

Original Article

Effects of unilateral and bilateral pedicle screw fixation on symptoms and quality of life of patients with lumbar degenerative diseases

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Received December 3, 2020; Accepted January 7, 2021; Epub May 15, 2021; Published May 30, 2021

Abstract: Objective: This research was designed to probe into the effects of unilateral and bilateral pedicle screw fixation on the VAS scores of low back pain, leg pain, ODI indexes and JOA scores in patients with lumbar degenerative diseases. Methods: Totally 113 patients with lumbar degenerative diseases admitted in our hospital from February 2016 to December 2018 were collected as the research objects. Among them, 52 received bilateral pedicle screw fixation (BPSF) and 61 were treated by unilateral pedicle screw fixation (UPSF). The intraoperative blood loss, time of operation and hospitalization, and incidence of perioperative complications of the two groups were compared. The VAS scores, ODI indexes and JOA scores were assessed before operation and 6 and 12 months after treatment. The intervertebral fusion rates were compared, and the quality of life was evaluated by SF-36. Results: The intraoperative blood loss in the observation group (OG) was higher than that in the control group (CG) ($P < 0.05$), while the time of operation and hospital stay were obviously shorter ($P < 0.05$). There was no marked difference in the incidence of perioperative complications ($P > 0.05$). Before treatment, there was no remarkable difference in the VAS scores of low back pain, leg pain, ODI indexes and JOA scores ($P > 0.05$). At 6 and 12 months after treatment, the first two parameters were remarkably lower than those before treatment, but the rest of the parameters were dramatically higher ($P < 0.05$). The VAS scores and ODI indexes of the OG were markedly lower than those of the CG, while the JOA scores, fusion rates and quality of life were obviously higher ($P < 0.05$). Conclusion: Bilateral pedicle screw fixation is valid and safe on lumbar degenerative diseases, which can improve patients' quality of life.

Keywords: Pedicle screw fixation, lumbar degenerative diseases, VAS score, ODI index, JOA score

Introduction

Lumbar vertebra, as the stress junction of upper thoracic vertebra and lower sacral vertebra, is not only the site with the most biomechanical stress, but also the earliest and most degenerative one clinically [1]. The degeneration of lumbar intervertebral disc is relevant to the age, stress and genetic factors discovered in recent years of the individuals [2]. One of the main manifestations of lumbar degenerative diseases is that the lower lumbar spine is unstable. First, the elasticity of the fiber annulus decreases, and then it breaks. After that, the tissues can herniate from the rupture, and stimulate or compress the nerve root or cauda equina of this segment by chemical means, causing low back and leg pain [3].

Clinically, lumbar degenerative disease treatment mainly includes options of non-surgical and surgical treatment. The former mainly includes bed rest, non-steroidal anti-inflammatory drugs, restorative training, physiotherapy, ultrasonic treatment, etc [4-6]. If patients do not achieve good results, they usually choose the latter. Lumbar internal fixation and fusion is the main surgical method for lower lumbar degenerative diseases complicated with instability, which aims at correcting deformity, stabilizing spine, promoting fusion and early rehabilitation [7, 8]. Fusion is the standard to judge the surgical effect of lumbar degenerative diseases. Spinal fusion has experienced different development directions, such as inter-transverse process fusion [9], posterior lamina fusion [10], posterolateral fusion [11], and

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interbody fusion [12]. It has been proved by experiments and clinical tests that interbody fusion is the most biomechanical and has satisfactory clinical effect [13]. The key to bone grafting fusion is the effective fusion of bone graft. At present, cage [14] is advocated abroad, and there are a lot of sites of interbody fusion. However, if the cage is used alone, the stability of the intervertebral segment is lower than that of the normal one. At the same time, the immediate stability of the interface of the cage is far less than the motion intensity against the lumbar spine itself, which easily leads to collapse, looseness, displacement or prolapse, thus affecting its efficacy. Therefore, it is necessary to add internal fixation in the meantime [15]. The most common internal fixation method is transpedicular screw fixation, which can provide three-dimensional three-column rigid internal fixation and good biomechanics and obviously improve the rate of interbody fusion [16].

Recently, a large number of unilateral and bilateral pedicle screws combined with interbody fusion have been reported. Both methods can fuse lumbar vertebrae with good long-term effect [17]. However, it is not unanimous on whether to choose unilateral or bilateral internal fixation, and the two methods have their own advantages and disadvantages. This study aims to explore the clinical efficacy of BPSF and UPSF on lumbar degenerative diseases.

