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The Effect of an Early Lumbar Exercise Program on Trunk Strength and the Oswestry Disability Index after Herniated Nucleus Pulposus Surgery

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Abstract. [Purpose] We investigated the changes in strength of the lumbar area and the Oswestry Disability Index (ODI) of HNP patients in their early recovery stage after surgery before and after performance of an exercise program, minimal walking, or no exercise. [Subjects] Ninety-six (men=54, women=42) HNP patients who had received surgery were divided into 3 groups: the self-stretching and strengthening exercise group (SG), the walking group (WG), and the control group (CG). CG conducted no exercise. [Methods] WG walked for 10 minutes to 1 hours at a time. SG was permitted to walk under the same conditions as WG and also conducted an exercise program for 10 to 30 minutes at a time. The lumbar extension strength and ROM were measured before and after the exercise program. [Results] SG showed the most decreased disability and improved muscle strength and ROM. [Conclusion] Intensive exercise, for example, stretching and strengthening exercise, was effective for trunk function. However, more scientific research will be needed in the future.
Key words: Herniated nucleus pulposus, Back exercise, Trunk function

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INTRODUCTION

The medication and conservation methods, for example complete bed rest, have generally been used for treatment after herniated nucleus pulposus (HNP) surgery, but the negative effects of these methods have often been reported[1,2)]. One possible reason is that so-called deconditioning syndrome increases pain and reduces motor functions after surgery[2,3)]. Actually, 22–70% HNP patients after surgery report sciatica and low back pain[4)] which leads to restriction of movement inducing muscular atrophy, weakness, fatigue, and overload on discs of the lumbar spine. Moreover, these pathologic progresses can impair the shock absorption mechanism of spinal processes hindering the effect of treatments[2,5)]. Accordingly, there has been increasing interest in early exercise within the no pain range of motion (ROM) as a method for enhancing recovery after HNP surgery[1,2,6)]. However, in the early stage after surgery, patients are usually recommended to maintain complete bed rest and to limit movements rather than early exercise. This has often resulted in delay of recovery and/or negative progress[2,7)]. High intensive physical therapies such as MedX, centar, and sling have generally been used after HNP surgery but they are expensive. In spite of the beneficial effects arising from these therapies, it is still necessary that self-exercise programs be developed and provided to reduce the treatment costs[8,9)]. As a result of this necessity, self-exercise programs after HNP surgery have been developed and it has been demonstrated that the early application of the self-exercise programs is more beneficial than at other points of time[8,10,11)]. However, early self-exercise programs after HNP surgery have been studied only by questionnaire survey, the results of which could easily be affected by the subjective views of testers and participants. Consequently, the necessity of objective measures such as the muscle tensile test, and spinal range of motion has been raised[8,12,13)]. To our knowledge, there are few therapeutic studies about early self-exercise after HNP surgery which have used objective methods. Therefore, we investigated the changes in strength of the lumbar area and the Oswestry Disability Index (ODI) of HNP patients in their early recovery stage after surgery before and after the application of self-exercise program, minimal walking, or no exercise.

SUBJECTS AND METHODS

Ninety-six (men=54, women=42) HNP patients who received surgery from January to August in 2008 in W hospital in Gyonggi Province, Korea were recruited for this study. They were 23 to 64 years old, 165.5 ± 9.6 cm tall, and weighed 66.4 ± 11.2 kg. They had no other diseases, and were not taking medications for HNP. They voluntarily chose to participate in an exercise program, walking, or no additional exercise, and were allocated to one of three groups according to their choices: the stretching and strengthening exercise group (SG), the walking group (WG), and the control group (CG). SG was educated about therapeutic exercises for the low back area in the hospitalization period after surgery. All participants were discharged and visited hospital as outpatients for one to two months. They were blinded to the contents and data of the study including grouping. They were informed of the procedures of this study, were given precautions, and we confirmed whether or not they had low back pain. All of them gave their written consent before participation. CG (n=57) conducted no exercise. WG (n=30) walked for 10 minutes to 1 hours at a time, 2–5 times a week without pain and fatigue on a level space or on a treadmill. They were instructed to stop walking if they experienced any signs of pain or sudden change in their physical or psychological state. SG (n=9) was permitted to walk under the same conditions as WG and also conducted an exercise program for 10 to 30 minutes at a time 2–5 times a week. The lumbar extension strength and ROM were measured using a MedX (lumbar extension strength machine, MedX Corporation, USA), and ODI was evaluated before and after the MedX measurement. We used MedX for evaluating lumber extension strength. The active ROM of the lumbar spine and the maximal isometric lumbar extension strength were measured at lumbar flexion angles of 0°, 12°, 24°, 36°, 48°, 60°, and 72°. To obtain the independent ROM of the lumbar spine and to prevent compensatory movements in other body areas, we stabilized the feet, knees, thighs, and pelvis area with straps and a foot plate. Prior to the measurements, we conducted a screen test and excluded angles which induced pain and/or any other negative symptoms such as discomfort during lumbar flexion from 0 to 72°. The measurement was initiated at 72° from the fully extended position. Subjects performed maximal strength while watching a monitor, the visual biofeedback system of the MedX monitoring the expression of muscle strength. The lumbar extension strengths at each angle were measured in the same manner. There was a rest of 15 seconds between measurements at each angle. ODI consists of 10 items (pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and travelling) and the score of each section is calculated using a 6-point Likert scale ranging from no disability (0) to total disability (5). The ten sections are summed to gain the total score which ranges from 0 (no disability) to 50 (maximum disability). A higher score indicates more severe disability[14]. Statistical analyses were conducted using SPSS for Windows, version 12.0. The mean and standard deviation (SD) of the maximal strength of lumbar extension and ODI score were calculated, and differences among CG, WG, and SG were analyzed with one-way ANOVA (post-hoc with Duncan's method). Significance for all statistical tests was accepted at the 0.05 level of probability. The protocol for the study was approved by the Committee of Ethics in Research of the University of Yongin, in accordance with the terms of Resolution 5–1-20, December 2006.

