

The Effect of Posterior Pedicle Screws Biomechanical Fixation for Thoracolumbar Burst Fracture

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Abstract: The purpose of this study was to explore the clinical efficacy and safety of posterior pedicle screw fixation in the treatment of thoracolumbar burst fracture. A total of 120 patients with thoracolumbar burst fractures were selected from January 2014 to December 2016. 60 patients were divided into the study group, and 60 patients were as the control group. The patients in the study group were treated with posterior pedicle screw fixation. The control group was treated with posterior non-traumatic pedicle screw fixation. After treatment, there were six months follow up. The clinical indexes, complications, and the anterior aspect height ratio, the Cobb angle, and the numeric rating scales (NRS) score were compared between the two groups at one month, six months after the operation. Results were I incisions healed into two groups, and no infection occurred after the operation. The operation time of the study group was higher than that of the control group ($p < 0.05$), and there was no statistical difference in the amount of bleeding and the length of stay between the two groups ($p > 0.05$). At one month and six months after the operation, the anterior vertebral height of the two groups was significantly higher than before, and the Cobb angle and NRS score were substantially lower than those before surgery, the difference was statistically significant ($p < 0.05$). The height of the leading edge of the injured vertebra was higher than that of the control group at six months after the operation. However, the difference was not statistically significant ($p > 0.05$). Moreover, the angle of Cobb and the NRS score were lower than those of the control group ($p < 0.05$). The occurrence of postoperative low back pain and biomechanical fixation failure in the study group were significantly lower than those in the control group ($p < 0.05$). To conclude, through the posterior approach, the pedicle screw fixation can efficiently prevent kyphosis, correct the loss and reduce the postoperative complications. It is a useful method for the treatment of thoracolumbar burst fractures.

Keywords: Thoracolumbar burst fractures, Pedicle screw biomechanical fixation of the injured vertebra, Anterior pain of the injured vertebra.

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1 Introduction

Thoracolumbar burst fracture is a common fracture of the spine. It is also a kind of severe spinal injury, which involves the anterior and middle column, and the bio-stability of the spine is destroyed. Surgical treatment is necessary for thoracolumbar burst fracture. At present, the clinical treatment of thoracolumbar burst fracture surgery is still not unified. Therefore, the posterior vertebral pedicle screw fixation surgery is currently the most widely used, which has excellent mechanical fixation effect on the injured vertebra [Schupfner, Stoevelaar, Blattert et al. (2016)]. However, since a pedicle screw is placed in the upper and lower segments of the fractured vertebral body because the posterior pedicle screws are not broken and the short segment pedicle screws are fixed, the mechanical fixation of the injured vertebra is insufficient. Therefore, in some cases, the nail breakage and correction loss occurred in the later period, which influenced the treatment effect [Aly (2017); Aono, Tobimatsu, Ariga et al. (2016)]. The posterior pedicle screw fixation not only increases the stability of the injured vertebral segment, however, also reduces the loss of vertebral body at the end of the vertebral column [McAnany, Overley, Kim et al. (2016)]. To further investigate the clinical efficacy of posterior pedicle screw fixation in the treatment of thoracolumbar burst fractures, we selected 120 patients in our hospital for a comparative study.

2 Materials and methods

2.1 General information

From January 2014 to December 2016, 120 patients with thoracolumbar burst fracture were treated in our hospital (Wuxi Hospital Affiliated to Nanjing University of Traditional Chinese Medicine, Wuxin, Jiangsu, China).

Inclusion criteria: 1. All patients were confirmed by CT or magnetic resonance examination for thoracolumbar burst fractures; 2. The injured segment was T11-L2 segments; 3. The anterior vertebral compression height was lower than 1/2 of vertebral body; 4. Informed consent was obtained from the patients and their families.

Exclusion criteria: 1. Combined injury patients; 2. Dysfunction of the liver, kidney, heart and other organs; 3. Patients suffered from mental illness.

