



Original Article

Effects of muscle extension strength exercise on trunk muscle strength and stability of patients with lumbar herniated nucleus pulposus

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Abstract. [Purpose] The purpose of this study was to provide the data for constructing an integrated exercise program to help restore muscle strength and stability through extension strength exercise in adult females with lumbar disc herniation. [Subjects and Methods] An 8-week exercise program for lumbar muscle extension strength and stabilization was performed by 26 females older than 20 with lumbar disc herniation findings. [Results] Significant differences were found in lumbar extension muscle strength at every angle of lumbar flexion after participation in the 8-week stabilization exercise program; but there was no significant difference in the weight distribution index. [Conclusion] An integrated exercise program aiming to strengthen lumbar spine muscles, reduce pain and stabilize the trunk can help to maintain muscle strength and balance. In addition, improvement in extension strength is expected to be helpful in daily life by securing the range of joint motion and improving the strength and stability.

Key words: Herniated Nucleus Pulposus (HNP), Extension strength, Stability

(This article was submitted Dec. 9, 2015, and was accepted Jan. 19, 2016)

INTRODUCTION

Lumbar spine instability has been reported to be the leading cause of chronic back pain¹⁾. An abnormal vertebral joint creates mechanical lesions and pains in the lumbar spine, decreasing stability and increasing the range of motion, resulting in functional degeneration²⁾. These negative patterns have a variety of forms such as aging, medical history, and exercise deficiency and present serious problems in the age group of 20–40, due to developments of modern society and recent changes in various working forms of work^{3, 4)}.

Herniated Nucleus Pulposus (HNP) is a representative disease of the functional vertebral unit that occurs when the pulposus nucleus is exposed by rupture of the annulus fibrosus and it is a disease that causes chronic back pains^{5, 6)}. Chronic back pain patients not only have weak deep muscles of the lumbar region and muscle imbalance compared to normal subjects, but also show reduction in the re-positioning ability which leads to problem with the stability of the spine, due to the reduction in proprioceptive sense, which causes lumbar pain and recurrence^{7, 8)}.

Stabilization exercises help with functional return to daily life. They include exercises for increasing muscle strength, improving functions, and maintaining posture as well as preventing excessive movements of the lumbar spine⁹⁾. Exercise rehabilitation approaches for strength and stability are important even after surgical treatments, due to degeneration and restricted activities^{10, 11)} and conservative methods of treatment by exercise have been recommended for the purpose of preventing recurrence of pain and improving functions^{12–16)}. Thus, exercise therapies based on the stabilization exercises are considered to be necessary for preventing chronic pain and reductions in functional capabilities by the reduction of functional instability in various of type and the improvement of motor functional capabilities of the lumbar joints.

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Therefore, this study aims to help adult women with lumbar disc herniation recover muscle strength and stability through 8-week lumbar extension strength exercise programs, and to provide data for constructing an integrated exercise program.

SUBJECTS AND METHODS

In this study, an 8-week exercise program for lumbar muscle extension strength and stabilization was performed by 26 females older than 20 with lumbar disc herniation. This study was approved by the Hankuk University of Foreign Studies and the institution where it was performed, and it complied with the ethical principles of the Declaration of Helsinki. The purposes and process of the study were fully explained to the subjects and their consent was obtained before participation. Persons with neurological diseases such as dyskinesia were excluded from the study. The subjects' mean \pm SD was 27.2 \pm 4.4 years old their mean \pm SD height was 162.3 \pm 5.1 cm and their mean \pm SD weight was 55.4 \pm 7.1 kg.

The programs was conducted for a total of 8 weeks, 60 minutes a session, twice a week, to improve strength and stabilize lumbar extension. The exercise program was divided into warm-up exercises, main exercises and cool-down exercises. The warm-up exercises and cool-down exercises were conducted focusing on the range of joint motion (ROM) without pain, utilizing cycles and steppers for 10 minutes, alternately. For the purpose of improving the lumbar stability and resistance muscles, the main exercises were designed to be individually conducted in the form of a circuit training in which the number of repetitions increased gradually, utilizing sling and weight exercise equipment.

A lumbar Extension Strength Machine (MedX, MedX Inc., Ocala, FL, USA) was utilized for the evaluation of lumbar extensor strength. The maximum static muscular strength of lumbar extension was measured at 7 different angles of lumbar flexion: 0, 12, 24, 36, 48, 60, and 72 degrees. Passive tests were conducted to determine whether to limit the range of motion before measurement. The tests were conducted 12 times at 45 lbs in accordance with the MedX exercise measurement guidelines. The measurement was performed after fixing the pelvis and thigh of the subjects on the support. Then, the motion of the lumbar spine was limited during measurement by adjusting the footrest. The subjects were asked to increasingly extend the lumbar spine by sufficiently considering the limited angular range of motion of the joints. The measurements were performed in the same manner at every angle by maintaining maximum muscle contraction for about 2 seconds.

Stability was measured using a Tetrax (Sunlight Ltd., Israel). For the physical stability measurements, the total weight distribution index (WDI) was calculated by assessing the degree of interaction and coordination of the lower body through body away while maintaining a standing posture.

