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Effect of Core Program Exercise for Lumbar Extensor Strength and Pain of the Patient with Chronic Low Back Pain

Dae-Hun Kim[1] and Wan-Young Yoon[2*]

[1]Department of Physical Therapy, Kyungdong University, Goseong-gun, South Korea; vertetrac@k1.ac.kr
[2]Department of Physical Education, Seowon University, Cheongju, South Korea; wanyoung72@gmail.com

Abstract

The purpose of this study is to analyse and to compare the difference and the change between lumbar extension exercise group and lumbar extension exercise with core program exercise group in the area of lumbar extension strength through lumbar extensors strengthening exercise. 50 subjects (CP: 25, NCP: 25) were chosen among chronic low back pain patients between 20 and 60 years old patients who have no previous medical history and no abnormalities in lumbar confirmed by medical experts. Before of research, pre-tested the lumbar extension strength of each group. After 4, 8, 12 weeks of strengthening muscle exercise, retested it and compared the data with initial data. All data acquired in this study were analyzed using SPSS/PC V. 10.0 program for Windows. A t- test was conducted for the comparison of extended muscle strength in the lower back before and after the exercise. In order to see changes in muscle strength at various points (before exercise, 4 week point, 8 week point, 12 week point), a repeatedly measured ANOVA was conducted. To compare the statistical difference during the exercise period, a Tukey HSD was conducted as verification. To identify the level of lower back pain before and after exercise in each group, a paired t-test was conducted. The difference between levels of pain across groups underwent an independent t test and significance level was set at $p<.05$. By analysing results, After 4 weeks and 8 weeks and 12 weeks CP & NCP exercise, there was significant lumbar extensor muscular strength and VAS ($p<.05$). But there was significant difference to increase in lumbar extensor muscular strength and VAS between CP and NCP. Core program more effective exercises for patients with low back pain and the public in order to achieve more effective lumbar rehabilitation and better muscle strengthening in the field of weight-training or therapeutically exercise. apping is an important process for determining the final composition of steel products in steelmaking. For efficient tapping, various facilities and constraints are needed. This study presents a systematic methodology that can be applied for deciding the optimal equipment operation patterns in the tapping process.

Keywords: Low Back Pain, Lumbar Stabilisation Exercise, Chronic Pain, Lumbar

1. Introduction

Lower back pain refers to issues from just the musculoskeletal system and excludes pain of the lower back caused by pregnancy, menstrual period or infection of the urinary system. Regardless of whether there is radiating pain, it refers to cases where the pain in the lower back, the area lower than the No.10 thoracic vertebra, lasts for three days or more[17]. It is one of the common and burdensome medical issues of today[9].

There are various factors that increase lower back pain but major causes are damages to the soft tissue in

* *Author for correspondence*

the trunk or a diminished muscular strength in the area[9]. The muscular strength of the lower back in chronic lower back patients is lower than normal people and this causes tension and pain the area[12].

In order to reduce pain, these patients are reluctant towards physical activities and minimise the movement of the trunk, leading to further contraction of the extending muscle in the lower back, which in turn increases the pain or psychological pressure[16]. Moreover, when there is an imbalance of muscles around the vertebra, this constricts the movement of the vertebra, adding excessive weight to nearby joints and causing a weakening of muscles which in turn bring about lower back pain. In particular, we are bound to repeat movements of bending our body forward and obesity around the stomach area due to lack of exercise can further weaken the extensor muscles. Therefore exercises to strengthen the extensor muscle in the lower back can help treat lower back pain and prevent the situation from worsening [18].

Efforts and treatments to rehabilitate people from lower back pain have undergone changes over the past several centuries, from exercises to strengthen the extensor muscle of the lower back to more recently, dynamic lumbar stabilisation exercise[18]. The purpose of the stabilisation exercise is to improve the body's ability to maintain a neutral position that minimises stress on the vertebral structure, thereby reducing small damages to parts of the lower back that may happen repeatedly.