According to the random number table method, 120 patients were divided into the study group and the control group, 60 cases in each group. There was no significant difference between the two groups in terms of genders, ages, fracture section, Cobb angle, length of stay and Frankel spinal nerve dysfunction ($p>0.05$) (Table 1). The study was approved by the ethics committee of the hospital.

Table 1: General data comparison between the two groups

Group	n	M/F	Age (year)	Fracture segment (no.)				Cobb (°)	Frankel Grade (no.)				
				T11	T12	L1	L2		A	B	C	D	E
Study Group	60	39/21	38.4±8.8	4	14	12	2	20.1±5.2	11	9	8	2	2
Control	60	40/20	39.1±8.4	5	13	11	3	19.4±5.3	12	8	7	3	2
$\chi^2/t/Z$	-	0.068	0.534		0.142			0.375		0.674			
p	-	0.794	0.678		0.155			0.825		0.500			

2.2 Methods

2.2.1 Control group

The posterior vertebral pedicle screw fixation was used. The patient underwent surgery under general anesthesia with endotracheal intubation. The patient was supine and lying flat on the spinal surgeon's stent. The posterior median incision with the length of 10 cm was used as the center of the injured vertebral spinous process to reveal the adjacent vertebral lamina, transverse process and articular process of the wound vertebra and the upper and lower vertebrae. X-ray C arm fluoroscopy was performed to observe the fracture displacement. With the intersection of the outer side of the joint, the outer edge of the joint and the midline of the transverse process as the point of entry. Then we inserted four screws with the right length and diameter into the lower part of the injured vertebra according to the C arm fluoroscopy. Then, took the length of the connecting rod, pre-bending on the screw, in the C arm fluoroscopy we confirmed the satisfactory of the fixation reset. The patients with combined with nerve dysfunction should be admitted to hospital after conventional methylprednisolone pulse therapy. The vertebral canal exploration and decompression were performed, and the reduction achieved. No bone graft fusion found in all patients. The routine negative pressure drainage was conducted after the operation, and then the mechanical reduction and usual antibiotic treatment were performed. The internal fixation was removed after one year.

2.2.2 Study group

The study group was treated with posterior pedicle screw fixation. The method of anesthesia and the location of incision were the same as those of the control group. The X-ray C arm fluoroscopy was performed to observe the fracture displacement. The intersection of the outer edge of the articular process and the midline of the transverse process was as the entry point, and under the C arm fluoroscopy, the four screws fit into the upper and lower vertebrae of the injured vertebra. At the same time, two pedicle screws were placed at the site of the injury to enhance the biomechanical stability of injured vertebra. The other treatments were the same as the control group.

2.3 Evaluation index

The two groups of clinical indicators (operation time, intraoperative bleeding volume, hospitalization time) and postoperative complications were statistically compared and

compared. All patients were followed up for 6 months. The anterior limb height ratio (The ratio of the anterior edge height of the injured vertebra to the height of the upper and lower vertebral body adjacent to the front of the vertebral body $\times 100\%$), Cobb angle and numeric rating scales (NRS) score were compared between the two groups before operation, 1 month and 6 months after operation. The NRS score is 0-10, the higher the NRS score, the more intense of the pain. The 1-3 is mild pain, the 4-6 is moderate pain, and the 7-10 is severe pain [Azhari, Azimi, Shahzadi et al. (2016)]

2.4 Statistical analysis

SPSS 23.0 statistical software was used for statistical analysis. Sex ratio, complication rate and other enumeration data were expressed by rate (%), and χ^2 test was performed between groups. The vertebral height ratio, Cobb angle, NRS score and other measurement data were expressed as ($\bar{x} \pm s$). t test was performed between groups. Rank data were tested by rank sum test, and the standard was $\alpha = 0.05$

3 Results

3.1 Comparison of clinical indicators in two groups

In the two groups of patients after surgery, the incisions were stage I healed without infection. The operation time of the study group was higher than that of the control group ($p < 0.05$). There was no statistical difference in the amount of bleeding and the length of stay between the two groups ($p > 0.05$) (Table 2).

