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Original Article

The effects of gluteus muscle strengthening exercise and lumbar stabilization exercise on lumbar muscle strength and balance in chronic low back pain patients

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Abstract. [Purpose] The aim of this study was to examine the effects of exercise to strengthen the muscles of the hip together with lumbar segmental stabilization exercise on the lumbar disability index, lumbar muscle strength, and balance. [Subjects and Methods] This study randomly and equally assigned 40 participants who provided written consent to participate in this study to a lumbar segmental stabilization exercise plus exercise to strengthen the muscles of the gluteus group (SMG + LES group) and a lumbar segmental stabilization exercise group. [Results] Each evaluation item showed a statistically significant effect. [Conclusion] Clinical application of exercise in this study showed that lumbar segmental stabilization exercise plus exercise to strengthen the muscles of the gluteus resulted in a greater decrease in low back pain disability index and increase in lumbar muscle strength and balance ability than lumbar segmental stabilization exercise in chronic low back pain patients receiving the exercise treatments during the same period.

Key words: Muscle strengthening exercise, Lumbar stabilization exercise, Chronic low back pain

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INTRODUCTION

At present, low back pain is one of the most common diseases in industrialized modern societies. In Korea, the frequency of low back pain is gradually on the rise, and 60 to 80% of people experience low back pain at some time in their life[1)]. Low back pain occurs most frequently in those in their 30s to 50s in both men and women, and it occurs most in women aged 40 or older[2, 3)]. Low back pain is classified into acute (six weeks or shorter), subacute (from six weeks to three months), and chronic low back pain (three months or longer) according to duration[4)]. Weakening of the abdominal muscles among the trunk muscles of low back pain patients is generally prevalent, and the strengthening of the abdominal muscles is essential in recovery of the spinal neutral position[5)]. When imbalance between the abdominal muscles of the trunk and extensor muscles occurs, it triggers low back pain and reduces stabilization of the lumbar segment[6)]. In addition, low back pain patients experience a decrease in trunk activity because of pain, structural damage, and inhibition of the reflex muscle contraction mechanism, and due to decrease of the activity of the trunk for a long time and disuse, muscle atrophy and a decrease in muscle strength occur, which aggravate low back pain and bring about secondary lumbar segment damage and physical disability[7)]. Regardless of the clinical causes, all those who complain of low back pain experience a decrease in muscle strength, muscle endurance, and flexibility, and limitation of lumbar and lower limb joint range of motion[8)].

The lumber muscles, which consist of deep stabilizer muscles; the multifidus muscle, transversus abdominis muscle, and internal oblique abdominal muscle, and superficial stabilizer muscles, the erector spinae muscle, rectus abdominis muscle, and external oblique abdominal muscle-play a role in lumbar segmental stability and as a basic support, and for lumbar segmental stabilization, strengthening of deep and superficial stabilizer muscles and co-coordination are necessary[9)]. The multifidus muscle and transversus abdominis muscle contract faster than the other muscles engaged in lumbar segmental stabilization, thereby maintaining body balance in all movements of the human body[10)]. However, Adams[11)] noted that stabilization muscles of the lumbar pelvic area were first mobilized involuntarily during movement of the lower limbs in healthy people, while stabilization

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muscles of the lumbar pelvic area in low back pain patients with unstable lumbar vertebrae were mobilized later.

In order to reduce such instability and increase stabilization of the waist, lumbar stabilization exercise has been applied to low back pain patients in many cases, and lumbar segmental stabilization exercise requires normal motor sensation so that the correct alignment of the trunk can be perceived and incorrect alignment of the trunk can be corrected[12].

The ability to actively control the muscles of the hip plays an important part in lumbar segmental stability. As a function of the gluteus maximus muscle, the sacroiliac joint delivers loads from the trunk to the lower limb, and if this joint moves excessively, it results in pressure on the joints and disks between the L5–S1 vertebral body, sacroiliac joint, and pubic symphysis, which leads to functional failure of the sacroiliac joint and low back pain. This causes the gluteus maximus muscle to contract, creating a self-locking mechanism, thereby providing stability to the sacroiliac joint[13].

Those with low back pain have a decreased balance ability compared with healthy people[14]. When the human body is exposed to an unexpected load, the muscles should swiftly respond to maintain balance and posture against the load, but low back pain patients have a delayed response time, triggering a problem in postural maintenance and balance. Lumbar segmental instability resulting from low back pain triggers a decrease in trunk mobility and balance ability due to damage to postural adjustment and a decline in muscle mobilization ability[15].

Recently, a lot of research applying lumbar segmental stabilization exercise to chronic low back pain patients is being conducted. Nonetheless, research focusing on the muscles of the hip is insufficient, although there is a close association between low back pain and the muscles of the hip and the muscle of the hip greatly and positively affect low back pain. Accordingly, the aim of this study was to examine the effects of exercise to strengthen the muscles of the hip together with lumbar segmental stabilization exercise on the lumbar disability index, lumbar muscle strength, and balance.

