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Original Article

Comparison of four-versus six-pedicle screw without fusion for thoracolumbar mono-segment compression fracture: removal implants more than 1 year

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Abstract: Study Design: A retrospective study: Background context: Few articles studied on thoracolumbar compression fracture (TCF). In this prospective study, we observed clinical and radiographic outcomes of TCF by two surgical methods more than 1 year after removing instrument. Purpose: To evaluate the clinical efficacy of 4-(SS) and 6-pedicle screw (3 fixation) in treatment of thoracolumbar compression fracture (TCF). Methods: 61 consecutive patients with TCF were included in our study. Group A including 13 males and 16 females were treated by SS (bilateral pedicle screws 1 level superior and inferior to the injured vertebrae), Group B including 16 men and 16 women underwent 3 fixation (bilateral pedicle screws 1 level superior and inferior to the injured vertebrae and the injured vertebrae). Clinical and radiographic parameters were evaluated pre-implant (T1), post-implant (T2), remove implant (T3) (1 year after implanting instrument) and final follow-up (T4). Result: As a result, measurement of anterior vertebral body height compression rate T2 and T3 showed that 3 fixation had better result (P=0.046, P=0.003). But, considering middle vertebral body height compression rate T2 and T3, SS was better (P=0.047, P=0.044). However, another data, including posterior vertebral body height compression rate, intervertebral disc signal intensity, ODI score and VAS score were the same between two groups (P>0.05). Conclusion: In conclusion, the radiographic parameters implied that 3 fixation was a effective management of thoracolumbar compression fracture in improving and maintaining anterior vertebral body height. However, regarding the middle vertebral body height, SS was better. But the efficacy of both was the same in a long term.

Keywords: Thoracolumbar vertebral compression fractures, short segment, 3 fixation including injured vertebrae, Level II

Introduction

Acute fracture of the thoracolumbar was a major cause of disability in adult. The purpose of treatment for thoracolumbar fractures were obtaining spinal canal decompression and restoring vertebral column stability [1]. Posterior short segment transpedicular fixation has been the mainstream method for thoracolumbar fractures [2, 3]. Nevertheless, which one was better, short segment fixation or 3 fixation, remains a controversial issue [1]. Each has its own advantages. SS has shorter operation time, less blood and more motion segments [4, 5], but it does not ensure adequate stability, resulting poor results in the kyphotic deformity and instrument failure [6]. 3 fixation is opposite to SS [7]. 3 fixation acquired satisfactory outcomes in correcting kyphotic deformity because of stronger holding force. Previous articles compared efficacy and clinical outcomes of SS and 3 fixation for TBF in anterior injured vertebral body height rate. Few articles studied on anterior, middle and posterior injured vertebral body height rate pre-implant (T1), post-implant (T2), remove instrument (T3) and final follow-up (T4). And this is the first study to explore adjacent intervertebral disc signal intensity of fracture The goal of the study is to compare clinical and radiographic parameters of SS and 3 fixation for TCF more than 1 year after removing instrument.

Materials and methods

Patient population

Between January 2010 and June 2013, a total of 61 patients with TCF were obtained posterior

