

# Effects of an Exercise Treatment Program on Lumbar Extensor Muscle Strength and Pain of Rehabilitation Patients Recovering from Lumbar Disc Herniation Surgery

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**Abstract.** [Purpose] The purpose of this study was to examine effects of an exercise treatment program on lumbar extensor muscle strength and pain of rehabilitation patients following lumbar disc herniation surgery. [Subjects] This study randomly allocated 14 rehabilitation patients after lumbar disc herniation surgery to an exercise therapy group (ETG, n=7) and a control group (CONG, n=7). [Methods] Lumbar extensor muscle strength was measured using a Medx lumbar extension machine (Medx, USA) and pain was assessed using a visual analog scale (VAS). [Results] ETG showed significant improvements in all items that measured lumbar extensor muscle strength and pain after the intervention, but CONG did not exhibit any significant improvements. [Conclusion] The exercise treatment program for rehabilitation patients after lumbar disc herniation surgery was effective at strengthening lumbar extensor muscles and reducing pain.

**Key words:** Exercise therapy, Lumbar extensor muscle strength, Visual analogue scale

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## INTRODUCTION

Lumbar herniated nucleus pulposus occurs due to a rupture of the annulus fibrosus and is a major cause of lumbar pain and sciatica. Clinical symptoms of the disease include bilateral lower extremity hypoesthesia, muscular weakness, and radiating pain. It is representative of diseases affecting a functional spinal unit<sup>1)</sup>. Among the methods used to treat spinal disc herniation, surgical intervention is the most common and its success rates are high, from 80 to 90%, when surgery is performed with adequate consideration for the resulting adaptation syndromes; however, post-operative pain (20%), disabilities of physical functions (40 to 55%), and psychological problems (31%) may result<sup>2)</sup>. Kahanovitz et al. asserted that the majority of patients with intervertebral disc herniation had difficulty returning to a normal life, even after a successful operation, due to stiffness of the lumbar region resulting from mechanical (in other words, a decline in muscle strength and endurance), rather than neurological causes<sup>3)</sup>. Because the surgical removal of the disc and nerve decompression does not resolve the whole pathological process of the lumbar disorder, and the treatment purpose of surgery is to return patients to their normal lives by removing the cause of their symptoms and functional recovery of the lesion, post-operative exercise treatment programs for rehabilitation are important. It was reported that lumbar

disc herniation patients have unbalanced and weakened flexor and extensor muscle strength in addition to lumbar pain, making performance of exercise therapy necessary. In actual performance of such exercises, patients were reportedly able to perform lower extremity extension and muscle strength exercises two to three days post-operatively, flexion and spinal dorsal root extension exercises one week post-operatively, and extension exercises four to five weeks post-operatively, and the exercises conferred beneficial effects on patients' recovery<sup>4-6)</sup>.

The present study conducted a practical assessment of exercise treatment for rehabilitation patients after lumbar disc herniation operation. The goal was to examine the effects of an exercise treatment program on lumbar extensor muscle strength and patients' experience of pain.

## SUBJECTS AND METHODS

A total of 14 lumbar disc herniation patients who were scheduled to receive rehabilitation treatment after surgery at S Hospital's Spine Exercise Center located in Daegu, Korea, were randomly allocated to two groups: an exercise therapy group (ETG, n=7) and a control group (CONG, n=7). The study subjects were those patients who were taking rest and receiving only conservative treatment to help them return to daily life after surgery.

Patients for whom the rehabilitation program was considered risky according to their doctor's judgment were excluded. The control group subjects did not participate in any exercise rehabilitation program that might have induced the effect of exercise after surgery and ETG performed the exercise treatment program for 12 weeks. The average age, height, and weight of ETG and CONG were  $45.2 \pm 3.96$  years old,  $163.6 \pm 3.06$  cm,  $62.3 \pm 6.03$  kg, respectively and  $46.2 \pm 5.3$  years old,  $161.4 \pm 5.32$  cm, and  $63.4 \pm 5.77$  kg. The exercise treatment group's postoperative conservative treatment period was  $15.57 \pm 2.94$  days and the control group's postoperative conservative treatment period was  $15.43 \pm 3.74$  days. There were no statistically significant differences in the above items between the two groups ( $p < 0.05$ ); therefore, they were regarded as homogenous.