SUBJECTS AND METHODS

This study randomly selected 40 subjects from among female low back pain patients aged between 30 and 50, whose visual analogue scale score were 5 points or higher and whose low back pain disability indices were 20% or higher. They understood the purpose of this study, listened to an explanation about the experimental procedure, and voluntarily consented to participate in this study. The participants were provided a written informed consent form in accordance with the ethical standards of the Declaration of Helsinki. This study randomly and equally assigned 40 participants who provided written consent to participate in this study to a lumbar segmental stabilization exercise plus exercise to strengthen the muscles of the gluteus group (SMG + LES group) and a lumbar segmental stabilization exercise group (LSE group).

The same lumbar segmental stabilization exercise was applied to both groups, and the exercise to strengthen the muscles of the hip was added to the SMG + LSE group. All the subjects performed their respective exercise three times per week (for 50 minutes per day) every other day. The test items included the Oswestry Disability Index which was used to examine the degree of functional disability resulting from low back pain. In order to measure lumbar isometric muscle strength, M3 (Schnell, Germany) isometric muscle strength measurement equipment was utilized, and in order to examine balance, a Tetrax (Sunlight Ltd., Israel) was employed. Test were carried out before the intervention and again after six weeks of the intervention.

For all the exercises, in exercise of each step, the lumbar segment was located in the neutral position, and the targeted muscles were coordinately contracted. The neutral position here does not mean that the lumbar vertebrae lordosis angle was zero but instead refers to the lumbar vertebrae posture in which the patient felt most comfortable. The exercise to strengthen the muscles of the hip was conducted after thorough training of the patients; the patients were trained to precisely trigger muscle contraction with a focus on the muscles of the hip. For all the exercises, a therapist provided a demonstration in advance.

In exercise of the SMG+LSE group, the exercise to strengthen the muscles of the gluteus focused on the large gluteus muscle and the middle gluteus muscle. During the first to third weeks, the subjects conducted each exercise 15 times each per set without resistance, and two sets were performed for both the left and right sides; during the fourth to sixth weeks, the subjects performed each exercise 15 times each per set, with resistance, for a total of two sets for both sides.

Lumbar segmental stabilization exercise allows slight pelvic posterior tilt and increases intra-abdominal pressure by pulling the abdominal wall inward, triggering activation of the transversus abdominis muscle and internal oblique abdominal muscle, thereby promoting the contraction action of the muscles[16]. In a prone position, a biofeedback device (stabilizer) was located on the lower abdomen of the patients. While relaxing the body, the pressure was increased to 70 mmHg, and the patients were trained to pull the navel toward the waist while maintaining contraction and to breath before the actual exercise.

From the first to third week, the patients conducted exercise in a supine position, side-lying position, quadruped position, sitting position, and standing position on the wall without resistance, and from the fourth to sixth week, the patients conducted exercise with resistance in the same positions as in the first to third weeks. The abdominal muscle was pulled toward the inside of the abdomen within 10% of maximal muscle contraction power[17], and the contraction time of the deep muscles was 10 seconds per session, with 20 sessions per set.

The exercise was the same as the lumbar segmental stabilization exercise for the SMG+LSE group and was conducted for 10 seconds per session, with 20 sessions per set; two sets were performed.

Regarding the statistical processing in this study, means and standard deviations of all the data collected for the purpose of this study were calculated using PASW Statistics 18.0 for Windows. A paired t-test was conducted in order to

Table 1. General characteristics of the subjects

	SMG + LSE group (N=20)	LSE group (N=20)
	Mean ± SD	Mean ± SD
Age (years)	41.2 ± 5.5	41.2 ± 6.7
Height (cm)	161.5 ± 6.0	159.9 ± 4.7
Weight (kg)	59.7 ± 7.2	56.6 ± 4.2

SMG: strengthen the muscles of the gluteus; LSE: lumbar stabilization exercise

examine changes in lumbar disability index, lumbar muscle strength, and balance before and after the experiment within each group, and an independent t-test was carried out in order to compare homogeneity and changes between the groups. The significance level was set at (α)=0.05.

RESULTS

The general characteristics of the subjects were as follows Table 1.

The lumbar disability index changed by 9.9±3.2 in the SMG+LSE group and by 4.5±2.4 in the LSE group, and there was significant difference between the two groups ($p<0.05$). Isometric muscle strength with lumbar flexion changed by 23.7±10.9 in the SMG+LSE group and by 14.5±9.8 in the LSE group after the exercise, with significant differences between the two groups ($p<0.05$). Isometic muscle strength with lumbar extension changed by 30.6±17.4 in the SMG+LSE group and by 15.7± 14.7 in the LSE group, with significant differences between the two groups ($p<0.05$). The stability index changed by 4.8±1.8 in the SMG+LSE group and by 2.6±1.5 in the LSE group, with significant differences between the two groups after the exercise ($p<0.05$). The weight distribution index changed by 2.3±1.1 in the SMG+LSE group and by1.4±1.0 in the LSE group, with significant differences between the two groups ($p<0.05$) (Table 2).