Table 2: Comparison of two groups of operation time, amount of intraoperative bleeding and time of hospitalization ($\bar{x} \pm s$)

Group	n	Op Time (min)	Intraoperative blood loss (ml)	Length of stay (d)
Study Group	60	112.4 \pm 9.2	143.8 \pm 15.2	27.8 \pm 7.4
Control	60	89.7 \pm 8.8	138.7 \pm 12.9	28.2 \pm 7.1
t	-	3.021	1.124	0.823
p	-	0.000	0.089	0.154

3.2 The comparison of the vertebral height ratio, Cobb angle and NRS score of the two groups before, 1 month and 6 months after operation

The anterior limb height ratio, Cobb angle and NRS score of the two groups were not statistically significant ($p > 0.05$). At 1 month and 6 months after operation, the anterior vertebral height of the two groups was significantly higher than before, and the Cobb angle and NRS score were significantly lower than those before the operation, the difference was statistically significant ($p < 0.05$). At 6 months after operation, the Cobb angle and NRS score of the study group were lower than that of the control group ($p < 0.05$), and the leading-edge height of the injured vertebra in the two groups was not statistically significant ($p > 0.05$) (Table 3).

Table 3: The comparison of vertebral height ratio, Cobb angle and NRS score of two groups before and after operation, 1 month after operation and 6 months after operation ($\bar{x} \pm s$)

Group	n	Height ratio of anterior margin (%)			Cobb (°)			NRS Score		
		Preoperatio n	1 mon postoperati on	6 mon postoperati on	Preop eratio n	1 mon postoperati on	6 mon postoperati on	Preop eratio n	1 mon postoperati on	6 mon postoperati on
Study Group	60	48.2± 12.6	93.2± 2.8*	92.7± 2.6*	20.1± 4.2	10.6± 3.3*	11.3± 2.8*	8.3± 0.6	2.3± 0.7*	2.2± 0.7*
Control Group	60	49.3± 12.8	93.4± 2.7*	91.2± 2.8*	19.4± 4.3	10.5± 3.4*	13.8± 2.5*	8.5± 0.7	2.4± 0.6*	2.8± 0.5*
<i>t</i>	-	0.125	0.183	0.576	0.176	0.145	2.687	0.109	0.187	2.704
<i>p</i>	-	0.921	0.876	0.342	0.894	0.912	0.046	0.938	0.886	0.042

Note: Compared with preoperation, * $p < 0.05$

3.3 Comparison of postoperative complications between the two groups

The occurrence of postoperative low back pain and internal biomechanical fixation failure in the study group was significantly lower than that in the control group ($p < 0.05$) (Table 4).

Table 4: Comparison of postoperative complications between the two groups [n (%)]

Group	n	Lumbago and back pain	Failure rate of internal fixation
Study Group	60	5 (9.38)	0 (0.00)
Control Group	60	20 (31.25)	8 (12.50)
χ^2	-	4.730	4.267
<i>p</i>	-	0.040	0.049

4 Discussion

Thoracolumbar burst fractures are serious spinal injuries, and most of them are severe thoracolumbar fracture dislocations, even some causing spinal cord injuries. Therefore, surgical treatment should be performed as early as possible to restore spinal physiological curvature and bio-stability and relieve nerve damages [Li, Xu, Wang et al. (2015)]. The posterior vertebral pedicle screw fixation as a clinical treatment of thoracolumbar burst fracture is currently the most widely used method. The screw is inserted into the upper and lower vertebral bodies of the injured vertebra under the perspective of the C arm, and the fixation effect is effective for the injured vertebra. Moreover, it also has advantages of small trauma and easy operation [Shim, Lee, Kim et

al. (2016)]. However, in recent years, the clinical findings have found that through the posterior vertebral pedicle screw fixation with pedicle screw, the internal fixation failure complications may occur [Axelsson and Strömqvist (2016); McDonnell, Shah, Paller et al. (2016)]. Cheng et al. [Cheng, Long, Xu et al. (2016)] has reported that only 43% of the posterior vertebral pedicle screw fixation in patients with fracture healing occurred in vertebral sagittal collapse. And Gonschorek et al. [Gonschorek, Hauck, Weiß et al. (2017)] found that the failure rate was as high as 50% at 3 years after the operation.