The exercise treatment program was conducted for 70 minutes per session, three sessions per week, for 12 weeks. The program consisted of the Medx lumbar extension program and progressive resistance exercise (PRE). The lumbar extension exercise program was conducted in accordance with Medx's exercise protocol, University of Florida Center for Exercise Science's Spinal Rehabilitation Certification Program, and the initial exercise load was set at 40 to 50 percent of maximal isometric strength of the lumbar extensor muscles (peak torque), as measured prior to the intervention. The exercise program was conducted three times per week and the exercise intensity was gradually increased by increasing the weight 5 to 10 percent. Every four weeks, the lumbar extensor muscles' maximal isometric strength was measured and a new exercise load was set at 50 percent of the derived maximal strength.

PRE was applied largely using an instrument that can strengthen the lumbar region and surrounding muscles. The exercise intensity was adjusted at 40 to 50 percent of subjects' one repetition maximum (1RM), with 18 to 20 repetitions per set. Every four weeks, the 1RM was measured to adjust the exercise intensity. The exercise program included the following movements: torso flexion, hip extension, torso rotation, leg extension, seated leg curl, leg press, abdominal press, and overhead press.

Measured items were isometric muscle strength and degree of pain. These items were measured prior to the program in both the control group and the exercise treatment group and then measured in the control group after resting for weeks and in the exercise treatment group after performing the exercise treatment program for 12 weeks. The measurement was done by a physical therapist who had been educated on Medx's exercise protocol and University of Florida Center for Exercise Science's Spinal Rehabilitation Certification Program and had clinical experience of at least three years.

Maximal isometric muscle strength was measured using the Medx lumbar extension machine (Medx, U.S.A.). To measure pure maximal static lumbar extensor muscle strength, a subject's pelvis was put into tight contact with the pelvic restraint and the femoral region was fixed to the thigh restraint and the femur restraint. The foot hold was adjusted and fixed so that the femoral region and the tibial region were maintained at an angle of around  $135^\circ$ , and the upper back pad and the head rest pad were put into tight

contact with the dorsal thoracic region and the occipital region, respectively. Then, the subject was instructed to hold the handle with both hands.

Before conducting the test, to examine if the subject's range of motion was restricted at specific lumbar flexion angles ranging from  $0^\circ$  to  $72^\circ$ , the tester manually operated the device so that the subject could perform the exercise of the range of joint motion 6–7 times, and the centers of the device and the subject were adjusted to eliminate the effect of the center of gravity. In the procedure of the test, isometric maximal lumbar extensor muscle strength was measured at specific lumbar flexion angles ( $72^\circ$ ,  $48^\circ$ ,  $24^\circ$ ,  $0^\circ$ ) as the lumbar back extended, beginning at the  $72^\circ$  position. For the measurement, the study subject was requested to apply power to the back support slowly for 2–3 seconds and then maximally for around one second at the peak referring to the graph of the exercise displayed on a computer monitor.

Degrees of pain were measured using four items from the visual analogue scale (VAS). Huskisson's VAS, which attempts to quantify subjective back pain and a questionnaire developed by Million, Hall, Nilsen, Baker and Jayson were modified<sup>7, 8)</sup> to compile a questionnaire in which the best conditions are indicated by 0 and severest conditions by 10. The subject answers each question by marking a point on a line of 10 cm and the distance from the starting point and the point marked by the patient down to one decimal place becomes the subject's score. The questionnaire had four items: back pain, night pain, exercise pain and handicap. The reliability of the questionnaire in terms of Cronbach's  $\alpha$  is 0.96.

For data analysis, SPSS 13.0 was employed. The paired t-test was conducted in order to compare changes in each group prior to and after the intervention. A p value of  $\leq 0.05$  was considered statistically significant.

## RESULTS

With regard to lumbar extensor muscle strength, ETG showed significant improvements at all angles after the intervention ( $p < 0.05$ ), but the CONG did not show any significant changes (Table 1). Regarding the degree of pain, the ETG's pain was significantly reduced in the four items after the intervention ( $p < 0.05$ ), but the CONG did not show any significant improvement (Table 2).