Handa[19] Noted that because the trunk postures in daily life, the maintenance of proper muscle strength and endurance is important. The trunk muscles play an important role in supporting the lower back and there is a correlation between lower back pain and the muscle strength of the trunk. Therefore chronic lower back pain patients should work on improving the strength of their trunk muscles. Nan[13] Showed through a spectrum analysis of an electromyogram that the level of muscle fatigue in chronic pain patients was higher than the control group in not only the lower back muscles but also the abdominal muscles. Therefore, exercise for the patients of chronic lower back pain should be not just focused on the lower back muscles but also the entire trunk muscles including abdominal muscles.

Core programs is a method of stabilising the lower back and offers core stability and balance of the trunk against the effect of gravity as the human body seeks to maintain its upright position. Core muscles are trunk muscles in the vertebra, abdomen and pelvis that allow the muscles of the limbs to carry out their functions without excessive stress on the vertebra [1].These core muscles are where the body's strength and dynamics occur. Every time we move our body they help maintain center balance and the musculoskeletal structure, thereby protecting important muscles and bones. Through repeated maximum isometric contraction of these core muscles, the weakened muscles can be stretched and strengthened to maximize mobility and stability, as suggested in the core program of Brill and Couzen[5]. This core program is known to ease the pain among patients of chronic lower back pain and also as a way of preventing lower back pain for the general public. With the introduction of core programs in Korea, they are now being used as an exercise program to resolve pain in chronic patients. However, despite the clinical effects of such core programs there is a lack of objective studies that verify the effects. As such, this study was conducted to carry out a comparative analysis of the core program's effect on the increase of extensor strength in the lower back and changes to pain in the lower back.

2. Methodology

2.1 Study Subjects Ethical Consideration

Patients who were diagnosed by a neurologist at G Hospital located in Pyeongtaek, Korea with chronic lower back pain that has lasted for 6 months or longer but with no other abnormalities were prescribed to carry out exercises at the vertebral exercise center. Among these patients, those between the ages 20 and 60 amounted to a total of 50 patients. Among them, 25 patients who were taking lower back extensor exercises and core programs (CP) and 25 patients who were undertaking lower back muscle extensor exercises (NCP) were randomly selected regardless of gender for the study. These subjects have any cardiovascular diseases, have not undergone surgery and were able to carry out exercises (Table 1).

Table 1. General characteristics of subjects

	CP (n=25)	NCP (n=25)	Total (n=50)
Age(yrs)	45.60±13.34	39.36±12.52	42.48±12.93
Height(cm)	163.40±7.62	163.80±7.84	163.60±7.73
Weight(kg)	60.64±9.70	58.32±9.41	59.48±9.56

Mean±SD

2.2 Core Program

Core programs are categorised into beginner, intermediate and advanced. In the beginner stage, there are 14 movements, with most of the movements stabilising the lower back in a neutral posture and isometric exercise that involves contracting the muscles as much as you can without moving the joints. This is the safest stage with no concern for injury. In the intermediate and advanced stage, dumb bells or ankle weights are added to increase muscle strength and includes isotonic exercise. In this study, since the intermediate and advanced stages include movements of the joint that are pushing the limit for patients with chronic lower back pain, they were excluded and only the beginner core program (Table 2) was used.

Table 2. Core program

Core Program	Effect and Purpose
Head-to-toe warm exercise	The spinal stretch the entire body relieving joint stiffness
Stretching the tongue	Relax your face and jaw muscles and stretch the vagus nerve
Valley Blaster	With the spine to strengthen the abdominal muscles and pelvic floor muscles
Abdominal breathing	Muscle tension relaxation, gas exchange
Cobra	Such as the spinal discs to relax and relieve stress
Butterfly / heel encounter	Neck, shoulders, back muscles to stabilise, strengthen
Three step pelvic stabilisation exercises	Abdominal, lumbar, pelvic, Hamstring Muscle strengthen
Hamstring Stretch	Hamstring, quadriceps increase of flexibility
Fold the knee to the chest	Lumbar muscles and soft tissue stretch
Lying spinal twist	Chest, shoulders, neck muscles to the maximum stretch
Abdominal breathing	Muscle tension relaxation, gas exchange
Cross Extension	Both limbs of the body, balance and stability exercise acquisition
Cobra	Such as the spinal discs to relax and relieve stress
Last abdominal breathing	Muscle tension relaxation, gas exchange

