

# Postoperative functional exercise for patients who underwent percutaneous transforaminal endoscopic discectomy for lumbar disc herniation

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**Abstract. – OBJECTIVE:** To explore the effects of postoperative functional exercise on patients who underwent percutaneous transforaminal endoscopic discectomy for lumbar disc herniation.

**PATIENTS AND METHODS:** From January to May 2011, patients who had a lumbar disc herniation and then underwent percutaneous transforaminal endoscopic discectomy were divided randomly into two groups: the intervention group (n=46) and the control group (n=46). The intervention group conducted early functional exercises of passive and autonomic activities after their operations, while the control group conducted routine functional exercises after their operations. Short-term and long-term curative effects and quality of life were compared; risk factors that might affect the rehabilitation effects on the patients were analyzed using logistic regression.

**RESULTS:** The lumbar curvature, lumbar lordosis index and sacral inclination angle of the intervention group were better than that those same spinal stability factors in the control group six months after their operations ( $p<0.05$ ). Scores for residual lumbocrural pain, straight leg raising, muscle strength (skin) sensory, nerve reflex and lumbar function of patients in the intervention group were better than those scores of the control group ( $p<0.05$ ). The scores for physiological function, emotional function, activity and social function, mental health and quality of life of the intervention group were better than those of the control group ( $p<0.05$ ). After 1 year of follow-up, the total effective rate for the intervention group was 82.6%, significantly higher than the control group, which had a total effective rate of 71.7% ( $p<0.05$ ). After 3 years of follow-up, the score for the intervention group was 97.8%, significantly higher than the control group, which had an overall average score of 89.1% ( $p<0.05$ ). Logistic regression analysis showed that the type of disc herniation, whether

patients abided by their doctors' advice during treatment and protected their lumbar vertebra during treatment, and their age were all influential factors on patient rehabilitation.

**CONCLUSIONS:** Early functional exercises of passive and autonomic activities can improve the postoperative quality of life of patients with lumbar disc herniation and provides a basis for inclusion in postoperative treatment of lumbar disc herniation. Importance should be placed on factors, such as postoperative exercise, that can improve the curative effect of rehabilitation.

#### Key Words

Lumbar disc herniation, Percutaneous lumbar disc surgery, Functional exercise, Risk factors, Logistic.

## Introduction

Lumbar disc herniation is a main factor to induce pains in waist and legs. Once suffering from the disease, patients will likely have difficulty with work and life in general. At present, the treatment methods for lumbar disc herniation include operative treatment and non-operative treatment<sup>1</sup>. However, operative treatment can reach the purpose of radical treatment and drastically relieve pain in the waist and legs of patients. As a kind of minimally invasive operation method, percutaneous transforaminal endoscopic discectomy has drawn attention as a preferred treatment by patients with lumbar disc herniation<sup>2</sup>. In recent years, it has been widely used in clinic. However, the discussion on the risk factors of postoperative early functional exercises and on their rehabilitation effects on patients continues to be up for debate. It also provides an excellent research topic for regarding the postoperative

rehabilitation of patients with lumbar disc herniation<sup>2-4</sup>. This work mainly revealed the effects of postoperative functional exercises on patients with lumbar disc herniation who were treated by percutaneous transforaminal endoscopic discectomy. We applied logistic regression to analyze the influencing factors of these exercises in the rehabilitation of patients.

## Patients and Methods

### *Patients*

A total of 92 cases of patients with lumbar disc herniation who were treated by percutaneous transforaminal endoscopic discectomy in the First Affiliated Hospital of Yangtze University from January to May 2011 were selected as research objects, including 48 cases of males and 44 cases of females. The ages ranged from 20 to 68 years old, with an average age of  $57.4 \pm 6.1$  years old. A total of 50 cases were first acute onset and 42 cases were not first acute onset. Clinical symptoms were as follows: 20 cases of mild symptoms, 40 cases of moderate symptoms and 32 cases of severe symptoms. The features of intervertebral disc protrusion were comprised of 43 cases of bulging and 49 cases of protruding. The types of intervertebral disc protrusion were 54 cases of unilateral type and 38 cases of bilateral or central type. Protrusion positions of intervertebral disc were 20 cases of L3-4, 36 cases of L4-5, and 36 cases of L5-S1. This study was approved by the Ethics Committee of the First Affiliated Hospital of Yangtze University. Signed written informed consents were obtained from all participants before the study.