Materials and methods

Research objects

Totally 113 patients with lumbar degenerative diseases admitted in Subei People's Hospital from February 2016 to December 2018 were collected as the research objects. Among them, 52 were included in the observation group (OG), including 34 males and 28 females, (52.6±5.8) years old on average. Another 61 were enrolled in the control group (CG), including 39 males and 22 females, (53.4±6.3) years old on average. Inclusion criteria were as follows: 1) all patients were diagnosed as degenerative diseases such as LDH, LSS or lumbar spondylolisthesis by CT and MRI, which met the diagnostic guidelines [18] for lumbar degenerative diseases; 2) typical low back pain and/or leg pain; 3) it was ineffective after conservative treatment for more than 3 months; 4) muscle strength

grade was between 3 and 4. Exclusion criteria were as follows: 1) those who could not tolerate surgery; 2) moderate and severe lumbar instability; 3) degenerative spondylolisthesis of lumbar spine with degree II or above, or true spondylolisthesis of lumbar spine (spondylolysis); 4) lumbar degenerative scoliosis (Cobb angle ≥ 20); 5) patients with high lumbar disc herniation above L2/3; 6) those complicated with spinal tumors, tuberculosis, infection and other diseases; 7) severe osteoporosis (bone density >-5). The general data of both groups had no marked difference and were comparable. All patients signed informed consent forms, and the experiment was approved by the hospital ethics committee.

Treatment methods

Both groups of patients were given continuous epidural or general anesthesia, and they were guided to keep in a prone position. We chose the posterior median approach of lumbar spine, and took the intersection point between the apex of crista lambdoidalis or the central axis of transverse process and the lateral edge of upper articular process as the surgical needle entry point, and then imbedded pedicle screws. In the unilateral group (CG), only the affected side was separated, and one screw was screwed into the upper and lower pedicle of the same side. While patients in bilateral group (OG) were separated from bilateral paraspinal muscles, and one screw was screwed into the upper and lower pedicles of both sides. Then, part of the upper articular process of the lower vertebral body, the lower articular process of the upper vertebral body and the lamina were excised, and the ligamentum flavum was removed simultaneously. The nerve root and dural sac were protected by using brain cotton slices. The intervertebral disc annulus was cut with a sharp knife to remove the degenerated intervertebral disc tissue. The upper and lower cartilage endplates were treated by scraping the end plates. The excised bone tissue was trimmed to the size of rice grains and implanted into the intervertebral space of the patient. Concurrently, it was pressed and tamped. The connecting rod and screw were connected and pressurized with a Cage fusion device with appropriate size. After the correct position of interbody fusion cage and internal fixation was found by C-arm fluoroscopy, the incision was

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Table 1. Comparison of surgical indexes between both groups of patients

	Operation time (min)	Intraoperative blood loss (mL)	Hospital stay (d)
Control group (n=61)	135.6±15.8	179.3±22.5	9.1±1.3
Observation group (n=52)	123.2±11.3	225.3±31.6	8.3±1.7
χ^2/t	4.7216	9.0053	2.8312
P	<0.0001	<0.0001	0.0055

washed, and the negative pressure drainage tube was placed to suture the incision.

Outcome measures and evaluation criteria

The intraoperative blood loss, time of operation and hospitalization, and the incidence of perioperative complications in both groups were assessed.

The VAS scores of low back pain, leg pain, ODI indexes and JOA scores were assessed before operation, 6 and 12 months after treatment. The VAS score [19] ranged from 0 to 10, and the score decreased with pain relief; the theoretical highest score of ODI score [20] is 100; the worse the back function, the higher the ODI score is; the JOA score [21] included urinary bladder function, subjective sensation, activities of daily living and objective discovery; the score ranged from 0 to 29, and it increased with the decrease of dysfunction. The rate of intervertebral fusion was analyzed, and the quality of life 6 months after treatment was evaluated with SF-36.

The CT or MRI imaging changes of lumbar vertebrae in the two groups were observed.

Statistical methods

All the data were statistically analyzed by SPSS21.0, and the measurement data were represented as mean ± standard deviation. Both groups were assessed via independent-samples T test. The counting data were expressed by examples or rates and compared by Chi-square test. P<0.05 revealed that the difference was statistically remarkable. The figures were plotted by GraphPad Prism 8.0.

Results

Comparison of surgical indicators between both groups of patients

By comparing the operation conditions of two groups of patients, we found that the time of operation and hospitalization of the OG were

shorter than those of the CG, but the intraoperative blood loss was obviously higher than that of the CG (P<0.05) (**Table 1**).