2.3 Exercise Program

This study composed of 25 patients in the lower back extensor exercise and core program group (CP) and 25 patients in the lower back extensor muscle exercise group (NCP) as subjects. The subjects carried out their exercise three times a week for three months. Both groups also carried out Progressive Aerobic Exercises that are in accordance with the individual's joint pain and to an intensity of 40-60% of target heart rate, for 10 to 15 minutes. Lower back extensor and weight-lifting exercise was done after a pre-test and measuring the peak torque. The exercises were done starting at 50% of peak torque and were repeated 10-15 times for 60 to 90 seconds. If 12-15 repeats were possible without any specific symptoms, the weight was gradually increased by 5-10% and every 4 weeks the peak torque was measured to determine the dynamic weight as seen in Table 3.

Table 3. Exercise program

	Equipment	Min	
Warm up	Cycle	10 ~ 15 min	
	Treadmill	10 ~ 15 min	
Muscle strength exercise	Medx lumbar extension	6(sec)*10~15(rep)= 60~90(sec)	
	Hip extension	6(sec) * 12~15(rep)	* 3 set (20~25 min)
	Torso flexion	6(sec) * 12~15(rep)	
	Rotary torso	6(sec) * 12~15(rep)	
	Knee extension	6(sec) * 12~15(rep)	
	Abdominal	6(sec) * 12~15(rep)	
Core program		15 ~ 20 min	
Cool down	Stretch exercise	10 min	

2.4 Measurement Category and Method

2.4.1 Velocity Measurement of the Lower Back Muscle Strength

In order to measure the extensor strength of the lower back before and after the exercise of each group, a Medx Lumbar Extension Machine was used to measure the maximum isometric extensor strength in the lower back at 0°, 12°, 24°, 36°, 48°, 60°, 72° of the lower back joint angle. In order to measure only the extensor strength of the lower back, the patient was seated on the machine and his pelvis and thigh fixed using a knee restraint, thigh restraint, pelvic restraint to prevent the muscle strength

of the lower body from being mobilized. A counter balanced was used to offset external strength other than pure muscle strength of the lower back and to ensure a uniform measurement condition.

Referring to pain and the limited joint angles, at the call of the test conductor, the lower back was gradually extended, pushing the upper resistance pad for 2-3 seconds and when maximum strength is exerted, it was maintained for 1-2 seconds while the extensor strength of the lower back was measured.

2.4.2 Lower Back Pain

In this study, in order to measure lower back pain, the visual analogue scale which is commonly used in clinical or research settings was used. VAS has the patient mark the level of pain on a line where no grids are given then the distance from the beginning point to the marked point is measured and converted into scores. It is a method with a high reproducibility. Therefore in this study, patients were asked to mark their level of pain on a scale of 1 to 10 before the exercise and 12 weeks after the exercise.

2.5 Data Analysis

All data acquired in this study were analyzed using SPSS/PC V. 10.0 program for Windows. A t- test was conducted for the comparison of extended muscle strength in the lower back before and after the exercise. In order to see changes in muscle strength at various points (before exercise, 4 week point, 8 week point, 12 week point), a repeatedly measured ANOVA was conducted. To compare the statistical difference during the exercise period, a Tukey HSD was conducted as verification. To identify the level of lower back pain before and after exercise in each group, a paired t-test was conducted. The difference between levels of pain across groups underwent an independent t test and significance level was set at $p<.05$.

3. Findings

3.1 Changes in the Extensor Strength of the Lower Back Before and after CP and NCP Exercises

In the CP group that did both lower back extensor exercises and core program exercises, the change in extensor strength of the lower back was 5334.80±1888.49 before exercise and 11589.20±2539.32 after exercise, indicating an increase. In the NCP group, before exercise was 5533.36±1972.47 and after exercise 10015.48±3049.29, indicating an increase, thereby suggesting that both types of exercises were effective in improving the muscle extension strength of the lower back. The results were statistically significant (Table 4).