RESULTS

The spinal ROMs after HNP surgery are shown for each group in Fig. 1. SG showed no limitation of spinal ROM. For the maximal strength of lumbar extension after HNP surgery, SG showed significantly increased isometric tension of lumbar extension at all angles compared to CG. WG also showed increased isometric tension compared to CG at 60° and 72°. At all angles, SG showed the greatest extension strength, followed by WG, and CG showed the least (Table 1). For the total ODI scores after HNP surgery, all 3 groups showed significant differences in the ODI score (CG=30.63 ± 15.17, WG=28.49 ± 11.73, SG=11.55 ± 2.98 points). SG showed the lowest ODI score and CG the highest (Table 2). The scores of individual items also showed the differences among the groups. SG not only had the lowest ODI score for each item but also showed significant differences compared to CG in the items of pain intensity, walking, sex life, personal care, and travelling. WG showed a significant decrease only in the item of pain intensity compared to CG (Table 2).

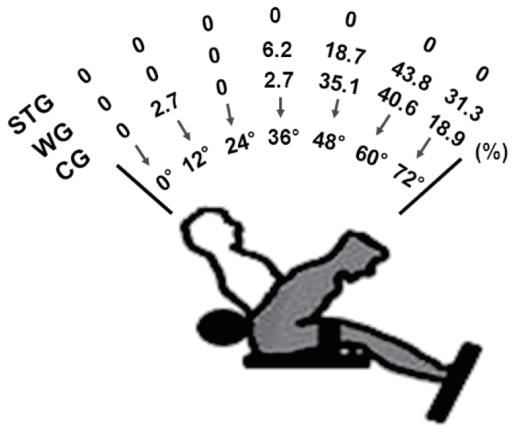

Fig. 1. Spinal range of motion in the control (CG), walking (WG), and strength & stretching exercise groups (SG) at different angles of lumbar flexion.

DISCUSSION

The proper rehabilitation procedure as well as the surgical skill of medical professionals is necessary to obtain optimal recovery after HNP surgery[3,15]. However, cooperative scientific research between surgeons and physical therapists about therapeutic exercises during the rehabilitation period after the surgery, have rarely been reported[9,13,16]. According to our results, the limitation of lumbar movement in the range of 0° to 72° was reduced in SG. Among all participants, the proportion of individuals who had low back pain and/or other negative symptoms during measurement were 7% in CG, 3% in WG, and 0% in SG at the position of full extension (0°). At each of 48°, 60°, and 72°, 25%, 51%, and 65% of CG, 10%, 37%, and 53% of WG showed movement limitation whereas none of the subjects in SG showed movement limitation at any angle. Limitation of lumbar ROM is closely associated with impairment of activities of daily life (ADLs). Lumbar ROM is critical for many activities such as bending one's waist forward, twisting the waist, Korean

Table 1. The change of isometric tension in the control, walking, and strength & stretching exercise groups at different angles of lumbar flexion

Angle	Group of Isometric Tension (ft-lbs)		
	Control	Walking	Strength & Stretching Exercise
0°	45.5 ± 29.8	57.7 ± 29.8	79.9 ± 35.8*
12°	68.7 ± 39.4	91.9 ± 49.0	117.6 ± 49.9*
24°	85.2 ± 40.4	108.1 ± 45.2	130.2 ± 50.1*
36°	95.1 ± 43.6	124.1 ± 53.7	147.1 ± 54.4*
48°	96.9 ± 54.5	130.6 ± 59.3	166.9 ± 54.9*
60°	85.1 ± 74.2	116.5 ± 80.4†	178.4 ± 55.2*
72°	56.0 ± 73.3	96.0 ± 88.2†	199.8 ± 51.3*

Significantly different from the control (*) and walking (†) groups (p<0.05).
ODI; Oswestry disability index.