VAS scores, ODI indexes and JOA scores of patients

Before treatment, there was no marked difference in the VAS scores of low back pain, leg pain, ODI indexes and JOA scores (P>0.05). At 6 and 12 months after treatment, the first two decreased, while the rest increased. The scores and indexes of the OG were obviously lower than those of the CG, while the JOA scores were obviously higher (P<0.05) (**Table 2**).

Interbody fusion rates of patients in both groups

Comparing the postoperative fusion rate between the two groups, we discovered that the rate of the CG (81.9%) was obviously lower than that of the OG (94.2%) (**Table 3**).

Imaging changes of CT or MRI before and after operation in both groups

By comparing the CT or MRI images of the two groups before and after operation, we found that the patients in the CG were diagnosed with L4/5 protrusion of intervertebral disc before operation. The intervertebral discs of L3/4 and L5/S1 were slightly protruded. There were degenerative changes of lumbar vertebrae. The T12 vertebrae became flattened (**Figure 1A**). After operation, there were metal fixators in lumbar 4 and 5 vertebrae, implants in lumbar 4 and 5 intervertebral spaces, hyperosteoecy in lumbar vertebrae, and slightly straight physiological curvature; the relationship between vertebrae and appendages was normal, and size and shape of intervertebral foramen were normal; there was no obvious stenosis in intervertebral space, no obvious abnormality in paraspinal soft tissue, and wedge-shaped changes in thoracic 12 vertebrae (**Figure 1B**).

In the OG, intervertebral disc herniation was found in L4/5, and slight protrusion of intervertebral disc in L3/4 and L5/S1. There were lumbar degenerative changes (**Figure 1C**). After operation, metal fixators were seen on both sides of lumbar 4 and 5 vertebrae, and implants were seen in lumbar 4 and 5 intervertebral spaces; the corresponding relationship

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Table 2. VAS score, ODI index and JOA score of patients in both groups

	VAS scores of low back pain			VAS scores of leg pain		
	Before operation	Six months after operation	Twelve months after operation	Before operation	Six months after operation	Twelve months after operation
Control group (n=61)	5.25±2.36	1.73±0.52	0.82±0.21	5.03±2.13	1.52±0.46	0.72±0.20
Observation group (n=52)	5.37±2.61	1.54±0.41	0.64±0.19	5.11±2.21	1.33±0.29	0.57±0.15
χ ² /t	0.2566	2.1298	4.7433	0.1956	2.5734	4.4455
P	0.7980	0.0354	<0.0001	0.8453	0.0114	<0.0001
	ODI/%			JOA score		
	Before operation	Six months after operation	Twelve months after operation	Before operation	Six months after operation	Twelve months after operation
Control group (n=61)	53.24±5.03	28.36±2.15	15.36±1.81	8.21±2.63	19.36±4.25	23.25±5.06
Observation group (n=52)	54.18±5.10	25.64±2.23	11.26±1.36	8.86±2.92	21.36±4.03	25.69±5.37
χ ² /t	0.9838	6.5891	13.4185	1.2446	2.6329	2.4838
P	0.3274	<0.0001	<0.0001	0.2159	0.0097	0.0145

Table 3. Interbody fusion rate of both groups

	Fusion	Possible	Impossible	Fusion rate
Control group (n=61)	38 (62.3)	12 (19.6)	11 (8.1)	50 (81.9)
Observation group (n=52)	43 (82.7)	6 (11.5)	3 (5.8)	49 (94.2)
χ ² /t				3.8891
P				0.0486

between each vertebral body and their appendages was normal, the size and shape of intervertebral foramen was normal, and there was no obvious stenosis in intervertebral space; meanwhile, there was no obvious abnormality in paraspinal soft tissue (**Figure 1D**).

Quality of life of patients in both groups

We scored the eight dimensions of SF-36 health questionnaire six months after operation, and found that the scores of patients in the OG were higher than those in the CG, and the difference was statistically obvious (P<0.05), indicating that the quality of life in the former was dramatically improved compared with that in the CG six months after operation (**Figure 2**).

Incidence of complications of patients in both groups

There was no marked difference in the total incidence of complications between the CG (16.4%) and the OG (9.5%) (**Table 4**).

Discussion

The morbidity of lumbar degenerative diseases is increasing year by year [22]. Lumbar fusion

and internal fixation is a classic surgical scheme for the disease. Pedicle screw and interbody fusion is recognized as an effective method to treat lumbar instability. With the development of minimally invasive techniques in spinal surgery, Kabins *et al.* [23] first

proposed in 1992 that there was little difference in clinical efficacy and imaging parameters between UPSF and BPSF on lumbar degenerative diseases. Since then, it has been controversial. The clinical application of UPSF and BPSF interbody fusion was studied, and the differences between the two fixation methods were compared to provide reference for clinicians to choose reasonable fixation methods.

