

Comparison of the Wiltse Approach and Percutaneous Pedicle Screw Fixation for the Treatment of Neurologically Intact Thoracolumbar Fractures

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Abstract: *Purpose:* To compare the curative effect of two minimally invasive techniques for neurologically intact thoracolumbar fractures. *Methods:* 37 patients with type A fractures without neurological deficits were selected and divided into two groups. Among them, 18 patients received percutaneous pedicle screw fixation (PPSF group), and 19 patients were treated using a mini-open Wiltse approach with pedicle screw fixation (WPSF group). The clinical outcomes, surgery-related results, and radiological findings were compared between the two groups. *Results:* The length of incision, intraoperative blood loss, post-operative hospitalization time, satisfaction, visual analog score (VAS), and Cobb's angle between the two groups showed no significant differences ($P > 0.05$). However, the operation time and the number of intraoperative fluoroscopy of the WPSF group were significantly lower than those of the PPSF group ($P < 0.05$). *Conclusion:* Both minimally invasive techniques are effective for neurologically intact thoracolumbar fractures. Nevertheless, the mini-open Wiltse approach has lower radiation exposure and a shorter learning curve compared with PPSF. A larger sample, multi-center randomized controlled study is necessary to prove the clinical effectiveness of the Wiltse approach.

Keywords: Percutaneous pedicle screw; Wiltse approach; Thoracolumbar fractures

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1. Introduction

The percutaneous pedicle screw fixation is currently the main method for treating thoracolumbar fractures. Still, the traditional midline approach has many shortcomings, such as damage to the paravertebral muscles and postoperative complications. The Wiltse approach and percutaneous pedicle screws are two minimally invasive techniques for the treatment of thoracolumbar fractures. In 1968, Wiltse first used the paravertebral muscle space approach (Wiltse approach) to treat lumbar fractures^[1]. In 1977, Magerl reported the first case of percutaneous pedicle screw fixation of the thoracolumbar spine^[2]. Compared with traditional approaches, these two minimally invasive techniques have the advantages of less damage to lumbar soft tissue, less intraoperative

bleeding, and shorter postoperative recovery time ^[3]. This paper conducts a randomized controlled study from different perspectives, such as efficacy, surgery-related parameters, and imaging, to explore which techniques are more suitable for the minimally invasive treatment of thoracolumbar fractures.

2. General information and methods

2.1. General information

From February 2021 to February 2023, 37 patients with thoracolumbar vertebral compression fractures (Danis-Weber type A, AO classification type A) were selected and randomly divided into two groups. Two doctors performed the surgical treatment for the two groups. Inclusion criteria were single vertebral body compression fracture at the T10 to L2 stage (Danis-Weber type A, AO classification type A); no symptoms of spinal cord and nerve root injury; aged between 18 and 60 years old; thoracolumbar fracture occurred within 7 days. Exclusion criteria were spontaneous vertebral fractures caused by pathology or osteoporosis; other serious combined injuries, such as limb fractures, etc.; patients with previous surgery on the fractured vertebral body; patients suffering from spinal stenosis, severe osteoarthritis, etc.; basic diseases of normal life. The hospital's Medical Ethics Committee reviewed and approved this study, and all patients gave informed consent.

2.2. Methods

Patients in the WPSF (Wiltse approach with pedicle screw fixation) group underwent open reduction and pedicle screw internal fixation through a minimally invasive posterior Wiltse approach. The patient laid prone on the operating table. The position of the diseased vertebra was determined through fluoroscopy, and then it was sterilized and draped. A midline incision was made, the skin and subcutaneous tissue were incised, and the bilateral longissimus and multifidus muscles were exposed and separated along the muscle space to expose the

bilateral facet pedicle screw implantation points ^[4]. The pedicle screws were implanted, the position of the screws was confirmed by fluoroscopy, and rods were installed to restore the height of the compressed vertebral body. After it was confirmed that the height had been restored satisfactorily using fluoroscopy, the incision was rinsed repeatedly, the bleeding was carefully stopped, and the incision was closed with sutures (**Figure 1**).

Another group of patients underwent percutaneous pedicle screw internal fixation surgery (PPSF group). G-arm fluoroscopy was used to determine and mark the projection points of the diseased vertebra and the pedicle surface of the upper and lower vertebral bodies. After sterilizing and draping, a longitudinal incision of about 1 cm was made in the marked skin, a puncture needle was inserted under fluoroscopy, making sure the puncture needle was in a good position. Then, six pedicle screws were tapped and screwed in, the rod was installed, and special instruments were used to expand, reduce, and compress the vertebral body. Fluoroscopy showed that the fracture was satisfactorily reduced, and the internal fixation was in a good position. The incision was then flushed and sutured (**Figure 2**).



