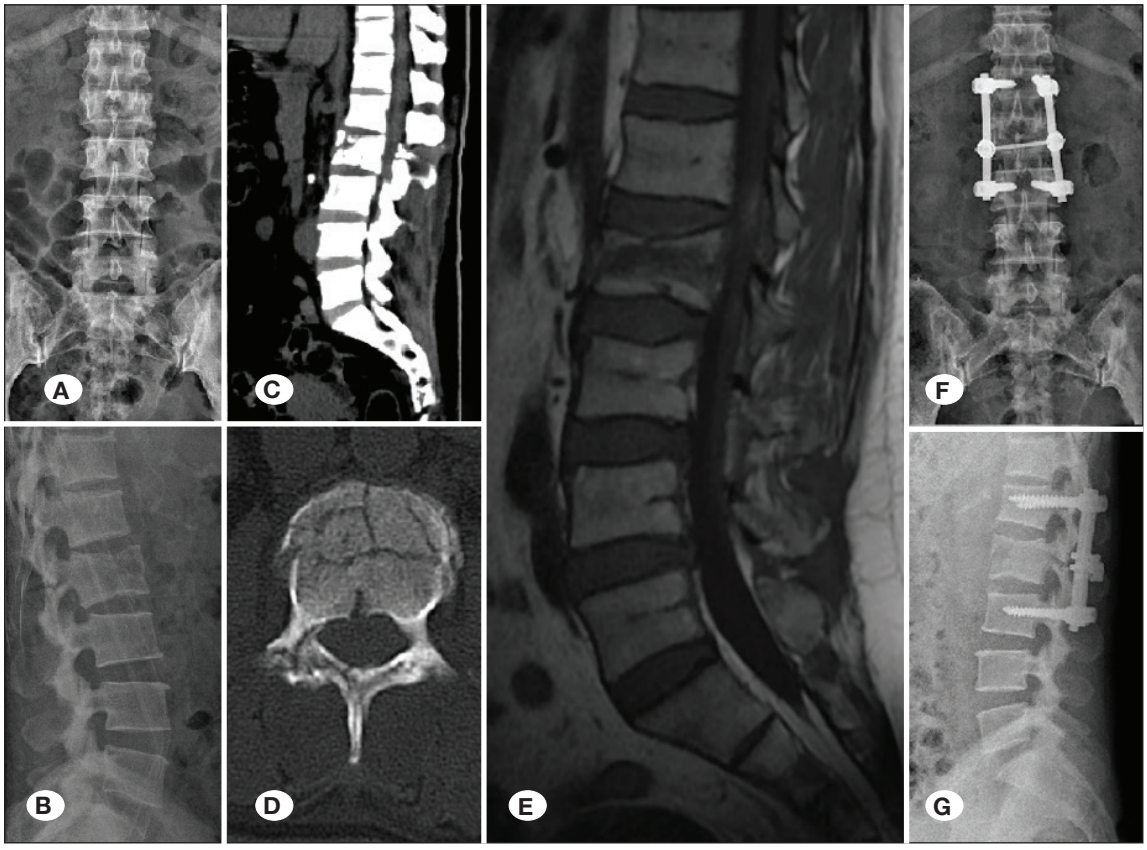

Figure 3: Female, 51 years old, L2 burst fracture caused by traffic accident, and performed PSPFI. **A, B)** preoperative X-rays, **C, D)** Preoperative CT examination, **E)** preoperative MRI examination, **F, G)** postoperative lateral X-ray.