Table 2. Comparison of changes in the Oswestry Disability Index, isometric lumbar flexion and extension strengthening, stability Index, and weight distribution index between the groups

	SMG+LSE group (N=20)	LSE group (N=20)
	Mean ± SD (Post–Pre)	Mean ± SD (Post–Pre)
ODI *	9.9 ± 3.2	4.5 ± 2.4
ILFS *	23.7 ± 10.9	14.5 ± 9.8
ILES *	30.6 ± 17.4	15.7 ± 14.7
SI *	4.8 ± 1.8	2.6 ± 1.5
WDI *	2.3 ± 1.1	1.4 ± 1.0

*$p<0.05$
SMG: strengthen the muscles of the gluteus; LSE: lumbar stabilization exercise; ODI: Oswestry Disability Index; ILFS: isometric lumbar flexion strength; ILES: isometric lumbar extension strength; SI: stability index; WDI: weight distribution index

DISCUSSION

This study conducted experiments in order to examine the effects of exercise to strengthen the hip muscle together with lumbar segmental stabilization exercise on the low back pain disability index, lumbar muscle strength, and balance.

At present in the clinical field, lumbar segmental stabilization exercise programs focusing on deep muscles are being applied to many chronic low back pain patients for motor therapy. For prevention and treatment of low back pain, excessive movement of the lumbar segment should be decreased, and the body alignment of the spine and pelvis should be corrected; for stabilization of the distal parts of the four limbs when the limbs start to move, proper isometric contraction of the trunk muscles is necessary[18].

Lumbar segmental stabilization exercise is drawing attention as a method for effective pain management in chronic low back pain patients, and stabilization exercise has been shown to improve lumbar stability through better muscle strength and improvement of muscle and movement adjustment ability based on the sensory motor control mechanism. In order to reduce instability of the lumbar segment and increase stability, this study applied the abdominal drawing-in maneuver as a lumbar segmental stabilization exercise and conducted exercise therapy.

Recently, studies of low back pain, the hip joint, and hip muscle strength have been reported, and Reiman noted that for low back pain treatment, the causes and methods of treatment of diverse types of lumbar pain should be considered, including movements of the waist, pelvis, hip joint, and lower limbs[19].

Reiman also observed that functional disorder resulting from weakening of the hip muscles and restricted hip joint range of motion has elements related to pathology of the waist and the lower limbs and that there is some association between the weakening of the hip muscles, functional disorder of the hip joint, and pathology of the waist[20].

As mentioned by leading researchers, there is a biodynamic relationship between low back pain, the hip joint, and hip muscles, and when applying an exercise program for low back pain treatment to chronic low back pain patients, stability of the pelvis and hip joints and strengthening of the hip muscles are important.

This study applied hip muscle strengthening exercise and lumbar segmental stabilization exercise to female chronic low back pain patients in their 30s to 50s and examined changes in the low back pain disability index, lumbar muscle strength, and balance. The subjects were divided into the SMG+LSE and LSE groups, and the SMG+LSE group conducted lumbar segmental stabilization exercise (abdominal drawing-in technique) plus hip muscle strengthening exercise, whereas the LSE group carried out lumbar segmental stabilization exercise (abdominal drawing-in technique). It is not easy to perfectly maintain the abdominal drawing-in technique. Therefore, prior to the experiment, the patients lay on a prone position and were trained on how to utilize the biofeedback device (stabilizer), and then the experiment proceeded.

The results showed that hip muscle strengthening exer-

cise in addition to lumbar segmental stabilization exercise increased the stability of the hip joint and pelvis, which was conducive to increasing lumbar segmental stability. It was also more effective for increasing the lumbar low back pain disability index, isometric muscle strength of lumbar flexion and extension, and balance ability.

To sum up the results, both SMG+LSE and LSE were effective for improving the low back pain disability index, lumbar muscle strength, and balance in chronic low back pain patients. Comparison of the changes in the two groups revealed that there was a more significant effect on low back pain index, lumbar muscle strength, and balance in the SMG+LSE group than in the LSE group. It is considered that the lumbar segmental stabilization exercise strengthened deep muscles, increasing lumbar segmental stability, and that hip muscle strengthening exercise increased the stability of the pelvis and hip joint, thereby positively affecting an increase in lumbar segmental stability.

The limitations of this study are that although the experiment was conducted with female chronic back pain patients in their 30s to 50s as the subjects, the number of subjects was small, and therefore it is difficult to generalize the results. Furthermore, physical activities and environmental factors other than exercise were not completely controlled for the subjects who participated in this experiment. Therefore, it is considered that continuous research actively complementing the proposed limitation is necessary.

In conclusion, clinical application of exercise in this study showed that SMG+LSE resulted in a greater decrease in the low back pain disability index and increase in lumbar muscle strength and balance ability than LSE in chronic low back pain patients receiving the exercise treatments duing the same period. In exercise therapy programs for chronic low back pain patients, adding hip muscle strengthening exercise to lumbar segmental stabilization exercise will be very helpful for rehabilitation and maintenance of smooth daily life. In the future, research focusing on hip muscle strengthening as well as lumbar segmental stabilization should be conducted continuously.

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