

Clinical Outcome of Internal Fixation and Fusion in the Treatment of Spinal Fractures by Paraspinal Muscular Space Approach

Yafei Zhao^{1*}, Qiushuang Ma², Meng Zhang¹, Shengwang Li¹, Yannan Li¹, Chenguang Tian¹

¹Baoding No.1 Hospital of TCM, Baoding 071000, Hebei Province, China

²Baoding No.1 Central Hospital, Baoding 071000, Hebei Province, China

*Corresponding author: Yafei Zhao, fei858884@126.com

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Abstract: *Objective:* To explore the clinical effect of internal fixation and fusion with the paraspinal muscle gap approach in the treatment of spinal fracture patients. *Methods:* 104 spinal fracture patients admitted to Central Hospital of TCM from October 2022 to April 2024 were selected as the study subjects and were randomly divided into the control group ($n = 52$) and the observation group ($n = 52$) according to the random number table method. The control group was treated with the conventional approach of internal fixation surgery, and the observation group was treated with the paraspinal muscular interspace approach of internal fixation fusion. The two groups' general data, surgical indexes, pain, lumbar spine function, and postoperative complications were observed. *Results:* The baseline data of the two groups of patients were not statistically significant (all $P > 0.05$) while the intraoperative bleeding, the first postoperative time getting up from bed, and the length of hospital stay of the patients in the observation group were shorter than that of the control group (all $P = 0.000 < 0.001$), and the duration of the operation was longer than that of the control group ($t = 2.644, P = 0.010 < 0.05$); at 3 months postoperatively, the VAS scores of the patients in the observation group were significantly lower than those in the control group ($t = 10.768, P = 0.000 < 0.001$), and the JOA score was higher than that of the control group ($t = 6.498, P = 0.000 < 0.001$); the total complication rate of patients in the observation group (3 / 5.77%) was significantly lower than that of the control group (12 / 23.08%) ($\chi^2 = 6.310, P = 0.012 < 0.05$). *Conclusion:* In the treatment of spinal fracture patients, compared with the conventional approach to internal fixation surgery, the paraspinal muscular gap approach to internal fixation and fusion treatment is less traumatic, postoperative lumbar spine function recovery is faster, and can reduce the incidence of postoperative complications.

Keywords: Paraspinal muscular interspace approach; Fixation and fusion; Spinal fracture

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1. Introduction

A spinal fracture is a common and complex injury in orthopaedics, which is often caused by severe trauma such as a fall from a height or a traffic accident. The goal of treatment is not only to restore the anatomical structure

and stability of the spine but also to prevent damage to the spinal cord and nerve roots in order to protect the patient's life safety and motor function. In recent years, with the continuous progress of medical technology, the treatment methods of spinal fractures are also being innovated and improved. Among them, the paraspinal muscular space approach of internal fixation and fusion, as a new type of surgical method, has gradually attracted the attention of clinicians and patients due to its unique surgical path and significant therapeutic effect. Compared with traditional surgical methods, the paraspinal interspace approach of internal fixation and fusion has significant advantages. It adopts a paraspinal muscular interspace approach, avoiding the stripping of important posterior muscles and soft tissues, thus reducing surgical trauma and bleeding^[1-2]. In addition, this surgical approach is able to preserve posterior stabilizing structures such as the spinous processes, supraspinous ligaments and interspinous ligaments, which further enhances the stability of the spine. These advantages make the paraspinal muscular interspace approach to internal fixation and fusion show good prospects for use in the treatment of spinal fractures^[3]. However, despite the theoretical advantages of the paraspinal muscular gap approach, the clinical effects of the paraspinal muscular gap approach in practical application still need to be further explored. Therefore, this study compares the clinical effects of conventional approach internal fixation surgery and paraspinal muscle gap approach internal fixation and fusion in the treatment of spinal fracture patients, aiming to provide a more scientific and effective treatment plan for the clinical treatment of spinal fracture.

2. Information and methods

2.1. General information

104 patients with spinal fractures admitted to the hospital from October 2022 to April 2024 were selected as the study subjects and randomly divided into the control group ($n = 52$) and observation group ($n = 52$) according to the random number table method.

Inclusion criteria: (1) patients diagnosed with spinal fracture by imaging (e.g., MRI, CT, etc.); (2) fracture type of T11-L2 single-stage vertebral body fracture without nerve injury; (3) voluntary participation in this study and signing of informed consent.

Exclusion criteria: (1) patients with coagulation disorders; (2) patients with pathological spinal fractures; (3) patients suffering from severe heart, lung, liver, kidney and other organ insufficiencies, as well as those who can't tolerate surgical anaesthesia; (4) patients with old fractures; and (5) patients who are unwilling to sign the informed consent form or can't cooperate with the relevant examinations and follow-up visits.

