Original Article

Effects of a low back exercise program on low back pain patients' lumbar lordotic angle, abdominal muscle power, and pain

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ABSTRACT

Purpose: This study aims to identify the effects of a low back exercise program on low back pain patients' lumbar lordotic angle, abdominal muscle power, and pain. Methods: This study was conducted with 20 low back pain patients. The lumbar lordotic angle, abdominal muscle, and pain of participants were measured before and after the interventions. The participants were asked to conduct McKenzie Exercise and William Exercise through a low back pain exercise program for 30 minutes three times a week for six weeks. Results: the lumbar lordotic angle increased after the interventions, but there was no significant difference, and there were significant differences in abdominal muscle power and pain ($p < .05$). Conclusion: As a result of this study, the low back exercise program acted positively on the increase in abdominal muscle power and pain reduction. Therefore, it is judged that a low back exercise program would help manage low back pain efficiently.

Keywords: Low back exercise program; Low back pain patients; Abdominal muscle power; McKenzie Exercise; William Exercise.

Cite this article as:
Hong, S., & Lee, G. (2021). Effects of a low back exercise program on low back pain patients' lumbar lordotic angle, abdominal muscle power, and pain. *Journal of Human Sport and Exercise*, *16*(2), 456-462. https://doi.org/10.14198/jhse.2021.162.19

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Submitted for publication July 05, 2019.
Accepted for publication September 06, 2019.
Published April 01, 2021 *(in press* April 23, 2020).
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2021.162.19

INTRODUCTION

Low back pain is the term extensively expressing the pain syndrome appearing in the waist range from the second lumbar vertebra through the sacroiliac joint. Low back pain is the most common disease in modern society, which may cause the limiting of ADL. Medical expenses spent on inspection and management of it reach a socially considerable level (O'Sulivan et al., 2000). It has been reported that there is a high prevalence of 31% abroad (Hoy et al., 2012) and 26% at home (KCDCP, 2010).

The causes of low back pain include structural factors due to the lesion of the spine, psychological factors such as diseases of organs in the abdominal cavity or reproductive organs, lack of exercise and stress and biomechanical factors due to the dysfunction of the musculoskeletal system (Graves, 1994), and the main symptoms include muscle cramps, muscle dystonia, and pain in the local part (Manek & Macgregor, 2005). In addition, the decline of muscle power, the reduction of endurance, the loss of flexibility, the limited range of motion of the waist and lower extremity joint accompany due to low back pain, and especially, the reduction of low back muscle power is reported as an important cause and characteristic of the occurrence of low back pain (Nachemson, 1992). Therefore, it was reported that strengthening low back muscle power plays an important role in protecting the lumbar from stress (Nelson, 1993). In addition, it was noted that low back pain patients have weaker and unbalanced low back deep muscle than normal persons and poor position or motion sense due to the reduction of proprioception sense, resulting in the occurrence of stability problem of the spine, which brought about the recurrence of low back pain (O'Sulivan et al., 2003). Moreover, it was reported that the variation of lordosis due to the abnormality of posture greatly contributes to the occurrence of low back pain (Christie, 1995) and that the balance of the lumbar lordotic curve is a very important factor that improves the absorption of energy and the efficiency of muscles around the spine and maintains the upright posture. The increase in the lumbar angle of inclination increases shearing force, which suppresses facet joint and posterior spine ligaments to cause low back pain. Harrison et al. (1998) noted that hypolordosis occurs in chronic low back pain patients, and studies that compared lumbar lordotic curve with normal persons noted that low back pain patients' lumbar angle is noticeably lower than that of normal persons (Carvalho et al., 2010; Sevinç et al., 2007).

To resolve various problems due to low back pain, low back (lumbar part) exercise methods in certain forms are proposed, and representative exercise methods are McKenzie Exercise (McKenzie, 1979) and William Exercise (William, 1965).

Many studies reported effects of McKenzie Exercise and William Exercise (Williams, 1965; McKenzie, 1979; Moffett, 1989; Charles & Ruth, 1994; Lars et al., 2008), and there have been few studies of the effects of the application of the two exercise methods. Accordingly, this study would examine the effects of low back (lumbar) exercise program (combined with McKenzie and William Methods) on the lumbar lordotic angle, abdominal muscle power, and pain with low back pain patients.