The included cases excluded the patients with recurrent intervertebral disc protrusion who had lumbar spine instability and reoperation. A total of 92 cases were randomly divided into an intervention group ( $n=46$ ) and a control group ( $n=46$ ). The general information of the two groups had no difference through comparison ( $p>0.05$ ).

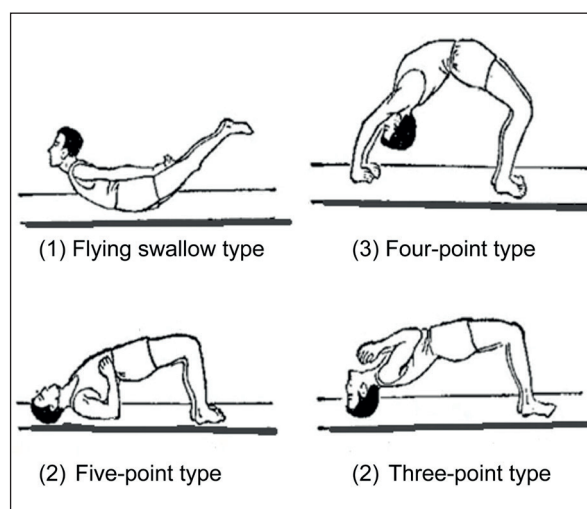
### *Operation Methods*

A total of 92 cases of patients in this group were treated with percutaneous transforaminal endoscopic discectomy. Under the condition of local anesthesia, a C-arm X-ray machine was used to assist in finding the ideal area of skin for inserting a needle. A puncturing operation

was conducted on patients, along with a test for pain. A puncture needle was applied to gradually inject a certain amount of iohexol contrast medium and methylthionium chloride into the intervertebral disc so as to conduct a pain replication test and discography. After the completion of these operations, the puncture needle was removed and a working channel was expanded through the intervertebral disc. A percutaneous transforaminal endoscopic discectomy was then conducted to enable observation through an endoscope. Finally, blue-staining degenerated nucleus pulposus was removed by applying nucleus pulposus rongeur and nucleus pulposus scissors. At the end of the operation, the outer sleeve was removed and the incisions of patients were sutured under aseptic conditions.

### *Functional Exercises*

The control group performed routine functional exercises after their operations. The intervention group performed early functional exercises of passive and autonomic activities after their operations, which meant that after each operation was finished and narcotism receded, early functional exercises of passive and autonomic activities were implemented, including extension and flexion exercises of the lower limbs, toes and neck. Muscle contraction movements were conducted on the day after a patient's operation. Patients were guided to implement the exercise of a straight-leg raising movement on the next day after their operation. The movement could be conducted on two legs alternately, and then the range of motion and daily exercise times of all joints were added. One week after a patient's operation, the lumbodorsal muscles exercises were gradually performed, while the functional exercises of the lumbodorsal muscle arch bridge (supine position) were conducted by applying five-point type, four-point type and three-point type<sup>5</sup>. Two weeks after a patient's operation, functional exercises of the flying swallow type (prone position) could be added gradually (Figure 1). Five weeks after an operation, each patient was guided to conduct activities out of bed and under protection. Waistline and waist lateral exercises were added gradually at the same time. Ten weeks after their operations, patients were instructed to walk backward or perform swimming exercises for 30 min per day. After a full recovery, patients could continue to perform functional exercises for more than 60 min every day.



**Figure 1.** Functional exercise methods of lumbodorsal muscles.

### Evaluation of Therapeutic Effects

The short-term effects of the exercise therapy included the fact that patients continued their functional exercises for 1 year after their operations, while the long-term effects included the fact of the patients continued the exercises for 4 years after their operations. The standards of therapeutic effects were divided into the categories of excellent, good and poor<sup>6</sup>. Within six months after the operation, the frontal and lateral X-ray films were used to evaluate the spinal stability of the patients. The scores of a lumbar function scale were used to compare the functions of lumbar vertebra. A living quality scale (SF-36) was used to evaluate the living quality of patients<sup>7</sup>. Three months after a patient's operation, an MRI was used to observe the differences in the surgical areas before and after the operation.

### Factor Analysis

Independent factors were screened from the factors that might affect the clinical effects of lumbar disc herniation treated by percutaneous transforaminal endoscopic discectomy through combining clinical experiences. These factors

included age, gender, clinical symptoms, types of intervertebral disc protrusion, the number of intervertebral disc protrusions and whether patients abided by their doctor's advice and protected their lumbar vertebra during the treatment period. Then logistic regression analysis was conducted for these independent risk factors.

