

# Effects of the CORE Exercise Program on Pain and Active Range of Motion in Patients with Chronic Low Back Pain

HWI-YOUNG CHO, PT, PhD<sup>1)a</sup>, EUN-HYE KIM, PT, MS<sup>2, 3)a</sup>, JUNESUN KIM, PT, PhD<sup>2)\*</sup>

<sup>1)</sup> Department of Physical Therapy, College of Health Science, Gachon University, Republic of Korea

<sup>2)</sup> Department of Physical Therapy, College of Health Science, Korea University: 1 Jungneung-3-dong, Sungbuk-gu, Seoul 136-703, Republic of Korea

<sup>3)</sup> BK21+ Program in Public Health Sciences Program, Korea University Graduated School, Republic of Korea

**Abstract.** [Purpose] This study aimed to identify the effects of the CORE exercise program on pain and active range of motion (AROM) in patients with chronic low back pain. [Subjects and Methods] Thirty subjects with chronic low back pain were randomly allocated to two groups: the CORE group (n = 15) and the control group (n = 15). The CORE group performed the CORE exercise program for 30 minutes a day, 3 times a week, for 4 weeks, while the control group did not perform any exercise. The visual analog scale (VAS) and an algometer were used to measure pain, and pain-free AROM in the trunk was measured before and after the intervention. [Results] The CORE group showed significantly decreased VAS scores at rest and during movement and had a significantly increased pressure pain threshold in the quadratus lumborum and AROM in the trunk compared with those in the control group. [Conclusion] This study demonstrated that the CORE exercise program is effective in decreasing pain and increasing AROM in patients with chronic low back pain. Thus, the CORE exercise program can be used to manage pain and AROM in patients with chronic low back pain.

**Key words:** CORE exercise program, Chronic low back pain (CLBP), Active range of motion (AROM)

*(This article was submitted Jan. 22, 2014, and was accepted Feb. 16, 2014)*

## INTRODUCTION

Low back pain is a prevalent disorder in modern society, with 80% of the population suffering from it at least once in their life<sup>1)</sup>. Among them, 7–10% will develop chronic low back pain (CLBP), and 1% will have physical disabilities<sup>2)</sup>. CLBP is not only painful but also leads to loss of function, so this condition hampers a healthy lifestyle<sup>3)</sup>. Low back pain is increasingly seen in patients in their 20s to 40s, especially due to the economic development of society and changing working environments<sup>4)</sup>.

Low back pain is caused by a degenerated or damaged facet joint or sacroiliac joint with soft tissue injury on the trunk or by lumbar instability from weakened muscle strength<sup>5)</sup>. Lumbar instability restricts muscle strength, endurance, flexibility, and active range of motion (AROM). In particular, patients with CLBP persisting for more than 6 months restrict trunk movement to minimize pain in the lumbosacral area or leg, which aggravates the level of lum-

bar muscle weakness in paraspinal muscles and the multifidus<sup>6)</sup>. These changes increase lumbar instability and raise the recurrence of low back pain. Therefore, abdominal and spinal extensors are crucial in improving lumbar stability. Patients with CLBP suffer from deteriorated physical functions and production activities due to weakened muscle strength in the lumbar region. Therefore, exercises that increase muscle strength and flexibility are very important for CLBP patients not only to alleviate low back pain but also for continued self-care<sup>7)</sup>. In addition, differences in motor control patterns, such as poor postural control and altered muscle recruitment pattern, have been reported.

The CORE exercise program involves active participation to improve lumbar stability by recovering the ability to control muscles and movements through muscle strengthening<sup>8)</sup>. The CORE exercise program, suggested by Brill, focuses on lumbar stabilization by controlling tension of the lumbo-pelvic-hip joint, thereby maintaining lumbar stability, strengthening muscles, increasing endurance, and correcting posture<sup>9)</sup>.

One method of the CORE exercise program focuses on abdominal respiration. The abdominal respiration method supplies oxygen smoothly throughout the body and expands lumbar muscle, thus reducing muscle tension and stress, which ultimately alleviates fatigue. The CORE exercise program can easily be conducted at home with almost no restrictions regarding place, time, and cost, and has

<sup>a</sup>These two authors contributed equally to this work.

\*Corresponding author. Junesun Kim (E-mail: junokim@korea.ac.kr)

©2014 The Society of Physical Therapy Science. Published by IPEC Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License <<http://creativecommons.org/licenses/by-nc-nd/3.0/>>.

a low risk of injury<sup>9</sup>). It is designed to suit CLBP patients by combining traditional yoga movements and exercises to increase muscle strength and flexibility, and to correct posture. However, the effectiveness of Brill's CORE exercise program on pain and AROM in CLBP patients remains unclear. Thus, the purpose of this study was to identify the effects of the CORE exercise program on pain at rest and during movement and on AROM in patients with CLBP.

## SUBJECTS AND METHODS

Thirty patients with CLBP at local clinics located in Seoul were recruited for this study. Subjects were randomly assigned to the CORE group ( $n = 15$ ) or the control group ( $n = 15$ ). Patients who had a history of spinal or lower limb operation, signs of nerve compression, inflammatory diseases, or signs of aggravated acute pain or had performed stabilization exercises within 6 months were excluded from the study. All experimental procedures were conducted in accordance with the guidelines set by the local research ethics committee.