Figure 1. Minimally invasive Wiltse approach



Figure 2. PPSF method

2.3. Observation indicators

The operation time, incision length, intraoperative blood loss, number of intraoperative fluoroscopies, postoperative hospitalization time, postoperative Cobb angle recovery, visual analog score (VAS index for waist pain level), complications, and patient satisfaction were compared between the two groups.

2.4. Statistical analysis

Sample parameters are expressed as mean \pm standard deviation (SD). The location of diseased vertebrae, the ratio of men and women, differences in satisfaction, etc., were analyzed using the χ^2 test. The remaining parameters were analyzed statistically using the *F* test (analysis of variance) and SPSS22.0 statistical software. $P < 0.05$ indicated that there was a statistically significant difference in the data.

3. Results

The ages of the patients ranged from 23 to 60 years old. There were 22 males and 15 females, including 18 cases in the PPSF group (Figure 3) and 19 cases in the WPSF group (Figure 4). There was no statistically significant difference between the two groups in terms of age, gender, average follow-up time, pre-operative preparation time, compressed vertebral body position, vertebral body compression degree (Cobb angle), etc. ($P > 0.05$, Table 1).

Table 1. General information, Cobb angle, and vertebral body position

Group	Number of cases*	Age*	Cobb angle (preoperative)	Cobb angle (postoperative)	Vertebral body position* (t11, t12, l1, l2)
PPSF group	18	36.2 \pm 13.8	19.62 \pm 2.36	6.71 \pm 2.16	2, 6, 7, 3
WPSF group	19	38.4 \pm 15.2	20.25 \pm 3.16	4.98 \pm 2.52	3, 7, 5, 4
<i>P</i> value	-	0.21	0.22	0.26	0.362

* χ^2 test, the rest are Fisher tests (analysis of variance), parameters are expressed as mean \pm SD

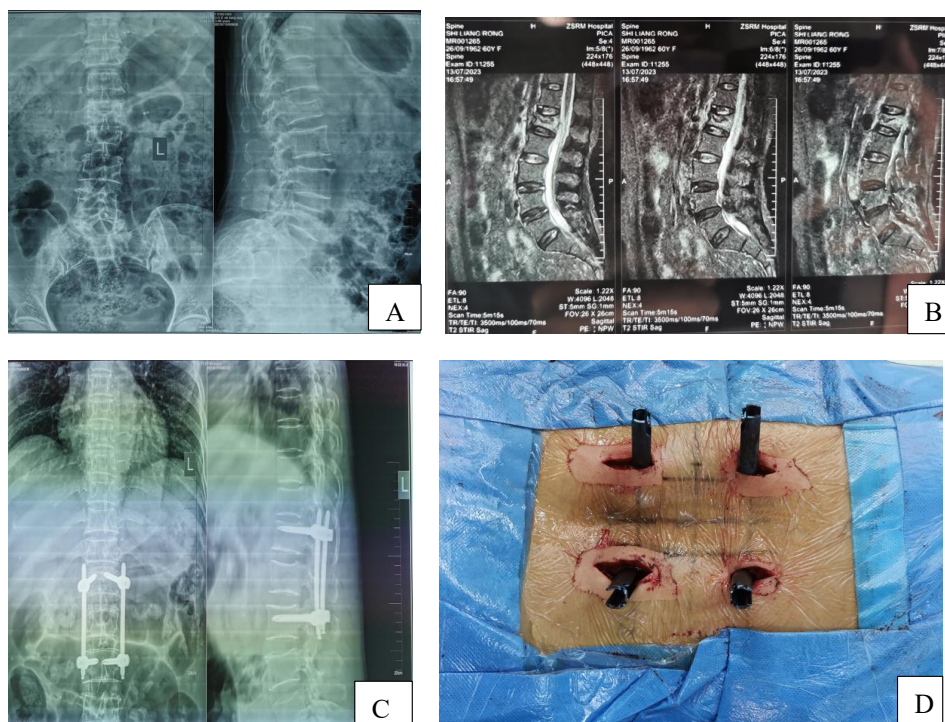


Figure 3. Percutaneous pedicle screw treatment of lumbar fractures. (A) Preoperative X-ray (B) Pre-operative MRI (C) Post-operative X-ray (D) Percutaneous pedicle screw implantation