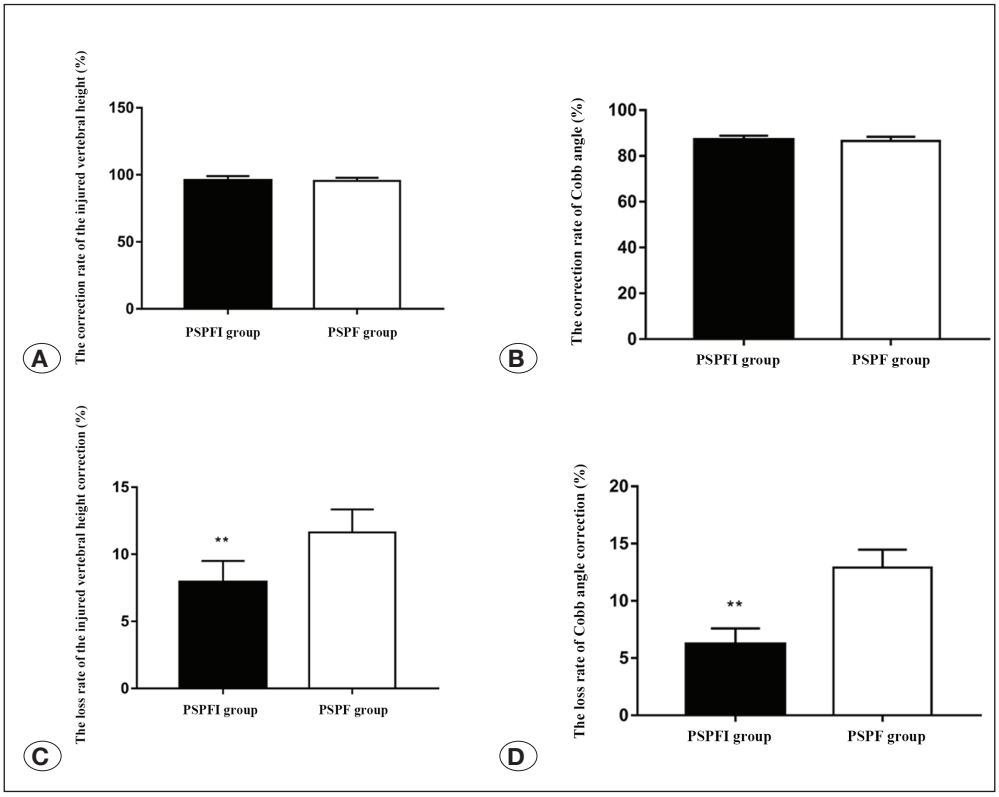

Figure 4: The injured vertebral height correction rate immediately after the operation **(A)**, and the loss rate of injury vertebral height correction at 1-year post-operation **(C)** between the PSPFI and PSPF groups. The Cobb angle correction rate immediately after the operation **(B)**, and the loss rate of Cobb angle correction at 1-year post-operation **(D)** between the PSPFI and PSPF groups. ** means $p<0.05$ between the groups.

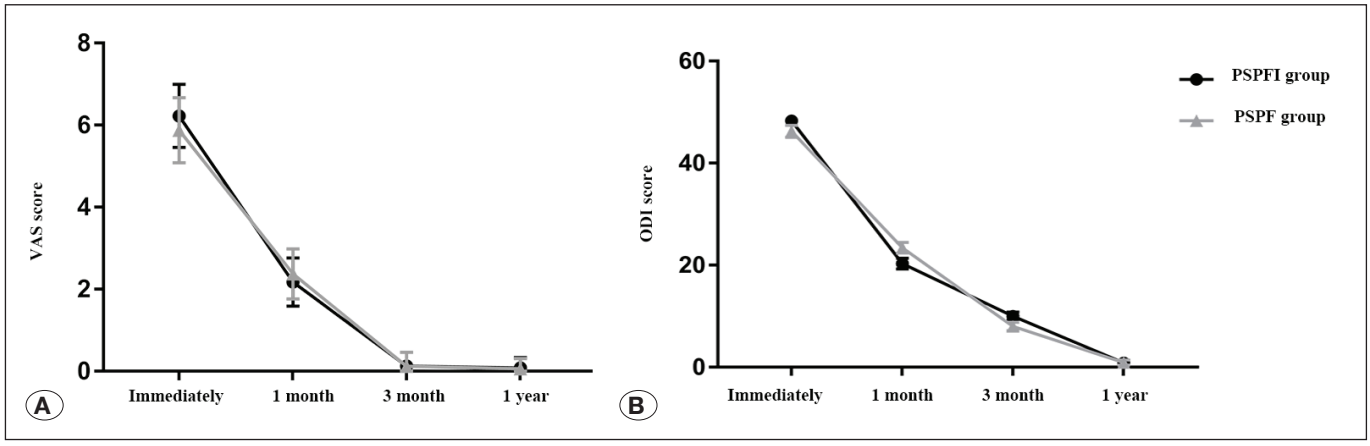

Figure 5: The VAS **(A)** and ODI **(B)** scores between the PSPFI and PSPF groups immediately, 1 month, 3 months, and 1 year after surgery.

Posterior approach short-segment fixation, with less trauma and short operation time, has been the most common therapy (29). Whether the posterior short-segment pedicle screw fixation for thoracolumbar burst fractures with the injured vertebrae placement or not remains unclear (18).