In recent years, scholars have found that vertebral pedicle screws can provide anatomical support for the thoracolumbar spine. In addition to the reduction of the injured vertebra, it can also stretch through anterior longitudinal ligament, psoas muscle fibers in order to play a fixed role of soft tissues, thereby maintain a long-term biomechanical stability of the injured vertebra [Tang, Long, Shi et al. (2016)]. A comparative study of 120 cases of thoracolumbar burst fractures in our hospital was carried out. Results showed that there were I incisions healed in two groups and no infection occurred after the operation. The operation time of the study group was higher than that of the control group, and there was no significant difference in the amount of bleeding and the length of stay between the two groups. The probable cause was related to the need for 2 pedicle screws in the affected vertebra, except for routine biomechanical fixation. However, this procedure did not increase the occurrence of postoperative infection. After 1 month, 6 months after the operation, the anterior vertebral height of two groups was significantly increased compared with the preoperative. The Cobb angle and NRS score was significantly lower than preoperative which confirmed two operative methods can reconstruct the spine bending and stability, and reduce the pain of injury patients. The height of the leading edge of the injured vertebra in the study group was higher than that in the control group 6 months after the operation, and the score of Cobb angle and NRS score was lower than that of the control group. It showed that the posterior pedicle screw fixation is a better method. This is mainly related to the stability of posterior pedicle screw fixation and the low rate of postoperative failure [Chen, Xu, Sheng et al. (2016); Wang, Sun, Wang et al. (2015)]. The anterior edge height of the injured vertebra in the two groups was not statistically significant, which might be related to the low number of cases and the shorter observation time.

The advantages of posterior pedicle screw fixation in this study can be summarized in the following aspects: 1. The operation of the pedicle screw fixation of the injured vertebra is more direct and more stable after the reduction. The recovery of the injured vertebra is more reliable [Deqing, Kejian, Teng et al. (2017); Spiegl, Jarvers, Heyde et al. (2017)]. 2. The injured vertebra was fixed with its adjacent vertebral body and intervertebral disc, and the floating of the injured vertebra was avoided compared with the traditional method [Gajjar, Menon, Chaudhari et al. (2016)]. 3. Through the injury of pedicle screw fixation, stress dispersion, two points fixed to three points fixed, the load of the screws and long-term complications were reduced [Sun, Guan, Liu et al. (2016)]. From the results of this study, the occurrence of postoperative low back pain and internal fixation failure in the study group was significantly lower than that in the control group. It was proved that the posterior vertebral pedicle screw fixation for thoracolumbar burst fracture has lower postoperative complications. It was believed that the purpose of the

treatment of thoracolumbar burst fractures is to restore the height of the vertebral body and the physiological curvature of the spine. It was also to relieve the compression of nerves and hormones by the fracture and to restore the physiological curvature of the spine. Therefore, it is not enough to insert only 4 screws from the upper and lower vertebrae of the injured vertebra. Since the whole stress can not be formed, it causes the formation of the vertebral space of the injured vertebra, which leads to the rise of the long-term complications [Cahueque, Cobar, Zuñiga et al. (2016); Dobran, Nasi, Brunozzi et al. (2016)]. The pedicle screw can provide anatomical support for the thoracic and lumbar vertebrae, so that the anterior vertebral body is more substantial. Therefore, the treatment effect is better

5 Conclusion

To sum up, posterior vertebral pedicle screw fixation can effectively prevent kyphosis, correct loss and reduce postoperative complications. It is an effective method for the treatment of thoracolumbar burst fractures

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