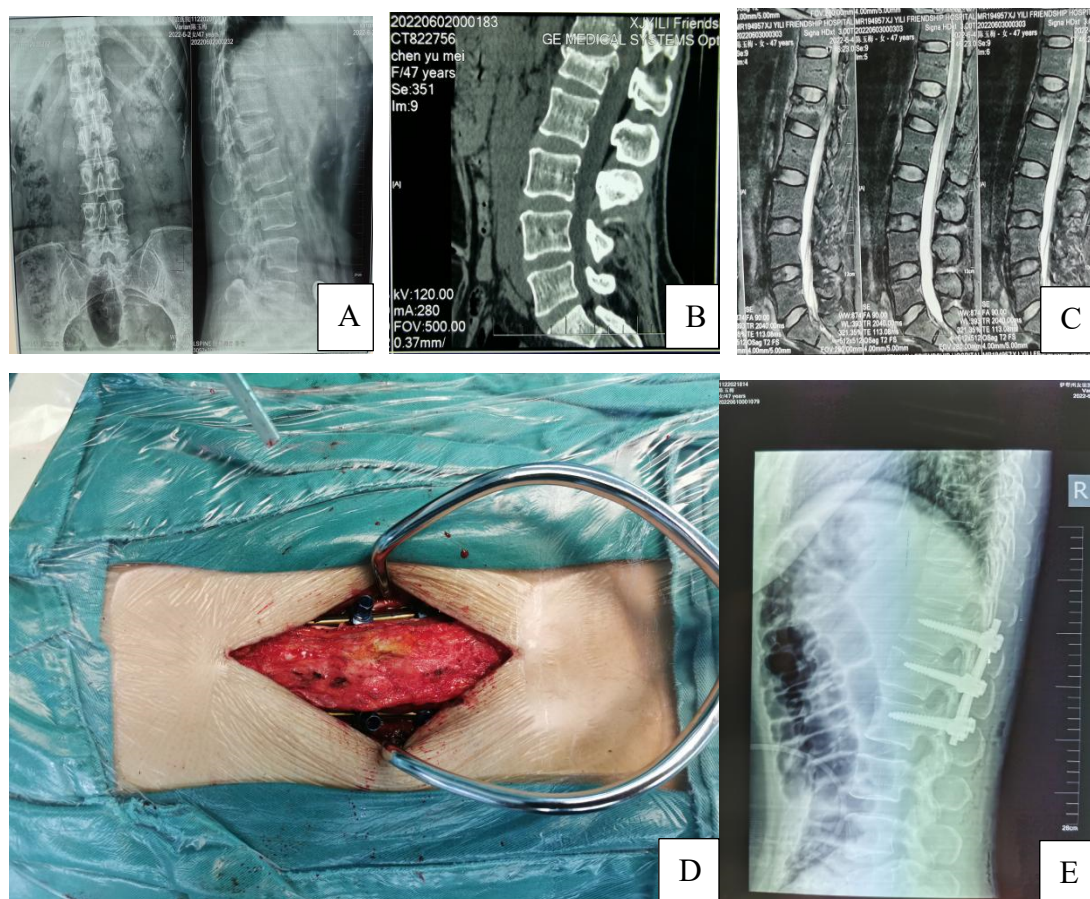


Figure 4. Minimally invasive Wiltse approach to open reduction and pedicle screw internal fixation to treat lumbar spine fractures. (A) Preoperative X-ray (B) Preoperative sagittal CT (C) Preoperative MRI (D) Implantation of pedicle screws through the Wiltse paravertebral muscle space approach (E) Postoperative X-ray

The average operation time of the WPSF group was 72.6 minutes, which was significantly shorter than the 110.4 minutes of the PPSF group ($P < 0.05$), while the number of intraoperative fluoroscopy in the PPSF group was more than that of the WPSF group ($P < 0.01$). The two groups had no significant statistical differences in the incision length, intraoperative blood loss, and postoperative compressed vertebral height recovery ($P > 0.05$, **Table 2**).

Table 2. Intraoperative indicators of the two groups

Parameter	WPSF group	PPSF group	P value
Incision length (cm)	6.0 ± 1.5	4.5 ± 0.5	0.44
Operation time (minutes)	72.6 ± 8.4	110.4 ± 10.5	$P < 0.05$
Intraoperative blood loss (ml)	40.3 ± 20.6	30.4 ± 8.2	0.34
Number of fluoroscopy (times)	3.5 ± 0.5	13.8 ± 2.2	$P < 0.01$
Cobb angle (postoperative)	4.98 ± 2.52	6.71 ± 2.16	0.25

Note: Fisher test (analysis of variance), parameters are expressed as mean ± SD

Among them, 2 cases in the WPSF group developed a subcutaneous hematoma at the postoperative incision, and all of them were cured after a puncture, drainage, and pressure bandaging. One case in the PPSF group failed to insert pedicle screws due to anatomical variation, so the screws were inserted through the

Wiltse minimally invasive approach. There was no statistical difference between the two groups regarding postoperative hospitalization time, postoperative waist pain level, and patient satisfaction at discharge ($P > 0.05$, **Table 3**).

