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Original Article

Curative effects of Dynesys dynamic stabilization system for lumbar intervertebral disc herniation

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Abstract: Objective: To investigate the curative effects of Dynesys dynamic stabilization system for lumbar intervertebral disc herniation. Methods: Fifty patients diagnosed as lumbar intervertebral disc herniation and accepted Dynesys dynamic stabilization from February 2014 to February 2016 were prospectively analyzed. The follow-up lasted two years. The general information about patients, Oswestry disability index (ODI) and visual analogue scale (VAS) scores were recorded in perioperative period. Woodend classification and apparent diffusion coefficient (ADC) were applied to evaluate lumbar intervertebral disc degeneration via lumbar MRI examination. The intervertebral disc space height of fixed segments and intervertebral range of motion (ROM) before and after operation were compared. Results: All the fifty patients completed Dynesys dynamic stabilization system and were followed up successfully. The mean operative incision length was (5.47±2.8) cm, mean operative time was (95.43±25.4) min and mean amount of blood loss was (137.18±61.2) ml; compared with pre-operative scores, post-operative VAS and ODI scores at each time point significantly improved, and the differences had statistical significance (all P=0.000). Lumbar MRI evaluation indicated that there was one case of lumbar disc deterioration changed from grade II to grade I, one from grade III to grade II, while the others had no significant changes. After operation, ADC value remarkably increased with statistically significant differences (P=0.002). Compared with those before operation, intervertebral disc space height of fixed segments in the last follow-up increased and the intervertebral ROM decreased somewhat, and the differences reached statistical significance (both P=0.000). Conclusion: Curative effects of Dynesys dynamic stabilization system for lumbar intervertebral disc herniation are satisfactory. It can significantly relieve pain, prevent and cure lumbar intervertebral disc degeneration of fixed segments, remains intervertebral ROM of fixed segments, and has little influence on adjacent segments.

Keywords: Lumbar intervertebral disc herniation, degenerative disease, Dynesys dynamic stabilization system, MRI

Introduction

With the aging of the population, the incidence of lumbar degenerative disease increases gradually, which has seriously affected people's life quality. At present, lumbar interbody fusion is a kind of traditional operation in the treatment of lumbar intervertebral disc herniation; however, the decrease of fixed segmental activity, and the increase of fixed segmental stress after this operation are inclined to increase the risk of adjacent segment degeneration [1]. Besides, the lumbar fusion of this operation is not proportional to its long-term clinical satisfaction. These phenomena have drawn an increasing attention of orthopedic clinicians.

Dynesys dynamic stabilization system is a new type of posterior lumber non-fusion technology in recent years, which is mainly achieved by the connection of polyethylene terephthalate (PET) cord and synthetic polyester sleeve with the use of pedicle screws [2, 3]. Studies concerning the vertebral stability after Dynesys dynamic stabilization system for lumbar spinal canal stenosis (LSCS) and other lumbar degenerative diseases have shown that it delays the instability or degeneration of lumbar [4, 5]. However, its clinical application in China is short and there is still a lot of controversy about its indications [6-8]. This study reported the curative effects of Dynesys dynamic stabilization system for lumbar intervertebral disc herniation during a two-

Table 1. General information about patients in perioperative period

Basic feature	Value (n/mean ± standard deviation)
Age (years)	44.7±5.2
Sex (case)	
Male	27
Female	23
Operative fixed segments (case)	
L2-L3	2
L3-L4	3
L4-L5	20
L5-S1	25
Operative incision length (cm)	5.47±2.8
Operating time (min)	95.43±25.4
Amount of blood loss (ml)	137.18±61.2

year follow-up, in an attempt to provide experimental basis for the clinical application of this system.

Materials and methods

Case selection

This study was approved by Hospital Ethics Committee. All patients and their families were informed and signed informed consents. Fifty patients with lumbar intervertebral disc herniation treated with Dynesys dynamic stabilization system from February 2014 to February 2016 were selected. Inclusion criteria: Patients were diagnosed with lumbar intervertebral disc herniation by lumbar spine MRI examination, accompanied by low back pain with or without unilateral or bilateral lower limb radiating pain caused by corresponding nerve root compression; over three months after conservative treatment, there was no effect or the effect was unobvious. Exclusion criteria: Patients suffered from serious cardio-cerebral vascular diseases, severe hepatic renal dysfunction, grievous spinal deformity, and severe osteoporosis associated with vertebral dislocation, infection, trauma, tumor and history of spine surgery.