### Statistical Analysis

Statistical product and service solutions (SPSS) 20.0 (IBM, Armonk, NY, USA) was used to conduct statistical treatment. Enumeration data were tested by  $\chi^2$ -test. The two-independent-sample  $t$ -test and Pearson correlation analysis were applied for measurement data, and  $p < 0.05$  was considered to be statistically significant. The independent risk factors with statistical significance were included in a regression model to conduct unconditional logistic regression analysis. The screening of independent variables was conducted by applying the forward stepwise regression of maximum likelihood estimation.

## Results

### Comparison of Spinal Stability of Two Groups

The lumbar curvature, lumbar lordosis index and sacral inclination angle of the intervention group six months after operation were significantly better than the control group ( $p < 0.05$ ) (Table I).

### Comparison of Lumbar Function Scale Score

Scores for residual lumbocrural pain, straight leg raising, muscle strength (skin) sensory and nerve reflexes, as well as a total score for lumbar function of patients in the intervention group, were better than in the control group ( $p < 0.05$ ) (Table II). Typical cases were detected by MRI, and the results showed that L4-5 disc herniation had significant improvement 3 months after a patient's operation (Figure 2).

**Table I.** Comparison of spinal stability of two groups.

Group	N	Lumbar curvature	Lumbar lordosis index	Sacral inclination angle
Intervention group	46	1.3±0.4*	2.3±0.5*	31.8±3.7*
Control group	46	1.9±0.6	1.7±0.6	25.5±3.4

Note: Compared with control group, \* $p < 0.05$ .

**Table II.** Comparison of lumbar function scale score of two groups.

Group	N	Residual lumbocrural pain	Straight leg raising	Muscle strength (skin) sensory and nerve reflex	Total score of lumbar function
Intervention group	46	8.34±1.52*	2.52±0.67*	10.34±2.16*	50.15±2.64*
Control group	46	12.76±2.05	6.17±1.24	13.81±2.31	65.46±3.86

Note: Compared with control group, \* $p < 0.05$ .

**Comparison of Quality of Life SF-36 Scale Score**

Six months after surgery, scores for physiological function, emotional function, activity function, social function, mental health and quality of life of the intervention group were better than those scores for the control group ( $p < 0.05$ ) (Table III).

**Comparison of Short-Term Curative Effect of Two Groups**

After 1 year of follow-up, the total effective rate of the intervention group was 82.6%, which was significantly higher than the total effective rate of 71.7% for the control group ( $p < 0.05$ ) (Table IV).

**Comparison of Long-Term Curative Effect of Two Groups**

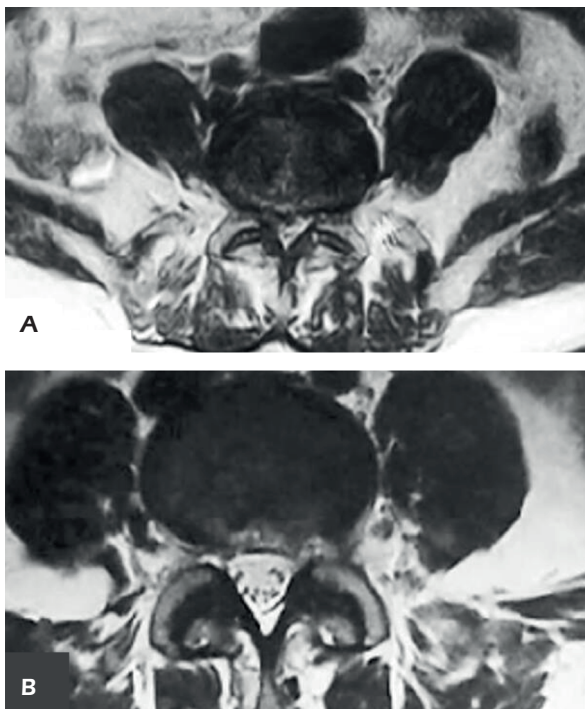
After 3 years of follow-up, the total effective rate of the intervention group was 97.8%, which was higher than the total effective rate of 89.1% for the control group ( $p < 0.05$ ) (Table V).

**Logistic Regression Analysis Results**

Age, type of disc herniation and whether patients abided by their doctor’s advice during treatment and protected their lumbar vertebra during treatment were selected through single factor analysis to be independent factors. These factors were performed with unconditional logistic regression analysis. The results showed that the enrolled factors above could be listed as follows: type of disc herniation, whether patients abided by their doctor’s advice during treatment and protected their lumbar vertebra during treatment, and age (Table VI).