Table 3. Postoperative hospitalization, VAS index, and satisfaction

Group	Postoperative hospitalization (days)	VAS index (preoperative)	VAS index (postoperative)	Satisfaction* (high:low)
PPSF group	5.6 ± 1.2	7.2 ± 1.8	1.5 ± 0.5	13:5
WPSF group	7.3 ± 1.9	7.8 ± 1.0	2.8 ± 0.7	14:5
<i>P</i> value	0.32	0.54	0.36	0.94

* χ^2 test, the rest are Fisher tests (analysis of variance), parameters are expressed as mean ± SD

4. Discussion

Traditional posterior surgery for thoracolumbar fractures requires stripping and cutting of the paravertebral muscle attachment points of the longissimus and multifidus muscles, resulting in postoperative lumbar muscle dysfunction and complications such as waist pain [5,6]. In 1977, Magerl first percutaneously inserted pedicle screws to fix the vertebral body temporarily and then removed them [2]. In 2004, Assaker *et al.* [7] first listed thoracolumbar fractures as indications for percutaneous pedicle screw fixation (PPSF). The results of systematic reviews [8,9] and meta-analyses [10] show that the PPSF technique has the advantages of short operation time, little damage to lumbar muscles, less intraoperative blood volume, low infection rate, and short postoperative recovery time. Still, it may lead to spinal fracture rotation, severe osteoporosis, multi-stage fractures, pedicle fractures, severe kyphosis, etc., limiting the scope of use of this technique. In addition, the PPSF technique has shortcomings such as being highly dependent on intraoperative fluoroscopy and having a long technical learning curve. Zhao *et al.* [11] conducted a retrospective study on 781 patients with thoracolumbar fractures treated with PPSF. They found that 48 cases had guidewire breakage, abdominal vascular injury, cauda equina injury, postoperative loosening of internal fixation, screw breakage, reduction failure, and delay complications of varying degrees, such as infection.

In 1968, Wiltse [1] first described the paravertebral muscle space approach, the separation approach between the longissimus muscle and the multifidus muscle, which has the advantages of less bleeding and damage to soft tissue. Since then, this approach has been widely used in posterior internal fixation of thoracolumbar fractures [12-15], scoliosis (neuromuscular) orthopedics [16,17], degenerative spinal disease [18,19], transforaminal lumbar interbody fusion (TLIF) for isthmic spondylolisthesis [20-22], paravertebral giant tumor resection [23], etc., with satisfactory results. Compared with the traditional approach, this approach has the advantages of less damage to the waist muscles, reduced intraoperative blood loss, and postoperative low back pain for a shorter period [24]. Some researchers conducted cross-sectional measurement studies of the multifidus before and after surgery [21], and some scholars also conducted postoperative MRI, histological, and electrophysiological studies on the multifidus and proved that the Wiltse approach causes significantly less damage to the lumbar muscles than the traditional approach [25]. Gagliardi *et al.* [26] found no significant difference in the accuracy of pedicle screw placement between the Wiltse approach and the traditional approach in postoperative CT scans.

The Wiltse approach and percutaneous pedicle screws are two minimally invasive techniques for the treatment of thoracolumbar fractures. There have been retrospective studies in China comparing the efficacy of these two minimally invasive techniques in treating thoracolumbar fractures [27-29]. In this study, we designed

a randomized controlled study to compare the two techniques in many aspects. We found that the operation time of the Wiltse approach was shorter than that of the PPSF group, which may be related to the need for repeated fluoroscopy during the operation to determine the screw entry point and direction in the PPSF group. The number of fluoroscopies in the PPSF group is significantly more than that in the Wiltse approach, and the increased radiation dose is negative for the health of doctors and patients. In this research, we used the G-arm to significantly reduce fluoroscopies. In one patient, it was difficult to insert percutaneous pedicle screws due to anatomical variation, so the screws were inserted through the Wiltse minimally invasive approach. There were no significant statistical differences between the two groups regarding incision length, intraoperative blood loss, Cobb angle correction, postoperative pain, hospitalization time, and satisfaction. We believe that both methods are effective for treating thoracolumbar fractures. Still, the Wiltse approach is slightly better than the PPSF technique regarding application range and safety factors. There are still people in China who cleverly combine these two techniques, that is after determining the projection point of the vertebral pedicle surface through fluoroscopy, an incision of about 1.5 cm is made, the Wiltse approach to the intermuscular space is used to reach the screw insertion point, and a guide wire is inserted to determine the direction. Afterward, pedicle screws are inserted to achieve satisfactory results, which is worthy of promotion ^[30].

5. Conclusion

The minimally invasive Wiltse approach and percutaneous pedicle screw fixation are two effective and safe techniques for the treatment of thoracolumbar fractures. Still, the Wiltse approach is superior to the PPSF technology in terms of operation time, number of fluoroscopy, and learning curve. Due to the single-center study and small sample size, this topic requires further large-sample, multi-center randomized controlled studies, meta-analysis, or systematic review to prove the clinical effectiveness of the techniques.

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Disclosure statement

The authors declare no conflict of interest.

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