2.2. Methods

The control group was treated with the conventional approach of internal fixation surgery. The patients took the prone position and were given general anaesthesia. After disinfecting and spreading the towel, an incision was made in the posterior midline and incised layer by layer until the injured vertebra and its upper and lower vertebrae were completely exposed. The injured vertebra was repositioned and then fixed with pedicle screws. After repositioning and fixation, implant fusion was performed to ensure the stability and healing of the injured vertebrae. After the fixation effect was confirmed to be correct, the drainage tube was placed and the incision was closed within 24 hours after the operation when the patient had no abnormalities.

The observation group was treated with internal fixation and fusion through the paraspinal muscular interspace approach. The patients were placed in a prone position, with the chest and abdomen suspended, and general anaesthesia was performed with endotracheal intubation. Preoperatively, the injured vertebra was marked routinely and repositioned in the postural method first. A posterior median incision was made with the

injured vertebra as the center, and the incision was made layer by layer, reaching the lumbar dorsal fascia and then bluntly separating it bilaterally and the fascial layer was incised at a distance of 1.5–2 cm from the spinous process. After identifying the muscles, the multifidus and longest muscle gaps were entered and bluntly separated to reach the articular synchondrosis and transverse process. After protecting the posterior branch of the spinal nerve and accompanying blood vessels that traveled underneath the paraspinal process, the pedicle entry point was positioned at the root of the thoracic transverse process or at the top of the lumbar transverse process at the crest of the human head, and according to the e- and f-angles of the pedicle, the pedicle was advanced with an open cone and a probe and determined to be within the pedicle. The positioning pin was inserted again, and after satisfactory intraoperative fluoroscopy, two pedicle screws were implanted in the injured vertebra and the pedicles of the upper and lower vertebrae. The titanium rods were pre-bent to physiological curvature and fitted, and the normal vertebral pedicle screws were used as pivot points to continue restoring the vertebral body height by alternately bracing on both sides. Finally, after the screws were placed in a normal position, the height of the injured vertebrae and the physiological curvature of the spine was normal, and the fracture was satisfactorily repositioned, the drainage tube was routinely placed to close the incision. Two to three weeks after the operation, the patient should wear a brace to get out of bed and perform functional exercises.

2.3. Observation indicators

- (1) General information: Gender, average age, average duration of disease;
- (2) Surgical indicators: Intraoperative bleeding, first time getting up from bed after surgery, operation time, hospital stay;
- (3) Pain and lumbar spine function: Visual analogue scale (VAS) was used to determine the degree of pain of the patients, with a score of 0–10, and a higher score indicated a higher degree of pain; lumbar spine function was evaluated using the lumbar spine function score (JOA), with a score of 0–29, and a higher score indicated a more complete lumbar spine function;
- (4) Postoperative complications: Bleeding, oedema, infection.

2.4. Statistical methods

Statistical processing was analyzed with SPSS 20.0 software, and the measurement data were expressed using mean \pm standard deviation (SD), and the two-sample *t*-test and χ^2 test were used for comparison between groups, with $P < 0.05$ as the difference being statistically significant.

3. Results

3.1. Comparison of general information of patients

As shown in **Table 1**, the baseline information of the two groups of patients was not statistically significant ($P > 0.05$).

Table 1 Comparison of general information of patients in two groups

Group	Sex (male/female)	Mean age	Time from fracture to surgery (d)
Control group ($n = 52$)	36/24	45.89 \pm 9.35	2.25 \pm 0.52
Observation group ($n = 52$)	35/25	46.52 \pm 9.32	2.28 \pm 0.55
χ^2/t	0.0345	0.344	0.286
<i>P</i>	0.852	0.732	0.776

3.2. Comparison of surgical indicators

As shown in **Table 2**, intraoperative bleeding, first postoperative time getting up from bed, and hospital stay of patients in the observation group were shorter than that of the control group (all $P = 0.000 < 0.001$), and the operation time was longer than that of the control group ($t = 2.644$, $P = 0.010 < 0.05$).

Table 2 Comparison of surgical indexes between the two groups

Group	Intraoperative haemorrhage (mL)	First postoperative time getting up from bed (d)	Operative time (min)	Hospital stay (d)
Control group ($n = 52$)	156.25 ± 27.35	5.15 ± 1.35	113.72 ± 25.05	11.46 ± 2.72
Observation group ($n = 52$)	120.52 ± 22.35	3.02 ± 1.06	126.52 ± 24.31	8.13 ± 2.38
<i>t</i>	7.295	8.949	2.644	6.664
<i>P</i>	0.000	0.000	0.010	0.000

3.3. Comparison of pain and lumbar spine function

As shown in **Table 3**, 3 months after the operation, the VAS score of patients in the observation group was significantly lower than that of the control group ($t = 10.768$, $P = 0.000 < 0.001$), and the JOA score was higher than that of the control group ($t = 6.498$, $P = 0.000 < 0.001$).