Table 4. Lumbar extension exercise program, the exercise group and core (CP) and lumbar extension exercise group (NCP) of exercise before and after changes in lumbar extension strength

	Before	After	t	P
CP	5334.80±1888.49	11589.20±2539.32	17.14	.000
NCP	5533.36±1972.47	10015.48±3049.29	12.21	.000

3.2 Comparison of Muscle Extension in the Lower Back at Various Time Points for CP and NCP

For the CP group, the extensor strength of the lower back before exercise was 5334.80±1888.49, at four weeks 8290.12±2370.42, at eight weeks 10115.20±2830.45, and at 12 weeks 11589.20±2539.32. For the NCP group, the figure before exercise was 5533.36±1972.47, at four weeks 7513.28±2548.79, at eight weeks 9053.28±2770. 67 and at 12 weeks 10015.48±3049.29. There was a statistically significant difference as seen in Figure 1.

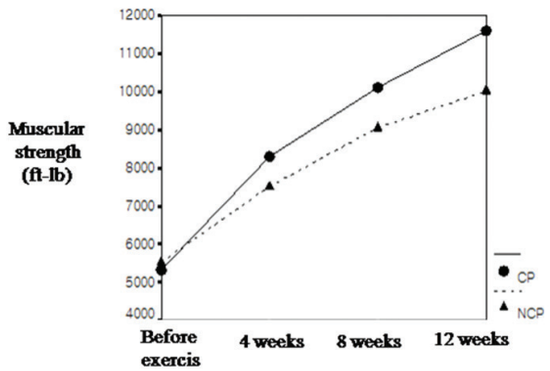

Figure 1. Exercise of the CP and NCP, 4 weeks later, after 8 weeks, and 12 weeks after the change in lumbar extension strength

In the above results, both groups showed an improvement in extensor strength of the lower back over time, from before exercise to 4 weeks after, 8 weeks after and 12 weeks after. But a post-study verification showed that for the group CP, there was a statistically significant

difference in all periods (p<.05) except for the period 4-8 weeks (p=.077), and for the NCP group all periods were statistically significant (p<.05) except for the period 8-12 weeks (p=.064). This result indicates that over time, the group that carried out the core program in addition saw a higher improvement in the extensor strength of the lower back.

3.3Changes in Lower Back Pain in the CP and NCP Groups Before and After Exercise

The CP group saw a change in lower back pain from 5.68±1.41 before exercise to 1.52±0.87 after exercise and the NCP group saw a change from 5.48±1.69 to 2.24±1.42 after exercise. Both CP and NCP had statistically significant differences (Table 5).

Table 5. CP and NCP exercise between the before and after comparison of visual analogue Scale

	Before	After	t	P
CP	5.68±1.41	1.52±0.87	16.242	.000
NCP	5.48±1.69	2.24±1.42	13.500	.000

In addition, comparing the results before and after exercise in each group, CP showed more statistical significance at4.16±1.28 than NCP at3.24±1.20. Therefore, both CP and NCP were effective in reducing the pain of patients suffering from chronic lower back pain, but CP saw a greater degree of reduction (Table 6).

Table 6. Between CP and NCP exercise of the visual analogue scale before and after comparison for the difference

	Before and After Comparison for the Difference	t	P
CP	4.16±1.28	2.62	.012
NCP	3.24±1.20		

4. Discussion

The aggressive exercise treatment program for lower back pain normalises the body's functions and reduces lower back pain[7]. Nachemson[14] measured the extensor and flexor to identify the importance of muscle strength in the lower back in regards to lower back pain and discovered that lower back pain was closely related to a weakened extensor.

Akuthota and Nadler[1] showed that extensor exercises in the lower back increase the muscle strength and reduce chronic lower back pain. In the experiment conducted on patients that underwent surgical and non-surgical treatment, muscle training exercises had a positive effect on reducing pain. In this study, too, the group that only carried out extensor strengthening exercises (NCP) saw an increase in muscle strength 12 weeks after the start of the exercise and a decrease in pain.