Operation methods

Under general anesthesia, patients were placed in the prone position. After the marked lumbar lesion space was confirmed by C-arm X-ray fluoroscopy before surgery, a posterior median incision was made, muscles along the spinous process were separated, exposing vertebral plate, and muscles were stripped to transverse process bilaterally. A localization needle was placed at the upper one-third position where the lateral superior articular process and transverse process met, and titanium screws were placed after their locations were confirmed by C -arm X-ray fluoroscopy. After vertebral plate decompression, the distance from the upper pedicle screw to the lower pedicle screw was accurately measured, and then synthetic polyester tubular sleeve was cut with length similar to the distance, PET cord was put into the sleeve between the upper and lower pedicle screws, tightened gradually, kept certain tension, and fastened with small screws. C-arm X-ray equipment fluoroscopy was used again to make sure the appropriate location. After that, adequate hemostasis was provided, and wound was washed before placing drainage tube, and sutured layer by layer.

Routine antibiotics were applied for 3 days after operation. Drainage tube was removed at 48 hours postoperatively. Patients were encouraged to do physical activities until the sixth week; one week after surgery, they were allowed to ambulate.

Follow-up and evaluating indicators

Operating time, length of surgical wound and the amount of blood loss of all patients were recorded. They were followed up for two years via telephone reservations and outpatient reviews. Oswestry dysfunction index (ODI) and visual analogue scale (VAS) scores of patients were recorded before and after surgery. ODI can evaluate the improvement of patients' life quality and their functional recovery. The scale ranges from 0 to 50, including items such as pain, self-care, lifting, walking, sitting, standing, sleeping, sexual life, social activities and travel. The higher the score is, the worse the dysfunction is. The total score of VAS is ten, the scoring standard of which is as follows: 0 is considered as painless; under 3 means slight pain, which patient can endure; 4-6 stand for pain and the patient's sleep is affected but still bearable; 7-10 indicate the patient has a strong pain, which is unbearable, and affects his/her appetite and sleep.

Lumbar MRI was performed before operation and in the last follow-up. Woodend classification and apparent diffusion coefficient (ADC)

Table 2. ODI and VAS scores of patients at each time point before and after surgery (n=50, mean ± standard deviation)

Item	Before surgery	Six months after surgery	One year after surgery	Two years after surgery
ODI	68.92±10.12	25.22±4.71*	24.82±4.28*	24.65±4.19*
VAS	6.14±1.13	2.53±0.44*	2.37±0.41*	2.29±0.38*

Note: Compared with pre-operative scores, *P<0.05.

Table 3. Woodend classification of intervertebral disc of superior fixed segments

Preoperative grading	Scores in 2 years' follow-up				
	Grade I	Grade II	Grade III	Grade IV	Total
Grade I	13	0	0	0	13
Grade II	1	32	0	0	33
Grade III	0	1	3	0	4
Grade IV	0	0	0	0	0
Total	14	33	3	0	50

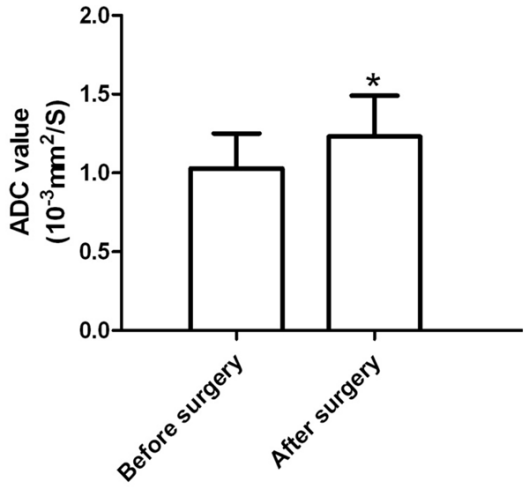

Figure 1. Comparison of ADC value of intervertebral disc before and after surgery Compared with that before surgery, *P=0.002.

were used to evaluate the occurrence of lumbar disc degeneration [9, 10].