Table 2. The change of Oswestry disability index (ODI) in the control, walking, and strength & stretching exercise groups

		Group		
		Control	Walking	Strength & Stretching Exercise
Total ODI		30.63 ± 15.17	28.49 ± 11.73	11.55 ± 2.98*†
Individual items of ODI	• Pain Intensity	1.45 ± 0.86	1.04 ± 0.35†	1.00 ± 0.50*
	• Walking	1.33 ± 1.10	1.04 ± 1.06	0.56 ± 0.73*
	• Sitting	1.39 ± 0.88	1.44 ± 1.19	0.78 ± 0.83
	• Standing	1.55 ± 0.98	1.08 ± 1.00	1.22 ± 1.20
	• Sleeping	0.60 ± 0.66	0.68 ± 0.48	0.33 ± 0.50
	• Sex life	1.83 ± 1.52	1.88 ± 1.89	0.43 ± 0.79*
	• Social life	2.13 ± 1.30	2.04 ± 1.02	1.89 ± 0.78
	• Traveling	1.52 ± 1.19	1.28 ± 1.17	0.78 ± 0.83*
	• Personal care	1.47 ± 1.09	1.60 ± 0.96	0.88 ± 0.60*
	• Lifting	2.47 ± 1.17	2.71 ± 1.37	2.22 ± 1.20

Significantly different from the control (*) and walking (†) groups (p<0.05).
ODI; Oswestry disability index.

bowing, and picking up an object from the floor. A previous study investigated lumbar flexion during touching the floor and showed that an intensive exercise program was more beneficial than no exercise in the early stage after HNP surgery. That result suggests the increase and preservation of ROM after HNP surgery are important factors in the early rehabilitation period. In accordance with that previous study, our lumbar ROM results also demonstrate it is a critical factor for the functional improvement of the lumbar spine and is related to muscle strength in the area and to the degree of disability. In our study, the self-stretching and strengthening exercise program (SSE) was added to walking exercise to increase the exercise intensity and it was clear that SSE with walking exercise was more effective than walking only or movement limitation for recovery after HNP surgery. It implies that intensive exercise in the early stage of rehabilitation after surgery, like our SSE program, may facilitate physical activities and contribute to an increase in lumbar ROM finally leading to recovery. This is supported by previous studies that have reported the quality and quantity of physical activities after HNP surgery depend on the degree of pain and fear induced by movement[17–20]. Compared to CG and WG, SG showed a significant improvement in muscle strength at each angle of lumbar flexion. The sum of muscle strength also increased most in SG compared to CG (92%), while WG showed only a 36% increase. Considering the possibility of inducing pain, we compared lumbar strength at 24°, the angle of least pain for all participants. SG and WG showed 53% and 27% increases in muscle strength compared to CG. SG also showed a 20% increase in strength over WG. In a previous study, which compared the effect of therapeutic exercise on strength of lumbar extension, the high intensity exercise group showed significant improvements in pain and muscle strength compared to the constrained exercise group. Moreover, it has been reported that an increase in muscle strength, pain reduction, and return to social participation were associated with high intensity therapeutic exercise[1,21–23]. A spine stabilization exercise begun 6 to 8 weeks after the surgery was shown to be more beneficial than stretching exercise for the improvement of lumbar extension strength[13]. These studies strongly suggest the importance of highly intensive strengthening exercises to prevent atrophy, which is easily caused by immobility after the surgery. They also suggest that evaluating the recovery of lumbar strength after HNP surgery can be used for identifying physical problems. Previous studies' results are also in accordance with our findings that the best improvement in muscle strength is induced by SSE, the high intensity exercise program in our study[1,13,24,25]. Once an individual has experienced deconditioning syndrome after HNP surgery, the disability index increases resulting in lower quality of life, e.g. activity constraints and delay in returning to work. The early application of therapeutic exercise is necessary to prevent deconditioning and to reduce pain and the disability index. In our results, SG had the lowest ODI score of the 3 groups, however, significant differences were found between groups not only in total scores but also in each of the 10 items of ODI. Because participants in this study were within one month surgery, the activities resulting in relatively high scores in ODI, such as sports activity, active social participation, and raising a heavy object were not allowed, considering the risk of injury recurrence. Consequently, it was difficult to find a difference among the groups in ODI during the early rehabilitation period after the surgery. A previous study also reported the intensity of therapeutic exercise had to be limited in the early stage after the surgery, possibly reducing the differences seen between groups[13,26]. In Korea, it is common that passive therapies such as wearing a waist support for a long period, constraining movements, electrotherapy, and thermotherapy are usually chosen after HNP surgery, instead active therapeutic exercise and increasing activities. Nevertheless, therapeutic exercise is effective and important for the patients after HNP surgery and can boost patients' satisfaction. Though lots of programs about therapeutic exercises including exercise and fitness programs have been developed in this aspect, it is still necessary to investigate the effect of these programs. Especially, the effect of physical therapy immediately after HNP surgery has been insufficiently studied[2,8,12]. Therefore, more scientific multidimensional investigations on the effects of physical therapy related to musculoskeletal disease should be conducted.

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