For data processing, the statistical program SPSS (SPSS Inc., IBM, USA) Ver. 23.0 was used. The mean and standard deviation of the measurements was calculated for all metrics. To compare the difference between the pre-exercise and post-exercise state of the 8-week exercise program, the paired t-test was used and statistical significance was accepted for values of $p < 0.05$.

RESULTS

Significant differences were observed in lumbar extension strength (LES) between pre-exercise and post-exercise at every angle of lumbar flexion, but no significant difference was found in WDI (%) (Table 1). The post-exercise LES were found to be very significantly ($p < 0.01$) higher than pre-exercise at 0 degree and 12 degree, and extremity significantly ($p < 0.001$) higher than pre-exercise at 24, 36, 48, and 72 degrees of lumbar flexion. The exercise resulted in significant changes in all angles.

Table 1. Changes of the LES and WDI

Variable	Angle	Pre-exercise	Post-exercise
LES (ft-lbs)	0	61.8 \pm 33.8	80.1 \pm 31.6**
	12	78.7 \pm 33.8	98.8 \pm 33.6**
	24	87.6 \pm 36.5	116.5 \pm 32.7***
	36	98.6 \pm 35.9	129.7 \pm 32.3***
	48	104.7 \pm 35.0	137.6 \pm 30.2***
	60	113.1 \pm 36.9	146.5 \pm 30.5***
	72	122.3 \pm 40.1	158.7 \pm 34.7***
WDI (%)		5.9 \pm 3.3	5.0 \pm 2.8

Values are mean \pm SD, LES: lumbar extension strength, WDI: weight distribution index.
** $p < 0.01$, *** $p < 0.001$

DISCUSSION

This study attempted to identify the positive impacts that were exerted on extension muscle strength and stability by an 8-week extension strength exercise program which was performed by 26 females with lumbar disc herniation.

HNP is caused by the annulus fibrosus that is squeezed into the spinal canal when the pulposus nucleus is torn due to a degenerative intervertebral disc. It has been reported that approximately 29% of the projected and escaped intervertebral discs are associated with the pulposus nucleus¹⁷). Chronic back pains resulting from HNP aggravate the instability of the lumbar spine, causing degenerative changes, atrophy of muscle strength, and reduce flexibility and joint range of motion due to trunk damage and instability^{18, 19}). Lumbar herniated nucleus pulposus does not occur due to lumbar pain or disability, but more frequently occurs due to deterioration of the related muscles or functions interacting with them adjunctively⁸). In addition, it is said that the joint range of motion is limited due to the loss of muscle strength and flexibility caused by occupational factors, mode of action, specific changes in posture, or degenerative disease¹⁸).

These musculoskeletal diseases can be generally improved by utilizing conservative treatments such as exercise^{9, 18}). Rehabilitation exercise therapies for muscular strength and stability are important even after surgery^{10, 16}). Various types of composite exercises and core exercises in addition to exercises for muscular strength and stability are currently being utilized^{8, 12}). Lumbar and trunk muscle extension exercise therapies were utilized. These exercise therapies help to stabilize the lumbar spine through lumbar and trunk dynamic stabilization and exercise modulation, and increase of muscle strength²⁰).

Similar to the present study, a study analyzing the impacts of an 8-week functional exercise program for lumbar muscle strength, that was performed by 26 females with degenerative disc findings, found that there were significant differences between pre-exercise and post-exercise¹⁵) in lumbar muscle extension strength at all 7 angles of lumbar flexion, proving that exercise participation develops stability of the muscles around the lumbar spine. In addition, a study analyzing the effects of decompression therapy by 4-week joint mobilization that was performed for patients with lumbar herniated nucleus pulposus, reported improvements in joint range of motion in flexion and extension²¹), proving its effectiveness. Similarly, a study of¹³) lumbar traction for patients with lumbar herniated nucleus pulposus, and a study¹¹) of lumbar discectomy and stabilization exercises for patients with lumbar herniated nucleus pulposus, both reported improvements in flexion and extension. The improvements in functions pursuant to improved muscle strength and stability were statistically significant, as were the results of the studies cited above. Therefore, prevention of excessive movement of the lumbar spine and trunk, in the patients with chronic back pains or lumbar herniated nucleus pulposus can be helpful in their daily life because they secure the joint range of motion, thereby improving strength and stability⁹).

Thus, the development of muscular strength for stabilization and integrated exercise for pain reduction and rehabilitation help to maintain the range of joint motion, muscle strength, and balance^{21–23}). For the improvement and rehabilitation of impaired capacity in daily life due to back pain-associated injuries experienced by about 80% of the population a higher occurrence rate^{8, 10}) when recurrence is included muscle weakness, and loss¹⁵) of balance the development of an integrated exercise program is required.

The above results indicate that improving muscle extension strength to enhance and improve the functions the patients with chronic back pain or lumbar herniated nucleus pulposus can help improve muscle functions and increase the range of joint motion thereby exerting a positive impact on physical stability.

ACKNOWLEDGEMENT

This work was supported by Hankuk University of Foreign Studies Research Fund of 2016.

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