Repeated stress on the lower back pain is one of the most common reasons that cause lower back pain and malfunction of the muscle in the trunk causes stress in the tissue which leads to lower back pain. Therefore, the capability to control the pressure and weight on the lower back pain can be a way of preventing the recurrence of pain and deter the pain from becoming chronic[10]. Patients with chronic lower back pain showed significantly lower muscle strength in the core[11] and this proves that the muscle strength of the core is a risk factor for lower back pain[6]. Beimborn and Morryssey[3] noted that while the core muscle strength plays a supportive role for endurance and stability, patients with lower back pain see their weakened core muscles causing decreased function, threatening their daily lives or work lives. Therefore core programs are exercise programs that can strengthen the core muscles and increase stability by maintaining balance in the vertebra including the pelvic cavity which forms the center of the body, as well as the contraction of the abdominal muscles that form the lower part of the abdomen[18].

This study was conducted to see if core programs had an effect on reduced pain or the extensor strength in the lower back of patients suffering from chronic pain in the lower back. To that effect, the level of extensor strength and pain when extensor exercises and core programs were conducted together were measured.

The results show that in the group that carried out 12 weeks of the core program (CP group), muscle strength after exercise increased to 11589.20±2539.32 while the NCP group increased to 10015.48±3049.2. There was a significant difference in the change of muscle strength in the two groups but the CP group appeared to be more efficient in increasing the strength of the extensor in the lower back. This is in line with the study by Blomberg[4] that while isometric exercises increase activity of the muscles in the lower back and the small and big muscle groups of

the core are emphasised for movement adjustment, the stability and strength of muscles increase.

In terms of the increase rate in muscle strength, verification of the change in muscle strength before and after the exercise for groups CP and NCP showed that the increase rate for extensor strength in the CP group was 55.40% at 4 weeks, 22.02% at 8 weeks, and 14.57% at 12 weeks. For the NCP group, it was 35.78% at 4 weeks, 20.50% at 8 weeks and 10.63% at 12 weeks, showing that the CP group showed a higher increase rate. Both groups saw the highest rate of increase at the 4 week point and at the 12 week point, the increase in muscle strength was smaller. Therefore, this was in line with the preceding study of Nam[13] on the effect of long-term exercises strengthening the lower back on lower back pain where it was shown that the increase rate for muscle strength was higher at week 4 and 8 than at week 12.

In terms of pain, the CP group changed from 5.68±1.40 before exercise to 1.52±0.87 after exercise and the NCP group changed from 5.48±1.68 before exercise to 2.24±1.42 after exercise, showing that both groups saw a significant effect on the reduction of pain in chronic patients, which was in line with preceding studies[2]. But the degree of reduction was more positive in the CP group. This shows that core programs strengthen the muscles surrounding the vertebra, prevents the vertebra from excessive weight and stabilises movements, thereby being effective to the reduction of pain. But given that after 12 weeks of exercise the pain had not completely gone away, a complete treatment would require longer-term exercise plans.

In order to maintain the effect of exercise, posture and habits in daily life are important[8] and because the weakening of the extensor in the lower back and bad postures in daily life take up a large portion of the cause in chronic lower back pain, consistent strengthening of the extensor in the lower back and proper posture will be required. Moreover, regular exercise that fit the lifestyle is required to maintain endurance and muscle strength. It appears that in order to improve the function of lower back pain patients, re-training of the muscle, strengthening of the stability in the lower back and isometric exercises rather than simple movements will have to be conducted to ease the burden on the damaged lower back.

Therefore this study was in line with preceding studies that showed that core programs for non-patients were helpful in improving the body's stability and flexibility, and reducing pain[15].

Core programs are deemed to be an effective exercise for the treatment of patients with chronic lower back pain, by increasing the muscle strength of the extensor in the lower back, reducing pain and improving the function of the lower back. The maximum effect is considered to be gained when an appropriate program is prescribed that fits the characteristics of the patient based on accurate assessment.

5. Acknowledgement

This study shows that while the extensor exercise for the lower back is effective in increasing the extensor strength and reducing pain, conducting a core program in addition has a more positive effect in improving muscle strength and reducing lower back pain.

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