METHODS

Participants

This study recruited low back pain patients who visited or were hospitalized at C. Neurosurgery Clinic, and the volunteers were screened according to the following criteria: 1) The persons who were diagnosed with low back pain; 2) Those who were diagnosed that no surgery would require in radiological examinations; and 3) Those who did not have any musculoskeletal or neurological disease other than low back pain. As for the general characteristics of the participants, the average of their age was 38.90 ± 6.08 (years old); the average

of their height, 165.40 ± 7.85 (cm); and the average of their weight, 65.00 ± 9.55 (kg).

Procedure

This study was a pretest-posttest design, which measured all participants' lumbar lordotic angle, abdominal muscle power, and pain before and after interventions and conducted low back exercise program, McKenzie Exercise and William Exercise for 30 minutes three times a week for six weeks, a total of 18 times. McKenzie Exercise and William Exercise were conducted for 15 minutes, respectively, and light stretching was conducted for 10 minutes in the beginning and after the exercise. As warming up and cool down exercises.

Table 1. Low back exercise program.

	Exercise program	**Exercise time**
Warming up	Passive stretching	10 minutes
McKenzie Exercise	Lie on one's face Lie with one's face down and stretch one's back (Both elbows) Lie with one's face down and stretch one's back (Opening one's arms) Stand up and stretch one's back Lie down and bend one's legs Sit down and bend the body	15 minutes
William Exercise	Lean the pelvis Lift the upper body Bend both legs Bend one's waist forward Extend iliopsoas Squat down	15 minutes
Cool down	Passive stretching	10 minutes

Outcome measurements

Lumbar lordotic angle

The lumbar lordotic angle was measured by radiography. Using DXG-525R Model, at a distance of 42 inches, the same radiologist took photographs of the front/back, sides, and oblique positions while the participants were standing up. In the photographs taken, lumbar lordosis was measured by the method of calculating the angle the vertical line of the straight line connecting the upper border of the first lumbar vertebra forms with the vertical line of the straight line connecting the upper border of the fifth lumbar vertebra (Wiltse & Winter, 1983).

Abdominal muscle power

Abdominal muscle power was measured by a 1-min sit-up test. It is an easy and simple abdominal muscle power test method for the intrinsic factors of back muscle and abdominal muscle, in which the number of sit-ups in one minute is measured, based on the touch of the elbows on the knees, lifting the upper body when one lies down on one's back with the knees drawn up on the mat, locking one's fingers together behind the neck while a third party is holding the ankles, sitting on the heels.

Pain

The pain was measured, using a Visual Analogue Scale (VAS) (Huskisson, 1974). It is a method of measuring pain in which the participants mark the position where they think there are their pain on a bar of 5 cm in height

and 10 cm in overall length laid at the bottom of the item of the questionnaire, and the pain is measured between "*0*" without pain and "*10*" with very severe pain.

Statistical analysis

This study conducted statistical analysis, using SPSS 18.0 version, and to analyse changes in the degrees of lumbar lordotic angle, abdominal muscle power and pain before and after interventions, a paired t-test was conducted. The statistical significance level was set at $\alpha = .05$.

RESULTS

Changes of lumbar lordotic angle, abdominal muscle power, and pain

After interventions than before, lumbar lordotic angle increased from 28.10 ± 4.98 to 28.60 ± 4.67 (degrees), but there was no significant difference. Abdominal muscle power increased from 18.30 ± 10.28 to 23.40 ± 10.53 (times), and pain decreased from 6.53 ± 0.86 (cm) to 1.64 ± 0.79 (cm), and there were statistically significant differences.