## DISCUSSION

The subjects of this study were lumbar disc herniation patients on whom nerve decompression was performed by surgically removing the disc compressing nerve roots, who were scheduled to receive post-operative rehabilitation treatment. Post surgery, the subjects needed an additional exercise treatment program to minimize their pain and achieve functional recovery of their weakened lumbar muscle strength since they had been in bed rest for so long.

Saal and Saal reported on their lumbar exercise treatment program, which was a stabilization method designed to improve trunk muscles and to ligaments and prevent repetitive micro-injuries of the intervertebral discs and facet

**Table 1.** The comparison of lumbar extensor muscle strength in the each groups

Group	Lumbar flexion angle	Pre (Mean ± SD)	Post (Mean ± SD)
ETG	0°*	57.29 ± 7.72	78.86 ± 10.65
	24°*	83.57 ± 10.06	110.14 ± 12.70
	48°*	102.42 ± 13.40	136.42 ± 11.41
	72°*	122.71 ± 17.64	149.85 ± 8.93
CONG	0°	61.71 ± 9.96	60.43 ± 12.27
	24°	85.66 ± 10.01	85.50 ± 7.25
	48°	100.40 ± 10.45	104.28 ± 12.24
	72°	121.85 ± 13.34	113.68 ± 10.04

(unit: Nm) \*p<0.05, ETG: Exercise therapy group, CONG: Control group

**Table 2.** The comparison of VAS in the each groups

Group	Category	Pre (Mean ± SD)	Post (Mean ± SD)
ETG	back pain*	5.11 ± 1.10	4.35 ± 0.94
	night pain*	3.54 ± 2.61	2.61 ± 1.96
	exercise pain*	5.52 ± 1.16	2.77 ± 0.72
	handicap*	5.27 ± 1.68	2.28 ± 0.75
CONG	back pain	5.42 ± 1.61	5.80 ± 1.89
	night pain	3.85 ± 1.21	3.90 ± 1.01
	exercise pain	5.11 ± 1.24	5.42 ± 1.37
	handicap	6.55 ± 0.92	6.27 ± 1.05

(unit: Nm) \*p<0.05, See Table 1 for abbreviation key

joints. They found that balanced development and improved flexibility of extensor muscles, such as the abdominal and gluteal muscles and lower extremity muscles, led to the establishment of a neutral spinal posture<sup>9</sup>). Lumbar extensor muscle exercise programs using progressive resistance exercises, with the pelvis fixed, enhanced isometric lumbar extensor muscle strength and substantially minimized leg pain, and improved joint range of motion and activities of daily living<sup>10, 11</sup>). Harvey, Tanner et al. also noted that lumbar extensor muscle-specific exercises significantly improved lumbar muscle strength<sup>12</sup>). Given the above observations, the exercise treatment program used in this study was conducted for lumbar disc herniation patients who were scheduled to receive rehabilitation treatment after surgery (with consideration for their adaptation syndromes), since improvement of their lumbar extensor muscles would help to enhance their functional movement capabilities.

Since lumbar pain is closely related to lumbar extension muscle strength<sup>5, 13</sup>), lumbar rehabilitation programs have focused on improving lumbar extensor muscles through the use of exercise treatment programs. Caillet noted that exercise therapy positively enhanced joint capsules, ligaments, and tendons, and increased blood flow, thereby aiding in the recovery of injured regions. Moreover, Caillet also found that resistance exercise improved muscle function by increasing the cross-sectional areas of muscles, thereby providing great benefits in prevent on and treatment of pain<sup>14</sup>). Ji et al. observed that chronic lumbar pain patients' pain could be reduced only by developing lumbar extensor muscle strength by a minimum of 27% to a maximum of 48%<sup>15</sup>). Choi et al. noted that the application of exercise

for isometric lumbar extensor muscles resulted in increased cross-sectional areas of the multifidus and longissimus muscles and improved lumbar extensor muscle strength, leading to a reduction in pain as well<sup>16</sup>).

The results of previous research together with this study's findings suggest that the performance of an exercise treatment program by rehabilitation patients after lumbar disc herniation surgery may significantly alleviate their pain as well as strengthen their lumbar extensor muscles. Therefore, this program should be introduced as their rehabilitation program after lumbar disc herniation surgery.

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