Table 3 Comparison of pain and lumbar spine function between the two groups of patients

Group	VAS score		JOA score	
	Preoperative	3 months after surgery	Preoperative	3 months after surgery
Control group ($n = 52$)	6.89 ± 0.98	1.45 ± 0.36	10.05 ± 3.48	17.21 ± 3.72
Observation group ($n = 52$)	6.87 ± 0.99	0.82 ± 0.22	10.06 ± 3.52	22.06 ± 3.89
<i>t</i>	0.104	10.768	0.015	6.498
<i>P</i>	0.918	0.000	0.988	0.000

3.4. Comparison of postoperative complications

As shown in **Table 4**, the total complication rate of patients in the observation group (3/5.77%) was significantly lower than that of the control group (12/23.08%) ($\chi^2 = 6.310$, $P = 0.012 < 0.05$).

Table 4 Comparison of postoperative complications between the two groups of patients

Group	Bleeding	Infection	Oedema	Total incidence (%)
Control group ($n = 52$)	4 (7.69%)	2 (3.85%)	6 (11.54%)	12 (23.08%)
Observation group ($n = 52$)	2 (3.85%)	0	1 (1.92%)	3 (5.77%)
χ^2	-	-	-	6.310
<i>P</i>	-	-	-	0.012

4. Discussion

A spinal fracture refers to the disruption of the continuity or integrity of the spinal bone, which may involve the vertebral body, pedicle root, vertebral plate and spinous process. As the main support structure of the human body, spinal fracture not only affects the patient's daily life ability but also may cause damage to the nervous

system, which may lead to serious consequences.

For the treatment of spinal fracture patients, the conventional approach is usually used, which is a traditional surgical method of incision and internal fixation for spinal fracture patients. However, this method has certain disadvantages, such as high surgical trauma, many complications, and slow surgical recovery^[4-5], for which a new treatment modality is urgently needed. As a result, the paraspinal muscle gap approach for internal fixation and fusion began to receive attention. Paraspinal muscle gap approach internal fixation and fusion is an effective method of treating spinal fractures, which achieves accurate treatment and rapid recovery of spinal fractures through the advantages of minimally invasive surgical access, the combination of internal fixation and fusion, as well as surgical procedures. This surgical method is not only suitable for many types of spinal fractures but also can meet the treatment needs of different patients, and has important clinical application value.

In this study, the intraoperative bleeding, first time getting up from bed after surgery and hospital stay of patients in the observation group were shorter than those in the control group ($P = 0.000 < 0.001$), and the VAS scores of patients in the observation group were significantly lower than those in the control group ($t = 10.768$, $P = 0.000 < 0.001$), while the JOA scores of patients in the observation group were higher than those in the control group ($t = 6.498$, $P = 0.000 < 0.001$), indicating that in spinal fracture patients, the treatment is more precise and quicker recovery. This study indicates that in treating spinal fracture patients, the paraspinal muscle gap access internal fixation and fusion treatment is less invasive, and the postoperative lumbar spine function is recovered faster, consistent with related studies^[6-7]. The paraspinal interspace approach is less invasive because the paraspinal interspace approach enters the surgical area through a specific paraspinal interspace, avoiding direct stripping of the paraspinal muscles, which significantly reduces surgical trauma^[8]. At the same time, the paraspinal muscular gap approach does not require extensive stripping of the muscle, does not alter the muscle fibre alignment, and only requires the stripping of the lateral portion of the lesser articular eminence for fibrous connective tissue attachment. This technique significantly reduces the surgical damage to muscle and soft tissue, further reducing surgical trauma.

The fast recovery of lumbar spine function after the paraspinal muscle gap approach is because it maximally protects the paraspinal muscles and nerves during the operation, reducing the damage to these tissues during the operation. This protective effect is conducive to the recovery of postoperative muscle strength and the maintenance of nerve function, providing a strong guarantee for the rapid recovery of lumbar spine function^[9]. Additionally, this surgical approach achieves stabilization of the fracture site and promotes fracture healing through the implantation of pedicle screws and fusion operation. This combination of internal fixation and fusion contributes to the restoration of postoperative spinal stability and healing of the fracture site, which provides the basis for early rehabilitation training and return to normal life.

This study also pointed out that the overall complication rate of patients in the observation group (3/5.77%) was significantly lower than that of the control group (12/23.08%) ($\chi^2 = 6.310$, $P = 0.012 < 0.05$). It indicates that in the treatment of spinal fracture patients, the treatment of internal fixation and fusion with the paraspinal muscle gap approach can reduce the incidence of postoperative complications. This is because the paraspinal muscle gap approach avoids direct stripping of the paravertebral muscles and reduces the medical damage to them. This helps to maintain the physiological structure and function of the the paravertebral muscles and reduces the incidence of postoperative complications due to muscle injury. This is consistent with the findings of Zhang Q *et al.*^[10].

In conclusion, compared with the conventional access internal fixation surgical treatment, the paraspinal muscle gap access internal fixation fusion treatment is less traumatic, the postoperative lumbar spine function recovery is faster, and it can reduce the incidence of postoperative complications in the treatment of spinal

fracture patients.

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