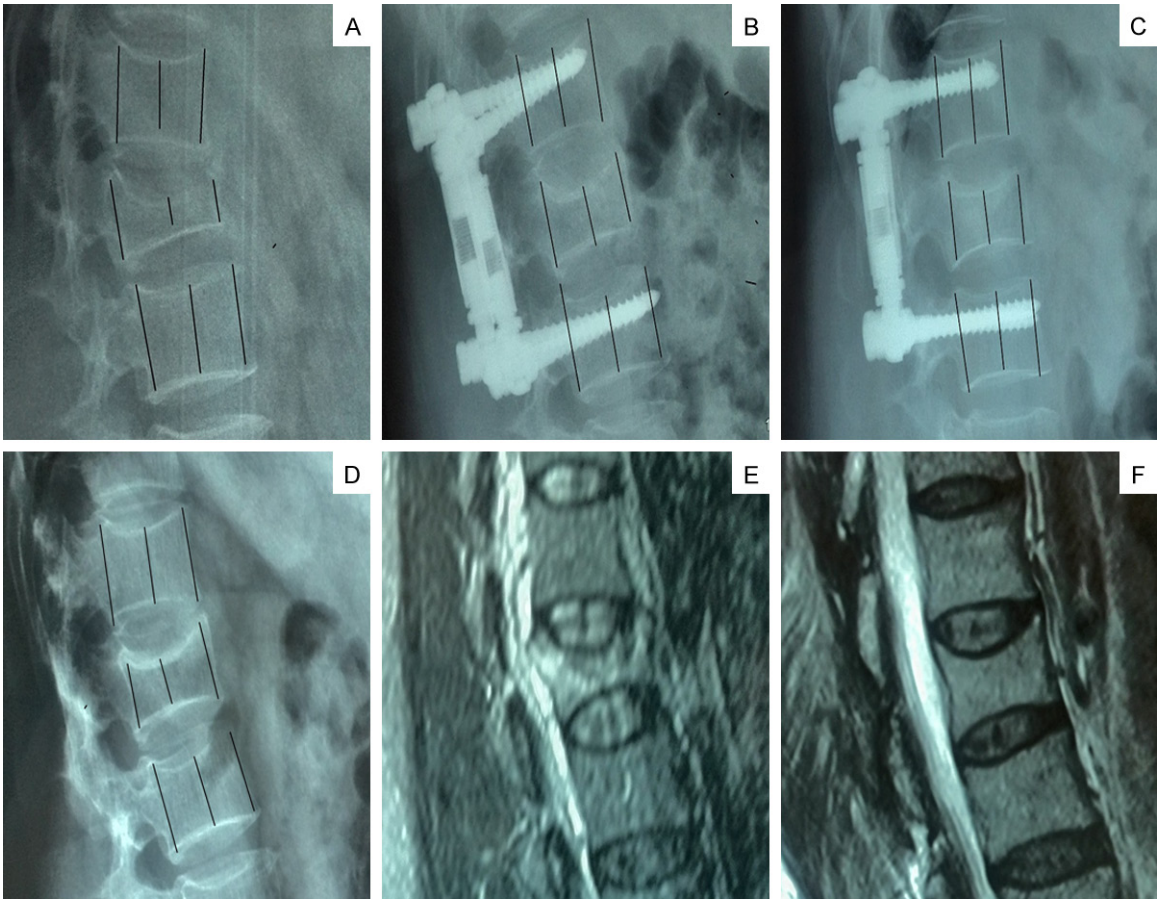

Figure 1. A. Short-segment internal fixation pre-implant. B. Short-segment internal fixation post-implant. C. Short-segment internal fixation remove implant. D. Short-segment internal fixation final follow up. E. Upper intervertebral disc signal intensity of injured vertebrae pre-implant in SS. F. Lower intervertebral disc signal intensity of injured vertebrae final follow-up in SS.

pedicle screw fixation at author's hospital. 1 year after implanting instrument, constructs were removed. 13 males and 16 females (mean 47.2 years) patients underwent posterior SS (**Figure 1A-F**), and 16 males, 16 females (mean 47.3 years) patients were treated by 3 fixation (**Figure 2A-F**).

Inclusion criteria

At last, 61 patients were included in this study. The inclusion criteria are: (1) TCF is belongs to type A0.1.2, TLICS >4; (2) only one vertebral fracture in T10-L2; (3) posterior internal fixation without fusion (4) follow-up more than 1 year after removing instrument. Exclusion criteria are: (1) non-posterior operation; (2) previous thoracolumbar fracture.

Surgical technique

Procedures were performed by 1 surgeon (WY. Ding), utilizing the same instrumentation system. Group SS: Implanting bilateral pedicle screws at 1 level superior and inferior to the injured vertebrae. Group 3 fixation: Implanting bilateral pedicle screws 1 level superior and inferior to the injured vertebrae and the injured vertebrae and the other steps were the same as Group SS.

Postoperative conventional anti-infection treatment of 1~3 days. After removing incision suture, patients can start to band fixed support within three months. Excessive bending and weight-bearing activities were avoided.