Some scholars believe that the therapy of thoracolumbar fractures with pedicle screws that have short segments (with no screw in the injured vertebrae) is prone to poor surgical reduction, recurrence of deformities, and loss of correction of the injured vertebrae (19). The stress on the vertebral body's anterior edge is increased under the effect of the residual kyphotic deformity, such that the pedicle screw is subjected to excessive stress load, causing the screw loosening and the screw failure and the connecting rod failure (19,24). In addition, some surgeons consider that the stress of the single screw of the short-segment pedicle can be dispersed, and complications such as screw loosening and fracture can be reduced by increasing the fixation of the injured vertebrae (13). However, Ren et al. found that pedicle fixation at the fracture level or not had no effect in facilitating the increase of the anterior wedge angle or the recovery of the anterior and posterior vertebral heights (21). Accordingly, this study was conducted to further evaluate the clinical efficacy and imaging results of thoracolumbar burst fracture treated by short-segment pedicle screws fixation with or without screws in injured vertebrae.

Extensive studies have noted that short-segment pedicle fixation of the injured vertebral motion segments is a standard method of stabilization in terms of thoracolumbar burst fractures, which exhibited the advantages of less intraoperative blood loss, shorter segment immobilization, shorter operative time, a smaller area of muscle dissection, and lesser complications (20). In this study, we found that the operation time, intraoperative blood loss and postoperative complications showed no significant difference between PSPFI and PSPF groups. Of note, pain and function-related outcomes are important factors to evaluate the surgical outcomes (28). This study exhibited that the visual analog pain score (VAS) and Oswestry disability index (ODI) were showed no difference at immediately, 1 month, 3 months, and 1 year after surgery between the above two surgical methods. The results indicated the same clinical outcomes between posterior short-segment pedicle fixation with the injured vertebrae placement or not for thoracolumbar burst fractures.

It has been widely found that successful kyphosis correction and implant based on short-segment fixation takes on a critical significance in successful operation (2). The pedicle screws are subjected to increasing anterior stress with the loss of kyphosis correction, thus causing screws to break and dislodge (15). Existing research found that segmental construction using short-segment pedicle screws including fractured levels is better and more reliable in the reduction for biomechanical stability (26). A progressive kyphosis in 6 months postoperatively was identified by McLain if the residual anterior column instability (14). The loss rate of anterior vertebral height correction and the loss rate of Cobb angle correction decreased remarkably in the experimental group, compared with the control group (the loss rates of experimental and control groups were 7.93 ± 1.57% and 6.22 ± 1.38% vs. 11.62 ± 1.72% and 12.91 ± 1.57%, respectively). The above results showed that the injured vertebrae fixation was better at maintaining anterior vertebral height and Cobb angle in the long-term follow-up. Numerous recent biomechanical studies have indicated that short-segment fixation combined with injured vertebral fixation is capable of significantly increasing the stability of the spine (13). Guven et al. have suggested that more satisfactory fracture reduction and correction of sagittal deformities can be obtained by adding screws to the injured vertebrae during the operation (9). Besides, it is recommended by a growing number of scholars due to the injured vertebrae fixation can better recover and maintain the height of the injured vertebral body and less loss of correction of postoperative kyphosis and failure of internal fixation occur (8,13). Moreover, increasing the fixation of the injured vertebrae is beneficial for the injured vertebrae to bear and transmit loads, such that the stability of the segments is increased, and a better environment is created for fracture healing (1).

However, the co-morbidities including, obesity, smoking, diabetes mellitus and osteoporosis, may affect the clinical results (7,12,17,27). Existing research has suggested that regional BMD directly affects pedicle screw stability, and screw loosening occurs more frequently in patients with lower BMD (25). Besides, Diabetes Mellitus is capable of affecting bone health, reducing the BMD, and causing osteoporosis (10). Moreover, smoking exhibits a longer time for the radiological union while having a high chance of delayed union and nonunion (22). In this study, the data of BMI, smoking, Diabetes Mellitus and osteoporosis of the patients were collected, and no difference was identified between the PSPFI and PSPF groups.

There are some limitations in this study. First, the included sample size is relatively small, and the average follow-up time is short. A larger sample size and a longer follow-up time were needed in further research. Second, this study was single-center clinical research, which is not very convincing. In addition, surgery performed by the same senior physician can produce bias, such that multi-center and different treating surgeons should be investigated in the future.

CONCLUSION

Posterior short-segment pedicle screws with or without screws in the injured vertebrae for thoracolumbar fractures have similar clinical outcomes. The fixation in the injured vertebrae is capable of restoring and maintaining the vertebral body height and reducing postoperative kyphosis correction. It showed a better long-term clinical effect, and it should apply to surgery of thoracolumbar fractures.

AUTHORSHIP CONTRIBUTION

Study conception and design: JZ, QL, JJ
Data collection: QL,JJ, LH, XL, AL
Analysis and interpretation of results: QL, JJ
Draft manuscript preparation: QL, JJ
Critical revision of the article: JZ, QL
All authors (QL, JJ, LH, XL, AL,JZ) reviewed the results and approved the final version of the manuscript.

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