The intervertebral disc space height and intervertebral range of motion (ROM) of lumbar fixed segments were measured by imaging. The intervertebral disc space height= (ventral height + dorsal height + central height)/3. Superior margin of upper vertebral body and inferior margin of lower vertebral body on the operative segment were connected into a line. And intervertebral ROM referred to the angle between the line in the status of extension and flexion.

Statistical analysis

SPSS19.0 statistical software was applied to analyze all data. Measurement data was expressed by mean ± standard deviation, and paired t test was used to compare the data before and after surgery. Enumeration data was represented by rate. P<0.05 was considered as statistical significance.

Results

General information about patients in perioperative period

Fifty patients were selected, including 27 males and 23 females at the age of 29-60 years old and their mean age was (44.7±5.2) years old. The fixation was performed at L2-L3 in two patients, L3-L4 in three patients, L4-L5 in twenty patients and L5-S1 in twenty-five patients. Before operation, there was no degeneration in adjacent segments. All the 50 patients completed the operation successfully, their symptoms were significantly improved, and all were followed up. Operative incision length was (5.47±2.8) cm, operating time was (95.43±25.4) min and the amount of blood loss was (137.18±61.2) ml. Postoperative wounds healed up well. During the follow-up period, there were no complications such as spinal cord nerve injury, deep infection and pedicle fracture. After operation, no pedicle screw loss, loosening or breakage appeared. See **Table 1**.

ODI and VAS scores before and after surgery

ODI and VAS scores of patients before surgery were (68.92±10.12) and (6.14±1.13) respectively. Compared with preoperative ODI and VAS scores, postoperative scores were significantly decreased. There were statistical differences in the scores at each time point between pre-and post-operation (all P=0.000). But there were no statistical differences among scores at post-operative 6-month, 1- and 2-year (P>0.05). See **Table 2**.

Evaluation of lumbar disc degeneration via MRI

After 2 years' follow-up, there was one case of lumbar disc deterioration changed from grade II to grade I, one from grade III to grade II, while

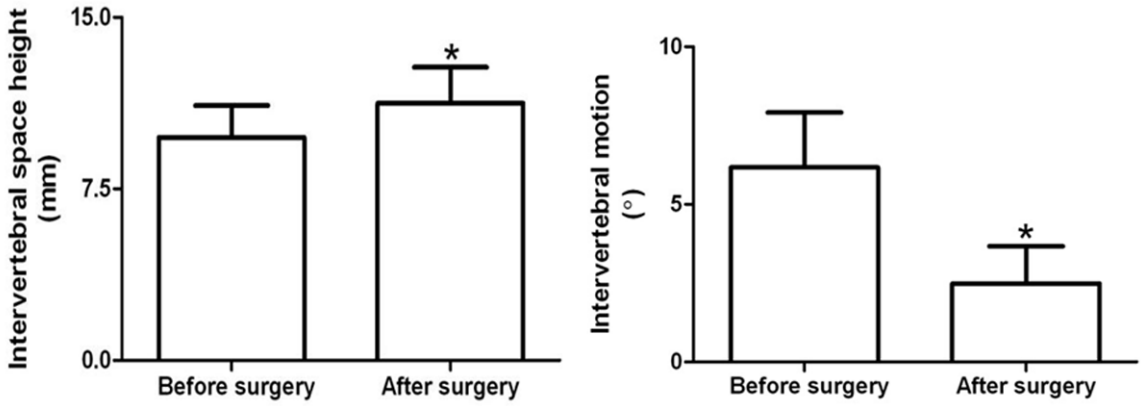

Figure 2. Comparison of the intervertebral disc space height and intervertebral ROM of fixed segments before and after surgery Compared with that before surgery, *P=0.000.

the others had no significant changes. See **Table 3**.