Follow up method

At T1, T2, T3, T4, patients performed lumbar lateral X ray. Then we measured anterior, middle, posterior height of injured vertebral body and adjacent upper and lower 1 each vertebrae. Observed upper and lower intervertebral disc signal intensity of injured vertebrae on MRI

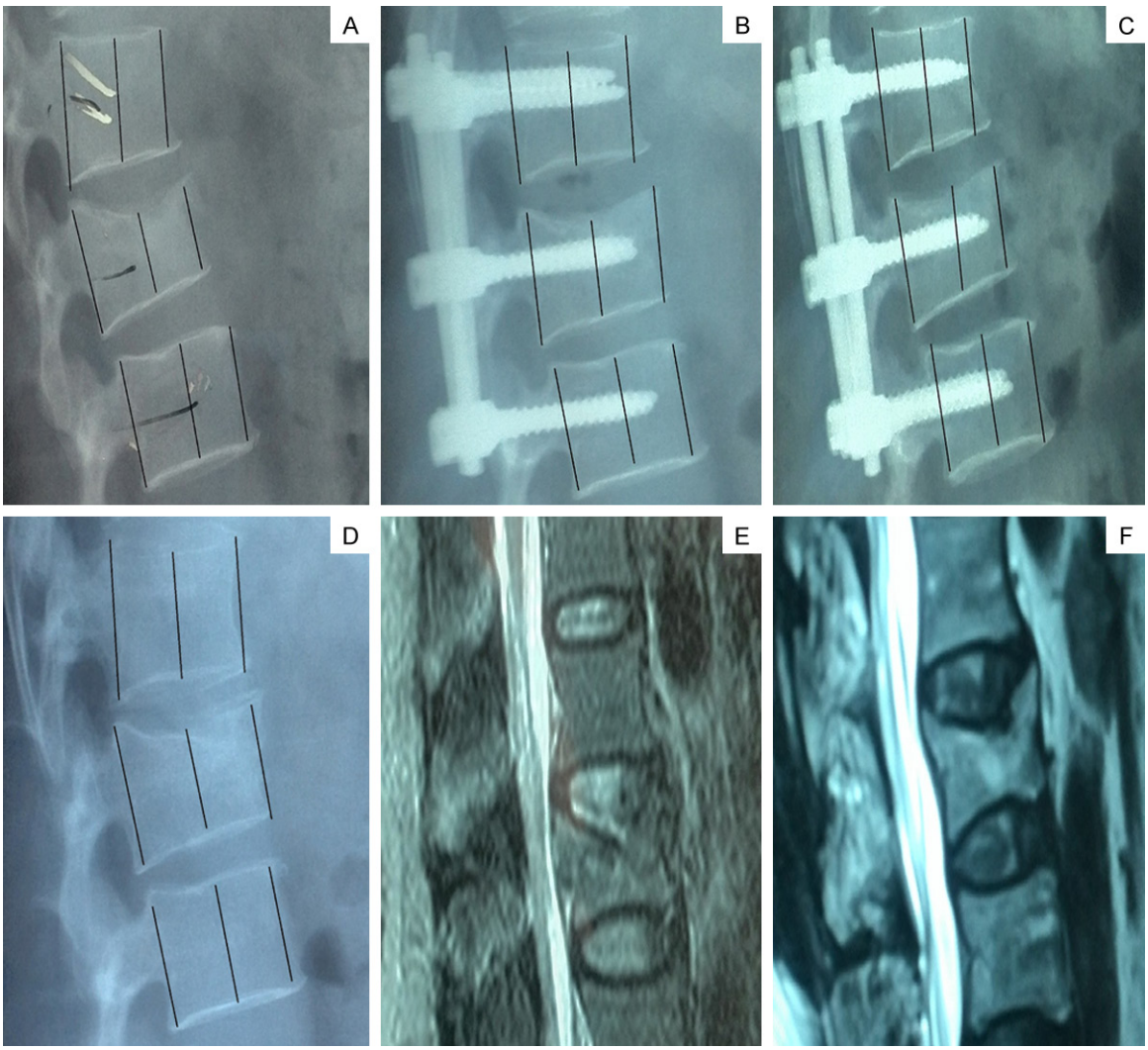

Figure 2. A. 3 internal fixation pre-implant instrument. B. 3 internal fixation post-implant instrument. C. 3 internal fixation remove implant instrument. D. 3 internal fixation final follow up. E. Upper intervertebral disc signal intensity of injured vertebrae pre-implant in 3 fixation. F. Lower intervertebral disc signal intensity of injured vertebrae at final follow-up in 3 fixation.

T1 and T4. Recorded ODI score and VAS score T1, T3, T4.