In this study, the intraoperative blood loss in the OG was higher than that in the CG, while the time of operation and hospitalization were remarkably shorter. There was no marked difference in the incidence of perioperative complications, indicating that the operation methods were safe. Before treatment, the VAS scores, ODI indexes and JOA scores were not significantly different. At 6 and 12 months after treatment, the first two were markedly lower than those before treatment, while the rest were obviously higher. The first two of the OG were remarkably lower than those of the CG, and the rest were dramatically higher. It indicated that bilateral pedicle screw internal fixation could produce good therapeutic effect, effectively reduce the pain symptoms of patients, promote the recovery of dysfunction,

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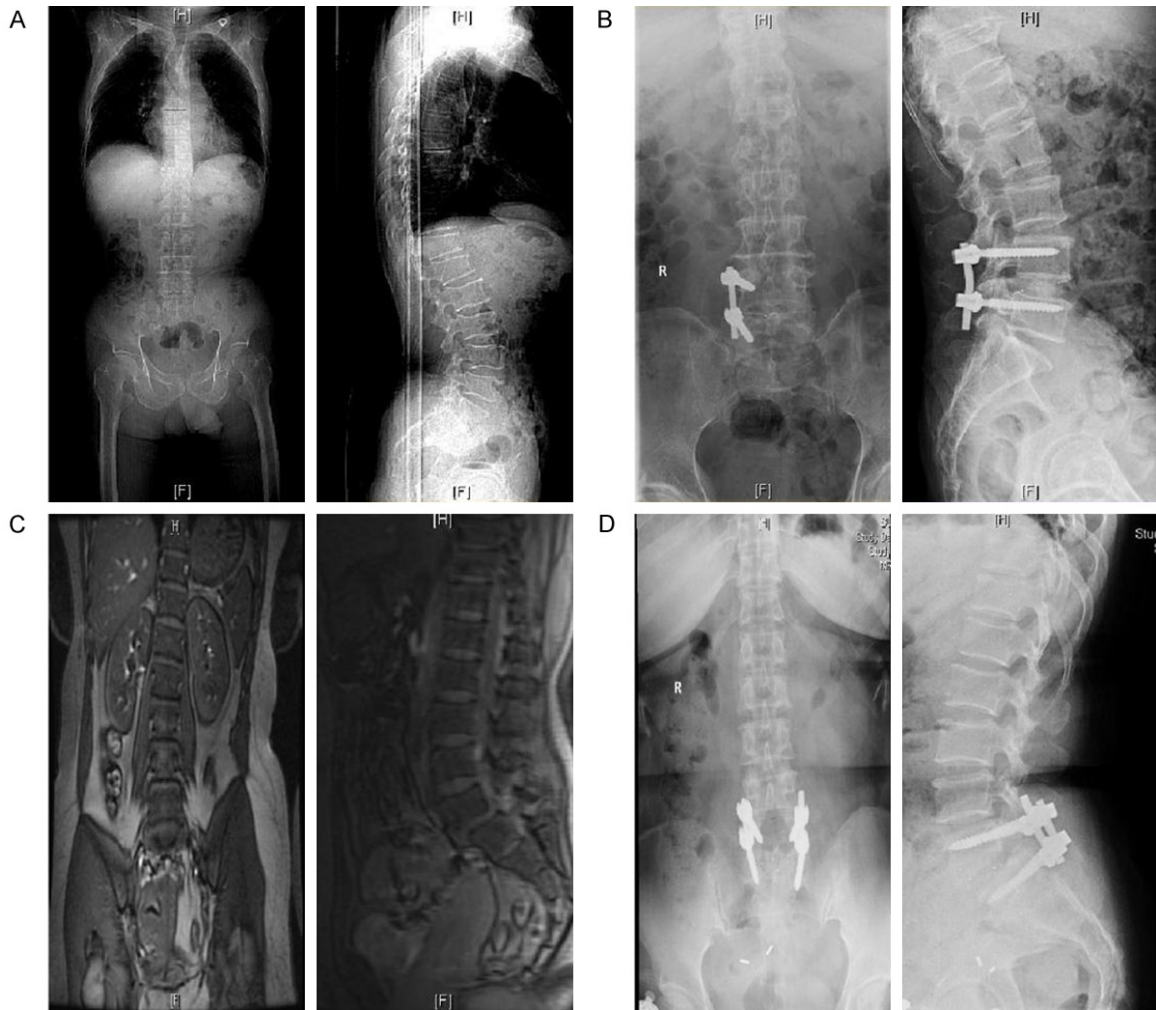


Figure 1. Imaging changes of CT or MRI before and after operation in both groups. A: Frontal and lateral images of lumbar vertebrae before operation in CG; B: Frontal and lateral images of lumbar vertebrae after operation in CG; C: Images of frontal and lateral lumbar vertebrae in OG before operation; D: Images of frontal and lateral lumbar vertebrae in OG after operation.