The results of MRI image of intervertebral disc showed that pre-operative ADC value of patients was (1.03±0.22)*10^{-3} mm^2/S. At the end of two-year follow up after operation, the ADC was (1.23±0.26)*10^{-3} mm^2/S, which was obviously increased and the difference was statistically significant (P=0.002). See **Figure 1**.

Intervertebral disc space height and intervertebral ROM of operative fixed segments before and after surgery

The intervertebral disc space height of fixed segments of patients before surgery was 9.76±1.38 mm and the intervertebral ROM was (6.17±1.74)°. After surgery, the intervertebral disc space height changed to 11.24±1.58 mm and intervertebral ROM changed to (2.49±1.18)°, and the differences were statistical significant (both P=0.000). See **Figure 2**.

Discussion

Lumbar intervertebral disc herniation is one of the common lumbar degenerative diseases in spine surgery. Operation is an effective therapeutic method in the treatment of lumbar intervertebral disc herniation accompanied by spinal cord compression. Dynesys dynamic stabilization system applies an effective lumbar spinal fixation system named posterior lumbar non-fusion technology, of which the design concept is to retain the normal physiological activity of the fixed segments, effectively maintain spinal stability and prevent the degeneration of adjacent segments [11]. It was reported that Dynesys dynamic stabilization system could significantly relieve low back pain of lumbar degenerative patients with obvious curative effects [12]. For LSCS and lumbar spondylolisthesis patients, Dynesys dynamic stabilization system can obviously improve VAS and ODI scores, stabilize fixed segments without increasing lumbar spondylolisthesis [13, 14]. Nevertheless, there are few reports about Dynesys dynamic stabilization system in treatment of lumbar intervertebral disc herniation in China. In this study, after the 2-year follow-up, we found VAS and ODI scores of low back pain remarkably improved at each time point after operation. Besides, it was reported that Dynesys treatment would cause some complications such as pedicle fracture and infection, as well as screw breakage and loosening [15]. The results in this investigation indicated that there were no complications such as spinal nerve damage, deep infection and pedicle breakage in follow-up period; additionally, there were no post-operative pedicle screw loss, loosening and breakage. These results were indicative of the definite curative effects of Dynesys dynamic stabilization system for lumbar intervertebral disc herniation.

At present, the effects of Dynesys dynamic stabilization system for adjacent segment degeneration are the research priorities. Numerous studies have demonstrated that Dynesys dynamic stabilization system can prevent and delay the adjacent segments degeneration, but its mechanism of action remains unclear [16, 17]. With a standard of nucleus pulposus and

intervertebral disc height, Woodend classification is currently considered to be an effective rating system based on MRI to evaluate the degree of lumbar disc degeneration. The results in this study showed that after the 2-year follow-up, there was no significant degeneration of lumbar intervertebral disc but with some improvements after applying Dynesys dynamic stabilization system. It has been suggested that diffusion weighted imaging (DWI) in lumbar MRI plays a role in the early diagnosis, efficacy evaluation and prognosis of lumbar intervertebral disc degeneration [18]. The degree of lumbar intervertebral disc degeneration mainly manifests in the integrity of anulus fibrosus and nucleus pulposus water content [19, 20]. The less the disc degeneration is, the more the water content contains and the less the damage to the integrity of anulus fibrosus occurs. Molecular diffusion is faster with higher intervertebral disc water content, and ADC value is higher; otherwise, ADC value is lower on DWI. In this study, it revealed that after Dynesys dynamic stabilization system, ADC value of lumbar intervertebral disc was obviously higher than that before surgery, which meant the nucleus pulposus water content increased and the lumbar intervertebral disc degeneration relieved. Apart from that, after operation, the intervertebral disc space height of fixed segments increased and intervertebral ROM reduced, which indicated that Dynesys dynamic stabilization system retained partial intervertebral ROM of fixed segments on the basis of stabilizing lumbar.

In conclusion, Dynesys dynamic stabilization system can obviously relieve low back pain with few complications, exact curative effects and little influence on adjacent segments in the treatment of lumbar intervertebral disc herniation. However, due to the small sample size in this study, the protective efficacy and the influence on the degeneration of adjacent segments of Dynesys dynamic stabilization system treatment need to be further explored.

Disclosure of conflict of interest

None.

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