Main observation index calculation

Theoretic height of anterior (middle and posterior) injured vertebrae is A; Actual is B. Actual inferior injured vertebrae is C. Actual superior injured vertebrae is D. Anterior (middle and posterior) injured vertebral body height compression rate is E. Middle vertebral height is the length that connection midpoint of segment that anterior and posterior endpoint of superior border of vertebral and midpoint of segment that anterior and posterior endpoint of inferior border of vertebrae.

A=(B+C)/2 E=(A-D)/A

Statistical analysis

Data were presented as mean ± standard deviation (SD) for continuous variables and as percentages for incidence rates. The normality test and homogeneity test were performed on measured data (The level of significance was set at 0.10). The characteristics and clinical data were compared between the groups using the *t*-test for normally distributed continuous variables and the *Chi-square* test for categorical variables. Continuous variables with non-normal distribution were analyzed with the *Mann-Whitney U* test. For quantitative vari-

Table 1. Comparison of baseline data of patients in two groups

Group	Age	Gender (Male/Female)	Fracture site
Group A	47.2±11.4	13/16	T11:6 T12:8 L1:8 L2:7
Group B	47.3±9.5	16/16	T11:8 T12:8 L1:7 L2:9
P	0.987	0.686	0.928

Table 2. Comparison of anterior, middle and posterior vertebral body height compression rate in two groups (%)

Vertebral body height	Group	Pre-implant	Post-implant	Remove implant	Final follow up
Anterior	Group A	38.4±4.2	15.1±3.1	6.1±1.8	4.6±1.5
	Group B	40.0±4.7	13.5±2.9	4.7±1.7	4.4±1.9
	P	0.152	0.046	0.003	0.688
Middle	Group A	24.5±5.8	7.3±3.8	4.3±2.1	3.6±1.7
	Group B	24.8±5.7	9.3±3.8	5.3±1.8	3.5±1.5
	P	0.81	0.047	0.044	0.985
Posterior	Group A	9.1±3.7	5.7±2.1	5.0±1.5	4.0±1.5
	Group B	10.7±3.2	6.6±2.7	5.8±2.4	4.5±1.6
	P	0.071	0.161	0.100	0.208

Table 3. Comparison of upper and lower intervertebral disc signal intensity of injured vertebrae in two groups

Disc signal intensity	Group	Pre-implant	Final follow up
Upper	Group A	846.5	907
	Group B	1044.5	984
	P	0.361	0.897
Lower	Group A	903	921.5
	Group B	988	969.5
	P	0.944	0.719

Table 4. Comparison of ODI score and VAS score in two groups

	Pre-implant	Remove implant	Final follow up
ODI score			
Group A	0.93±0.04	0.39±0.07	0.14±0.04
Group B	0.94±0.04	0.41±0.06	0.14±0.04
P	0.526	0.423	0.63
VAS score			
Group A	9.06±0.47	3.8±0.55	1.9±0.38
Group B	9.05±0.53	3.9±0.43	2.1±0.35
P	0.987	0.49	0.105

ables, comparing outcome of SS and 3 fixation were assessed using Independent *t* test. The level of significance was set at 0.05. All statistical analyses were performed using the software of SPSS (version 21.0, SPSS Inc, Chicago, IL).

Results

Comparison of age, gender and fracture site

Average age of the Group SS was 47.2 years, Group 3 fixation was 47.3 years (t=0.16, *P*=0.987). General information of Group SS were 13 males, 16 females. In Group B, 16 males, 16 females (t=0.163, *P*=0.686). The fracture site of Group A: T11:6 T12:8 L1:8 L2:7, Group B: T11:8 T12:8 L1:7 L2:9 (t=0.456, *P*=0.928). T test indicated that there were no statistical differences regarding age, gender and fracture site distribution in two group (**Table 1**).

Comparison of anterior, middle, posterior vertebral body height

As shown in **Table 2**, the anterior height compression rate T1 and T4 were not significantly different (*P*=0.152, *P*=0.17), but T2 and T3 in 3 fixation were significantly better (*P*=0.046, *P*=0.003). Statistic indicated that the middle compression rate T1 and T4 were not significantly different (*P*=0.81, *P*=0.763), however, T2 and T3 in SS were significantly better (*P*=0.047, *P*=0.044). The posterior compression rate T1, T2, T3, T4 were the same (*P*=0.071, *P*=0.122, *P*=0.118, *P*=0.17).

