# **Research Article**

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# Use of unilateral screw-stick and cage bone graft fusion for the treatment of lumbar disc herniation

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## **ABSTRACT**

**Background:** The clinical application of unilateral pedicle screw internal fixation to the treatment of lumbar disc herniation is rarely reported. The aim of our study was to discuss the feasibility and clinical effects of using unilateral pedicle screw-stick and single polyether ether ketone (PEEK) Cage combined with unilateral pedicle internal fixation for lumbar disc herniation.

**Methods:** Retrospective analysis was made on the clinical data of 353 patients with unilateral monosegmental lumbar disc herniation from January 2007 to February 2013. Unilateral pedicle screw-stick and single PEEK Cage were used for the study group, and bilateral pedicle screw-stick and single PEEK Cage for the control group. Criteria such as Oswestry Disability Index (ODI), Visual Analog Scale (VAS) for pain and Macnab were used to effects of surgery.

**Results:** Compared with those in the control group, the patients in the study group had considerably smaller size of incision, shorter duration of operation, lower intraoperative blood loss, lower postoperative drainage and shorter length of stay and much less money spent on hospitalization (P < 0.05). There was no significant difference between two groups in preoperative and postoperative intervertebral heights, fusion time and fusion rate (P > 0.05). In the postoperative follow-up evaluations of ODI, VAS and postoperative curative effects of lumbar surgery, excellent and good rates of the study group were higher than those of the contract group (P < 0.05).

**Conclusions:** Compared with bilateral pedicle screw-stick and single PEEK Cage, unilateral pedicle screw-stick and single PEEK cage are a reliable choice for the treatment of monosegmental lumbar disc herniation.

Keywords: Lumbar disc herniation, Interbody fusion, Unilateral implantation, Pedicle screw rod, Curative effect

### INTRODUCTION

Lumbar disc herniation is an important cause of chronic low back pain and sciatica. Most patients can be relieved from symptoms through conservative treatment, but still 15%-20% of patients have to receive surgical treatment. Previous traditional surgery is simple removal of nucleus pulposus, but the study of Eie et al. shows high recurrence rate of lumbago and herniation after such surgery, therefore, fusion internal fixation of interbody fusion cage combined with bilateral pedicle internal

fixation system is often used for treatment at present, so that three-dimensional fixation can be achieved at fused lumbar spine segment to improve postoperative fusion rate. However, some researchers found, in long-term follow-ups for the patients with bilateral internal fixation, that the greater the strength of internal fixation is, the greater stress-shielding effect becomes, which will cause bone mass loss of fused vertebral body. Besides, for the bilateral fixation, bilateral posterior muscles and soft tissues are separated to a large extent, and the rigidity of fused segment is excessive, which aggravate adjacent

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segmental degeneration.<sup>6,7</sup> Furthermore, bilateral fixation will cause great surgical trauma, large amount of intraoperative bleeding and high cost.<sup>8</sup> In 1992, Kabins<sup>9</sup> et al. proposed and reported the clinical application of unilateral pedicle screw internal fixation to the treatment of lumbar disc herniation.

## **METHODS**

#### Case data

353 cases treated by the same surgeon during January 2007 and February 2013 were selected. Unilateral pedicle screw-stick and single interbody fusion cage were used for the treatment of the study group, and bilateral pedicle screw-stick and single interbody fusion cage for that of the control group. Both the study group (n=78) and the control group (n=275) followed the same criteria for inclusion and exclusion. See Table 1 for the herniated segment.

Table 1: Two groups of the herniated segment.

Group	L3/4	L4/5	L5S1	Total
Research group	6	49	23	78
Control group	8	163	104	275

Criteria for inclusion (1) Age >35; (2) Monosegmental lumbar disc herniation, not improved after regular conservative treatment for more than half a year; (3) Lumbar spine CT showed herniated disc, which was consistent with symptoms, MRI showed lumbar spine degeneration and herniated disc (4) Follow-up for more than 12 months. Criteria for exclusion: (1) Multisegmental lumbar disc herniation accompanied by lumbar spinal stenosis; (2) Lumbar spondylolisthesis; (3) Patient with severe osteoporosis or severe obesity; (4) History of metabolic or mental disease.