**Fitting Effect Evaluation of Logistic Regression Model**

After completing a review of iteration, we found that, among 46 cases in the intervention group, 3 of them were misjudged as having a poor curative effect. While among 46 cases in the control group, 4 of them were misjudged as having an excellent curative effect. As such, the expected correct rate was 92.4%. The forecasting accuracy method was used to judge the model, but this method was deficient to some extent. To address this issue, our research adopted a ROC curve of SPSS 20.0 to analyze the results of the model (Figure 3). Through calculations, if applied according to the present model prediction rate, the ROC curve lower area was 0.886, while its 95% CI was 0.825-0.949, compared with a null hypothesis area of 0.5,  $p < 0.05$ , which indicated a difference of comparison in the logistic regression model predicted results. The null model had statistical significance ( $p < 0.05$ ).



**Figure 2.** MRI of L4-5 disc herniation before and after surgery. Note: Image A was before surgery; image B was 3 months after surgery.

**Table III.** Comparison of quality of life SF-36 scale score.

Group	N	Physiological Function	Emotional Function	Activity	Social Function	Mental Health	Quality of Life (total score)
Intervention group	46	69.7±16.7*	66.4±17.8*	67.5±21.4*	68.3±17.5*	72.1±16.7*	73.5±19.7*
Control group	46	51.5±12.4	60.1±14.6	51.3±11.5	50.3±15.7	58.3±14.4	56.6±16.3

Note: Compared with control group, \* $p < 0.05$ .

**Table IV.** Comparison of short-term curative effect of two groups (case).

Group	N	Excellent	Good	Poor	Total effective rate (%)
Intervention group	46	30	8	8	82.6*
Control group	46	20	13	13	71.7

Note: Compared with control group, \* $p < 0.05$ .

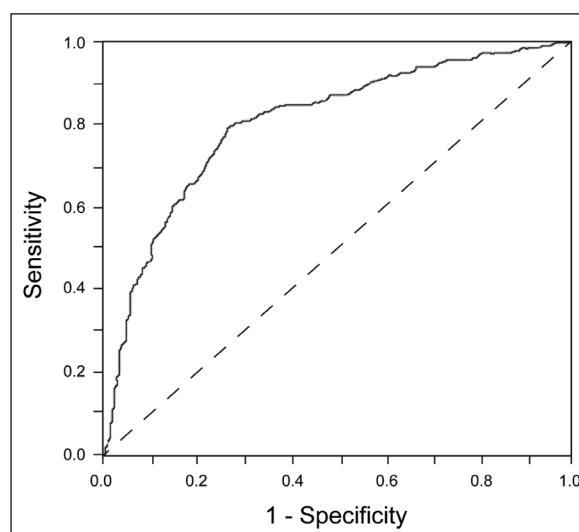
**Table V.** Comparison of long-term curative effect of two groups.

Group	N	Excellent	Good	Poor	Total effective rate (%)
Intervention group	46	43	2	1	97.8*
Control group	46	32	9	5	89.1

Note: Compared with control group, \* $p < 0.05$ .

**Table VI.** Logistic regression analysis results.

Risk factors	$\beta$	S $\beta$	wald	p	$\beta$ OR(95%CI)
Constant term	1.596				
Age	-0.544	0.168	5.013	0.025	0.342 (0.078-0.916)
Type of disc herniation	-2.742	0.427	10.282	0.002	0.136 (0.062-0.435)
Whether patients abided by doctor's advices during treatment period and protected lumbar vertebra during treatment	1.926	0.525	4.467	0.037	2.405 (1.413-4.351)



**Figure 3.** Fitting results of the logistic regression model.

## Discussion

Although treating lumbar disc herniation by percutaneous transforaminal endoscopic discectomy can relieve the pressure-related symptoms of patients, it is difficult to recover the biomechanical balance of the spine in patients<sup>8</sup>. Researches<sup>9-12</sup> have shown that muscles without functional exercise always have worse capillary response, which causes insufficient blood supply of muscles, fails to ensure the supply of nutritional components and makes muscle glycogen generate a large amount of lactic acid under hypoxia conditions. Moreover, the accumulation of lactic acid in the body will lead to muscle edema and generate pain. To promote the early recovery of patients as soon as possible and prevent relapse, it is necessary to conduct functional exercise<sup>13-15</sup>.