Comparison of upper and lower intervertebral disc signal intensity of injured vertebral

The upper and lower intervertebral disc signal intensity of injured vertebrae T1 and T4 were not significantly different between two groups (*P*=0.361, *P*=0.897, *P*=0.944, *P*=0.719) (**Table 3**).

Comparison of ODI score and VAS score

The ODI score and VAS score T1, T3, T4 were the same between two groups (*P*=0.822, *P*=0.884, *P*=0.22, *P*=0.795) (**Table 4**).

Discussion

TCF was a common traumatic fracture [8, 9]. Thoracolumbar area, a physiologic junction

region, endures great mobility and amount of weight, making it a one of the most predilection sites of spinal fractures [10, 11]. TCF usually injured spinal cord or even caused paralysis. Nowadays, according to TLICS system, if >4 points, operative intervention might be crucial [7, 8]. The goals of surgical treatment were mainly to maintain reduction and preserve sagittal alignment, reconstruct spinal stability, lift oppression of spinal cord and nerve [12-16] pedical screw instrument is being widely used, but the appropriate surgical strategy is still controversial, especially 4-pedical screw versus 6-pedical screws. SS had shorter surgery time, less blooding loss, less operative cost, more range of motion, but some reported it may cause high rate of construct failure and sagittal deformity [17-19]. However, 3 fixation provide additional stiffness to the instrument, reducing the incidence of instrumentation failure, screw pullout and deformity [7]. Previous studies only compared SS and 3 fixation affecting the anterior injured vertebral compression rate. To my knowledge, there were no reports on comparison of two surgical methods more than 1 year after removing instrument.

We concluded that in the anterior height compression rate of injured vertebrae T2 and T3, 3 fixation were significantly better (P=0.046; P=0.004). Our results were the same as previous. Both Mahar et al [5] and Guven et al [16] studied on pedical screw at the level of the fracture for thoracolumbar fracture, they concluded that 3 fixation can maintain anterior vertebral height. Robert et al [17] focused on biomechanical of 4-versus 6-pedical screw for thoracolumbar fracture, finding that additional screws at fracture level provided 31% greater construct stiffness and better support the injury during flexion-extension loading. But the efficacy was similar more than 1 years after removing instrument (P>0.05). From my prospective, it may be relative with great regeneration of bone.

However, regarding middle height compression rate of injured vertebrae T2 and T3, SS had a effective result (P=0.047, P=0.031). There was no study on this aspect. The explanation for this result, I think, has three reasons. First, additional two pedicle screws implanting the fracture was another damage to middle column of injured vertebrae [18]. Second, implanting pedicle screw may block regeneration of bone trabeculae. Third, extra pedicle screw may affect the blood supplying injured vertebrae. As above, these may be the last middle column of injured vertebrae recovery. Nevertheless, the efficacy of two techniques were similar more than 1 years after removing instrument (P>0.05). Because bones had great ability of restoration and construction.

Two methods in improving and maintaining posterior vertebral body height was not significant difference (P>0.05). In contrast with anterior and middle vertebrae, the posterior had minor injury and little loss of vertebral body height. So, the clinical outcome of both were not much difference.

There was no report focusing on signal intensity of disc for thoracolumbar fracture. According to Pfirrmann classification [20], we observed T2-weighted MRI T1 and T4 to compare. There were no significant difference T1 and T4, signal intensity of upper and lower disc adjacent to the fracture did not rapidly decrease and no significant difference between two groups. This result implied that 6-pedicle screw, as the same as 4-pedicle screw, do not accelerate adjacent degeneration. The ODI score and VAS score T1, T3, T4 were similar between two groups (P>0.05). This implies two surgical methods got satisfactory result in easing pain for patients, and both were not significant difference in relieving pain and recovering function.

Admittedly, there are some limitations. First, comparing two kinds of operative methods simply relying on retrospective study is not enough, we still need further prospective study. Second, the sample size is small, so we need expand the sample size in further study. Third, this is a single institutional study, we need multi-center study.

Conclusion

In summary, this is the first study to explore clinical comparison of SS and 3 fixation for TCF more than 1 year after removing instrument and concentrates on MRI signal intensity of injured vertebrae. In the aspect of anterior vertebral compression rate post-implant and remove instrument, 3 fixation were significantly better than SS. But regarding middle, the result was opposite. And the efficacy of two surgical methods was not significantly different more than 1 year after removing instrument.

Disclosure of conflict of interest

None.

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