# Equipment and materials

All the surgeries for this study adopt the screw-stick system of Waston Medical Appliance Co., Ltd and the polyether ether ketone (PEEK) Cage of Medtronic, Inc.

#### Surgical procedures

Study group: With the patient in the prone position under endotracheal general anesthesia, an incision was made in the center of the lower back. The sacrospinous muscle was separated from one spinous process, exposing the vertebral plate and the zygapophyseal joint. A pedicle screw was implanted respectively in the adjacent upper and lower segments of intervertebral space lesion. Unilateral (the herniated side as shown in CT and MRI) limited interlaminar fenestration for decompressing was performed. One third of the superior and inferior articular processes, hypertrophic ligamentum flavum and hyperplastic fibrous scar tissue were removed. The dural sac was carefully separated and the nerve root was

released, and both of which were pulled to the opposite side. The intervertebral disc tissue was removed and the end plates of the upper and lower vertebral bodies up to the subendplate bone were scraped. A vertical stick was installed and the distraction and fixation of the intervertebral space were made. A test mold was used to test the intervertebral height and a PEEK Cage with proper height was selected, which were filled with granular bones for standby. The remaining granular bones were impacted to the opposite and front sides to the greatest extent through intervertebral impaction bone grafting, and then the fusion cage was implanted in the intervertebral disc space (0.3~0.5 cm from the vertebral plate). The fixation stick was loosened and compressed gently to ensure bone grafting surface and PEEK Cage were in close contact with the end plate of the vertebral body. The nut was tightened. A lot of normal saline was used for washing. The bone debris was cleared away. The wide end of nerve dissector was bent into L shape to probe whether there were granular bones pushed to the opposite side and constricted the nerve root. After the surgery was finished, one drainage tube was placed as routine.

Control group: Except for bilateral separation, bilateral screw implanting and bilateral drainage tube placing, other procedures were the same as those for the study group.

# Postoperative rehabilitation

The drainage tube was placed as routine after the surgery, one tube for each patient of the study group, and two for the patient of the control group with each tube placed at one side. For two groups, the drainage tube were removed 24 hours after the surgery, and the patients administered antibiotics for 3d, did passive leg raising exercises 1 d after the surgery, had a reexamination of X-ray 3 d thereafter and if without abnormality, walked about with back support belt worn for about 8-10 weeks for fixation, and they could engage in daily life 3 months later and work and study normally and participate in non-heavy physical activities 4 months later.

#### Clinical evaluation

An examination was performed 3d after the surgery and semiannually 3 and 6 months thereafter to observe the relief time of postoperative lumbago and back pain, the time of bone graft fusion and the neural functional recovery. The follow-ups of the patients were conducted to evaluate vertebral fusion by routine X-ray examination (including anteroposterior and lateral projection and anterior flexion and posterior extension projection), postoperative condition by Oswestry Disability Index (ODI), and pain variation by Visual Analogue Scale (VAS). According to the criteria for fusion such as Schulte, <sup>10</sup> (bone bridge formation, trabecular structure of the bone between two end plates and transparency around the graft), the fusion rates were classified into: fused, 3

indicators positive; possibly fused, 2 indicators positive; possibly not fused, 1 indicator positive; pseudarthrosis formation, transparent zone around the graft. Macnab were adopted for evaluating the postoperative curative effects of lumbar surgery: excellent: pain in waist and lower extremities disappears, no movement disturbance of waist is present, and the myodynamia of the lower extremities is normal; good: preoperative symptoms disappear but there is mild lumbago or soreness of lower extremities, limitation of waist movement and slight myodynamia weakness of the lower extremities when being fatigue or walking a long distance; acceptable: there is mild lumbago and psoas weakness from time to time after the surgery; bad: preoperative symptoms still exist or are aggravated. In case that the measurement data

were recorded with mean  $\pm$  standard deviation (S  $\pm$  X), t test was adopted for the comparison among groups; if recorded with percentage (%), chi-square test therefor. SPSS15.0 was applied to the statistical treatment of results which were of statistical significance in case of P <0.05.