This study showed that the lumbar curvature, lordosis index and sacral inclination angle of the intervention group six months after a patient's operation were superior to those same spinal stability factors in the control group ( $p<0.05$ ). The scores of residual lumbocrural pain, straight-leg raising, muscle (skin) feeling and nerve reflex, and the total scores of lumbar vertebral functions of patients in the intervention group were superior to those scores in the control group ( $p<0.05$ ). The scores for physical function, emotional function, activity, social function, mental health and the total scores of life quality in the intervention group were superior to those scores in the control group ( $p<0.05$ ). It indicated that early functional exercises of passive activities and autonomic activities after an operation could effectively promote the recovery of muscle functions and the rehabilitation of limb nerves for patients and improve the life quality of patients. A possible reason for the improvement could be that during the process of early functional exercises of patients – including straight-leg raising exercises of the flying swallow-type and five-point type – muscle spasms were relieved and the muscle function state was improved to reduce the occurrence of edema and other conditions in the muscles. The exercises stimulated nerves and muscles to enable patients to gradually recover enough to the resume their level of normal activities. This helped relieve lumbocrural pain and improved the quality of living for patients.

Duration of 1-4 years was used for follow-up and to observe the patients' short-term and long-term curative effects. It was found that after being followed-up for 1 year, patients in the

intervention group had a total effective rate of treatment of 82.6%, which was significantly higher than the total effective rate of 71.7% in the control group ( $p<0.05$ ). After being followed for up to 3 years, patients in the intervention group had a total effective rate of treatment of 97.8% in the intervention group, which was significantly higher than the total effective rate of 89.1% in the control group ( $p<0.05$ ). Our study demonstrated that postoperative functional exercise could significantly improve the short-term and long-term postoperative rehabilitation effects of patients with lumbar disc herniation.

The range and quantity of exercises should be mastered moderately in postoperative functional exercise. It can be a misconception that higher repetitions and wider ranges of exercises result in better rehabilitation effects<sup>16,17</sup>. In general, the exercise positions and routines work best for patients when they have mild feelings of fatigue. The exercise routines are generally designed to expand range of motion and to be implemented from lower frequency to a higher frequency and from a slow range of motion to a faster range of motion, with the focus on perseverance according to a doctor's advice<sup>18</sup>.

During our study, we found that some patients did not exhibit obvious curative effects after their operations or non-operative treatments, often characterized by a lower degree of medical improvement<sup>19,20</sup>. Therefore, there might be some factors that affected the positive effects of rehabilitation in these patients. Logistic regression analysis showed that the type of lumbar disc herniation, whether patients abided by their doctor's advice during treatment and protected their lumbar vertebra, as well as a patient's age were independent factors that might have affected the rehabilitation effects of patients.

One possible reason that age affected rehabilitation negatively in elderly patients is because they have less moisture content in their lumbar intervertebral discs. The higher moisture content in younger patients likely resulted in having a lumbar intervertebral disc with less regression. Because of this moisture factor, it was beneficial to reduce the herniated nucleus pulposus to enable faster clinical rehabilitation and better treatment results. In multiple-factor analysis,  $OR=0.342$ , 95% CI: 0.078-0.916,  $p=0.025$ , which indicated that younger patients had better rehabilitation effects.

The reasons why the type of lumbar disc herniation affected rehabilitation effects might

be that patients with bilateral or central lumbar disc herniation had more serious conditions, more significant neurotmesis and more possibility to induce secondary spinal stenosis than those patients with unilateral protrusion and poor rehabilitation effects. This study showed that the rehabilitation and recovery rate of patients with unilateral central lumbar disc herniation was 7.4 (1/0.136) times that of patients with bilateral or central lumbar disc herniation.

The reasons why whether patients abided by their doctor's advice during treatment and protected their lumbar vertebra affected rehabilitation effects might be that under the guidance of doctors, patients could combine exertion and rest, implement scientific exercises and protect lumbar vertebra well. The results of this study showed that the rehabilitation and cure rates of those patients who abided by their doctor's advice during treatment and protected their lumbar vertebra had a differential of 2.405 times (95% CI: 1.413-4.351) when compared to those who did not take these steps.

## Conclusions

We showed that early functional exercises of passive and autonomic activities were beneficial to the rehabilitation of patients with lumbar disc herniation treated by percutaneous transforaminal endoscopic discectomy and can significantly improve their living quality after an operation. This study highlights the importance of functional exercises in the rehabilitation of patients.

## Conflict of Interests

The authors declared no conflict of interest.

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