DISCUSSION

There is an overall trend of increase or decrease in a lordotic curve in the cervical part and the lumbar part in low back pain patients (Briggs et al., 2011; Edmondston & Singer, 1997). Christie et al. (1995) argued that low back pain was associated with the increase of the lumbar lordotic curve, Been et al. (2012) observed that in chronic low back pain patients, lumbar lordotic angle and static balance changes as compared to normal persons, which leads to the faster progress of spondylarthritis and disc degeneration, and especially, the space of the disc joint in the lumbar part becomes narrow, which causes flat back in the lumbar part due to the reduction of lumbar curve and transforms the normal lumbar lordotic angle, resulting in the imbalance of the sagittal plane spine, continuous pain and the increase in muscle fatigue. Thus, it was reported that it would be important to maintain the normal person's lordotic curve in order to prevent the degenerative change in the spine structure and reduce the pain. Concerning this, Jackson et al. (1994) suggested that therapeutic approach should be made in the direction to increase the lumbar lordotic angle since lumbar lordotic angle decreases, and loads applied to the intervertebral disc, facet joint and the surrounding tissues increase in low back pain patients. These previous studies show the connectivity with this study, and that this shows the strengthening of the trunk muscle power through the lumbar part exercise causes the increase in lumbar lordotic angle, which accordingly has an important impact on low back pain reduction. Thus, it is necessary to consider the lumbar lordotic angle for the evaluation and management of low back pain patients.

The muscle power of the trunk plays an important role in creating posture stability and endurance while the weakening of the muscle power of the trunk in low back pain patients has negative impacts on daily life as well as occupational activities (Beimborn & Morryssey, 1988). As for studies of the correlation between the increase in muscle power due to low back exercise and low back pain, Yilmaz et al. (2003) reported that the increase of muscle power of the spine part improved the stability of the low back and reduced the pain due to the herniation of lumbar disc in the patients who received microdiscectomy on the lumbar part, and Kliziene et al. (2015) also reported that abdominal muscle exercise, using bridge exercise, brought about significant effects on the recovery of weakened muscle function of chronic low back pain patients and pain reduction. The results of these previous studies also support the results of this study. As one of the causes of low back pain, as another leading cause along with the weakening of lumbar part muscle power, the normal ratios of the flexor and extensor are emphasized much. According to Smith et al. (1985), the muscle ratio of the trunk on the same side, that is, the balance ratio of the muscle power of the flexor and extensor exhibited by the

surrounding muscles of the waist muscle power should be a level of 80%, and if this ratio breaks, injury in the lumbar part would be caused. In fact, in most of low back pain patients with lordosis on the lumbar part, the power of extensor is developed stronger than the power of the flexor, and as the weakened power of the flexor of the low back improves faster than the power of the extensor through low back exercise, low back pain can be controlled with the alleviation of the spine curve with lordosis. This theory would also support the results of this study.

The pain in a spine disease is one of the main symptoms in the patients, and in the judgment of the results of interventions, it is an important measure for determining the usefulness of the interventions. This study used VAS to check the results of interventions, and it turned out that the pain significantly decreased on the VAS after the interventions. This means that the subjects participating in this study realize pain reduction after the lumbar part exercise program. Exercise using the repeated low back extension, McKenzie Exercise reduced swelling, moving the nucleus pulposus subject to loads and stabilized the facet joint to reduce pain and inflammation, while isometric flexion exercise, William Exercise reduced the pressure of nerves, expanding the intervertebral foramen and facet joint and promoted the muscle power of abdominal muscle and gluteus muscle, to reduce the pain, reducing the fixation of lumbar (low back) synapses pain (Brotzman et al., 1996). This supports the results of this study that the improvement of muscle power through a low back pain exercise brings about changes in the pain.

However, this study has a few limitations. First of all, the limitation of the study design. This study was conducted with an experimental group to which interventions were applied but did not have a control group with which the effects could be compared. Also, no randomized controlled trial was conducted in addition to the inclusion of the control group. In addition, this study did not consider the period of the prevalence of individuals' pain. This would not exclude the possibility of the impacts of several biases on the study results. However, a positive aspect could be found out through the results of this study that without using a special resistance exercise apparatus, only a lumbar part exercise program could help strengthen the muscles and reducing the pain, and it would be necessary to examine the effects of the low back exercise program for the efficient management of low back pain through quality research in the future.

AUTHOR CONTRIBUTIONS

SKH and GCL participated in the design of the study and performed the statistical analysis. SKH and GCL interpreted collected data. SKH and GCL were main contributors in writing the manuscript. All authors read and approved the final manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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