#### **RESULTS**

During For two groups, see Table 2 for the perioperative periods and postoperative follow-ups and Table 3 for Macnab evaluations conducted 3 months after the surgery. The durations of follow-ups were 12-72 months with an average of 21.3 months for the study group, and 15-73 months with an average of 22.6 months for the control group. The study group had shorter duration of operation, lower intraoperative blood loss volume and lower postoperative drainage volume than those of the control group (P <0.05). There was no significant

statistical difference between two groups in preoperative and postoperative intervertebral heights, fusion time and fusion rate (t=2.15, P > 0.05) (Figure 1). See Figure 2 and 3 for the evaluations of ODI and VAS in the postoperative follow-ups. The excellent and good rates of evaluation results of the study group were found to be higher than those of the bilateral group according to Macnab criteria (P < 0.05).

There was no postoperative incision infection or cutaneous necrosis in the cases of two groups. In the control group, 1 patient had large drainage volume after the surgery for which the leakage of cerebrospinal fluid was suggested, the incision of whom healed well through drainage and treatment in the Trendelenburg position, and 3 patients had postoperative lumbago and back pain and the radiating pain of their lower extremities could not be relieved obviously, which were suggested to be caused by the separation of the lower back muscles and the pulling of the nerve root during the surgery, and such symptoms disappeared after 3-week treatments of reducing swelling, anti-inflammation, nourishing the nerves, etc.

In the study group, a stick in 1 patient's body was found to be loose during the X-ray reexamination 3 days after the surgery, for which surgical exploration was performed and that the nut had not been tightened due to intraoperative error was suggested, and after tightening the nut for fixation, the patient's condition was found to be normal in subsequent follow-up. There were 3 patients with postoperative palsy of the opposite nerve root zone in the bilateral group and 1 in the unilateral group, whose symptoms were relieved completely after 2-week treatments of reducing swelling, nourishing the nerves, etc.

	<b>Table 2: (</b>	Comparison of	perioperative clinical i	indexes between two groups.
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Group	Incision size (cm)	Operation time (min)	Blood loss volume (ml)	Hospitalization time (d)	Hospitalization expenses
Research group	$8.3 \pm 1.2$	$78.2 \pm 15.3$	$180.7 \pm 51.3$	$9.7 \pm 1.3$	$23\ 653.8 \pm 1\ 374.3$
Control group	$10.7 \pm 5.3$	$103.8 \pm 19.5$	$305.8 \pm 63.1$	$12.5 \pm 2.8$	30 702.7 ± 1 589.1
Statistic	t=5.262 P=0.005	t=6.131 P=0.006	t=8.437 P=0.003	t=6.395 P=0.008	t=7.011 P=0.008

Table 3: Comparison of therapeutic effect.

Group	Excellent	Well	Fine	Poor	The excellent rate
Research group	20	52	6	0	92.30%
Control group	7	38	15	3	71.42%

<sup>\*</sup>Evaluated by Macnab criteria of lumbar spine surgery

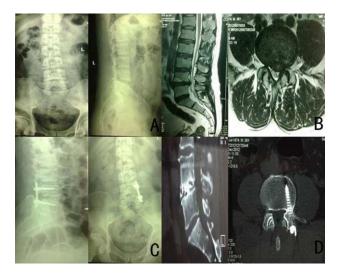


Figure 1: A 45-year-old female patient with disc herniation at L4-5.

A: Anteroposterior AP and lateral X-ray films bdfore operation, showing narrow L4, 5 space; B: Sagittal and coronal views of MRI, showing disc herniation at L4, 5 at the left side and obvious compressive nerve roots; C: Anteroposterior and lateral X-ray films at 3 days after operation, showing increased lumbar intervertebral height, good recovery of the lordosis, good position of needle and Cage; D: Sagittal and coronal views of CT at 1 year after operation, showing complete lumbar fusion and good position of pin track and bone graft fusion

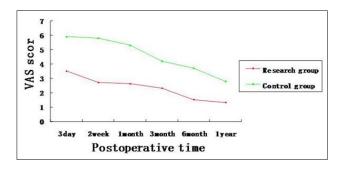


Figure 2: Two groups of cases of postoperative followup of VAS score.