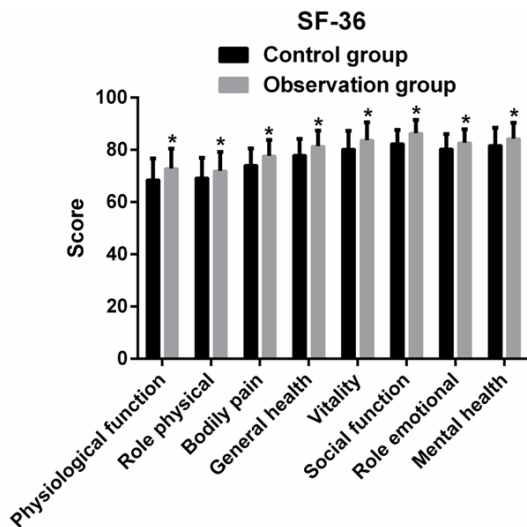


Figure 2. Comparison of quality of life between both groups of patients. (*indicates compared with the CG, $P < 0.05$).

and the operation situation is similar. The fusion rate and quality of life in the OG were obviously higher than those in the CG.

Unilateral fixation on lumbar degenerative diseases was first reported by Kabins [23], and was gradually accepted by researchers because of its satisfactory therapeutic effect. Some scholars [24] think that bilateral fixation is more stable than unilateral fixation in resisting axial rotation and lateral flexion, and the latter is less stable in preventing fusion cage from withdraw-

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Table 4. Incidence of complications of patients in both groups

	Loose or broken pedicle screws	Pseudarthrosis	Cerebrospinal fluid leakage	Infection	Total incidence rate (%)
Control group (n=61)	2 (3.3)	3 (4.9)	2 (3.3)	3 (4.9)	10 (16.4)
Observation group (n=52)	1 (1.9)	1 (1.9)	1 (1.9)	2 (3.8)	5 (9.5)
χ^2/t					1.1201
P					0.2899

ing. Kim *et al.* [25] found that the stability of unilateral fixation was related to the way of decompression. Unilateral decompression could not only provide good mechanical stability for fusion segment, but also reduce the stress concentration of adjacent segment, while bilateral decompression could not provide effective mechanical stability for fusion segment. However, at present, the indications of unilateral pedicle screw fixation are relatively narrow, which is mainly used for patients with symptoms of unilateral lower limbs, no isthmus and mild degeneration. Unilateral fixation is not suitable for patients with symptoms on both sides or multi-level (more than 2). Because of the incomplete anatomical structure of the non-operative side, patients with true spondylolisthesis are not able to get enough mechanical stability by unilateral fixation, and thus are not fixable with unilateral pedicle screws [26]. Hence, from this point of view, BPSF is a better choice. What's more, no matter which method is adopted, choosing a suitable type of fusion device requires that the intervertebral space can be opened, the length can contact with the periphery of the endplate more, and a stable fusion interface that is more conducive to osteogenesis can be provided [27]. The fusion cage needs a large contact area, which not only increases the area of the bone graft bed, but also reduces the load per unit area of the fixed interface, so as to improve the fusion rate of bone graft [28]. Excessive damage to the cartilage endplate will cause the Cage to sink, and improper treatment will bring about the decrease of fusion rate and the formation of pseudarthrosis [29]. During the operation, the soft tissue peeling and the damage to the facet joints should be reduced as much as possible, so as to avoid excessive decompression and keep the stable structure of the posterior spine.

To sum up, UPSF and BPSF interbody fusion can achieve satisfactory efficacy and safety on lumbar degenerative diseases, but the latter is

better for postoperative pain and quality of life. There are also some shortcomings in this study. For example, the number of samples is small and the follow-up time is short; besides, whether there will be adjacent segment degeneration and secondary scoliosis in the long run still needs further follow-up observation.

Acknowledgements

This research is financially supported by National Natural Science Foundation of China (82072423).

Disclosure of conflict of interest

None.

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