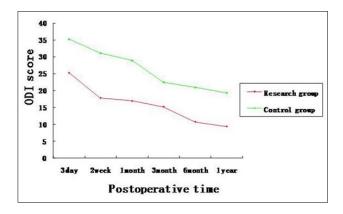


Figure 3: Two groups of cases of postoperative followup of ODI score.

#### **DISCUSSION**

The principle of the surgical therapy of lumbar disc herniation is to decompress fully and effectively and to maintain spinal stability. Bilateral fixation decompression and interbody bone craft fusion were adopted frequently in the past, however, many domestic and foreign researchers have questioned the overuse of internal fixation of spine. 12 With the deeper realization of posterior ligament complex of spine and improvement of the surgeons' skills, more and more surgeons advocate that the damage to the stable structure of spine and posterior ligament complex be minimized. At present, unilateral interlaminar fenestration for decompressing combined with interbody bone graft fusion has been applied to the treatment of unilateral lumbar disc herniation. Therefore, some authors proposed unilateral screw-stick system fixation, namely, for unilateral pedicle screw internal fixation, only unilateral sacrospinous muscle and paraspinal muscle are separated, and unilateral interlaminar fenestration for decompressing and interbody bone craft fusion are performed, which significantly reduces the incidence rates of amyotrophy, myasthenia and lumbodorsal muscle feebleness syndrome. 13,14 Unilateral fixation does not have the inevitable disadvantages of bilateral fixation, including increased surgical risk, prolonged surgery, increased surgical cost, and relevant complications such as infection, bleeding and nerve root damage. 15 The surgery for the study group was limited interlaminar fenestration decompressing. A large number of animal experiments have proved that good vertical spine and spinal rotational stability can be achieved by unilateral screw-stick fixation interbody bone graft and single PEEK Cage fusion. 16,17 Besides, unilateral muscle separation has relieved postoperative pain in the lower back muscles, which is helpful for early postoperative ambulation and thus reduces various complications caused by lying in bed. 18,19 Shah et al. 20 pointed out that the firm internal fixation of bilateral screw-stick system and interbody bone craft fusion is prone to cause secondary herniated disc and facet joint degeneration at adjacent segments, and the corresponding stress that is too concentrated will cause complications such as broken screw and stick. Implanting granular bones and part of self-iliac bone in the decompressed intervertebral space and implanting PEEK Cage after impaction can effectively prevent the granular bones from protruding into the spinal canal so as to reduce complications of spinal canal stenosis.

In this study, the postoperative lordosis recovery, increase in intervertebral height, fusion rates and fusion time found in the follow-ups of two groups were within the normal range and there was no statistical difference between two groups (P >0.05). The results of postoperative VAS and ODI evaluations were much better than those of preoperative evaluations (P <0.05), however, there was no statistical significance of differences between the above-mentioned indicators

obtained in the last follow-ups of two groups (P >0.05). See Table 2. The lumbar curative effects of the study group according to the Macnab evaluations 3 months after the surgeries were much better than those of the control group and there was statistical significance of the corresponding differences ( $\chi^2$ =6.111, P=0.006). All of the above showed that in the treatment of lumbar disc herniation for the study group, the damage to the stable structure of spine was little and the spine was reconstructed effectively, surgical trauma was reduced and the spinal stability still existed, and the postoperative pain was relieved, thus the recent curative effects of the study group are much better than those of the control group.

The imperfection of this study is that the clinical cases are relatively few, which may cause difference in the selection of samples, and that the duration of follow-ups is short and there are not enough biomechanical studies on single peek cage and unilateral pedicle screw-stick fixation for vertebral body fusion, however, some clinical advantages are shown in the study group, including less trauma, more reliable fixation, shorter duration of operation, less blood loss, less expense and early postoperative ambulation, thus the overall curative effects of treating lumbar disc herniation with unilateral pedicle screw are good.

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Ethical approval: The study was approved by the first affiliated hospital of Nanchang University ethics committee

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