The subjects in the CORE group conducted the CORE exercise program for 30 minutes, 3 times a week, for 4 weeks. This program is divided into 3 categories: warm up, conditioning, and cool down, which are described in Brill's book<sup>9</sup>. The control group received routine care but did not perform the CORE exercise program. The purpose and process of the study were explained to the subjects, and they signed an informed consent form. In order to reduce measurement errors, assessments were conducted by the same investigator in the same place before and after the intervention.

All measurements were performed before and 1 day after the intervention. To assess the degree of pain, a 100-mm visual analogue scale (VAS) was used at rest and during movement. Unpleasant sensation or pain felt when keeping still was considered pain at rest, and pain experienced during full flexion of the trunk was considered pain during movement. Patients wrote down their pain intensity on a 100 mm-long table, and the investigator measured the length and marked it (mm). Pain pressure threshold (PPT) in the lumbar region was measured using an algometer (NeuroDyne Medical, Cambridge, MA, USA). Subjects were fully explained the purpose of the experiment. The instrument was placed perpendicular to the quadratus lumborum (2 cm lateral to L3 spinous process)<sup>10</sup>, and then pressure was applied to the region at a consistent pace of 1 kg/s. The subject was instructed to make a sound on experiencing an unpleasant feeling or pain. This was considered the PPT. An inclinometer (Angle/Level, Dejon Tool Co., Covington, OH, USA) was used to measure AROM without lumbar pain. The tester measured the total moved angle of lumbosacral flexion and extension with a single inclinometer placed over the L1-S2 spinous processes.

Statistical analyses were performed using SPSS v15.0. The independent t-test was performed to compare the differences in dependent variables between groups, and the paired t-test was used to evaluate the differences within groups. The level of probability was set at  $p < 0.05$ .

**Table 1.** General characteristics of the participants in this study

	CORE group (n=15)	Control group (n=15)
Gender (male/female)	6/9	5/10
Age (years)	38.1 ± 7.9	36.5 ± 7.7
Height (cm)	165.2 ± 7.6	164.6 ± 8.2
Weight (kg)	66.5 ± 11.5	65.1 ± 10.7
Onset time (months)	14.9 ± 7.5	13.4 ± 8.1

Values are expressed as the mean ± standard deviation (SD)

## RESULTS

The baseline characteristics of the participants are shown in Table 1. There were no significant differences between the two groups in baseline values.

Significant differences were observed in VAS at rest and during movement in the CORE group, while the control group did not show a significant difference. In addition, the improvement in VAS at rest and during movement in the CORE group was significantly greater compared with that in the control group. Similarly, the PPT of the quadratus lumborum was significantly increased, from  $4.69 \pm 0.62$  kg/cm<sup>2</sup> to  $6.11 \pm 0.78$  kg/cm<sup>2</sup> in the CORE group ( $p < 0.05$ ). The control group, however, showed no significant increase in PPT (from  $4.53 \pm 1.03$  kg/cm<sup>2</sup> to  $4.86 \pm 1.21$  kg/cm<sup>2</sup>). There was a significant difference in PPT between groups ( $p < 0.05$ , Table 2).

After the intervention, the AROM of trunk flexion increased significantly in the CORE group (from  $65.47 \pm 10.61^\circ$  to  $89.68 \pm 10.95^\circ$ ), but a significant increase was not found in the control group. In addition, significant differences were observed in AROM between the 2 groups ( $p < 0.05$ , Table 2).

## DISCUSSION

Pain and loss of flexibility are the main symptoms of CLBP; therefore, their assessment is important in determining treatment efficiency<sup>11</sup>. This study applied Brill's CORE exercise program to CLBP patients and showed that it is effective in resolving pain and improving AROM.

The VAS actually measures different items<sup>12</sup>; however, no study has separately evaluated pain at rest and during movement in patients with CLBP undergoing treatment with the CORE exercise program. Our study measured pain at rest and during movement separately. The CORE group showed significant decreases in pain at rest and during movement compared with those in the control group, and the significant pain reduction was sustained after the experiment. This is similar to the results of Goldby et al., which showed pain reduction in CLBP patients after 10 weeks of specific spinal stabilization, and those of Koumantakis, which showed the continuation of significant pain reduction in patients with low back pain 3 months after application of stabilization enhanced exercise<sup>13, 14</sup>. Typically, during the performance of a specific stabilization exercise, patients learn how to recruit the deep muscles of the spine and grad-

**Table 2.** Comparison of the changes in the VAS, PPT, and AROM

			CORE group (n=15)	Control group (n=15)
VAS	VAS at rest	Baseline	41.6 ± 7.4	38.5 ± 8.5
		Post	21.5 ± 5.7†	37.6 ± 10.5
		Post – Baseline	20.1 ± 6.3*	0.9 ± 6.5
VAS	VAS during movement	Baseline	60.8 ± 7.3	58.6 ± 8.0
		Post	36.4 ± 5.1†	57.1 ± 7.9
		Post – Baseline	24.4 ± 8.7*	1.5 ± 6.7
PPT	Quadratus lumborum	Baseline	4.7 ± 0.6	4.5 ± 1.0
		Post	6.1 ± 0.8†	4.9 ± 1.2
		Post – Baseline	1.4 ± 0.5*	0.3 ± 0.9
AROM	Flexion	Baseline	65.5 ± 10.6	66.3 ± 18.3
		Post	89.7 ± 11.0†	68.6 ± 18.7
		Post – Baseline	24.2 ± 8.9*	2.3 ± 7.8

Values are expressed as the mean ± standard deviation (SD). VAS, visual analogue scale; PPT, pain pressure threshold; AROM, active range of motion. † Significant difference within the group. \* Significant difference compared with the value of the control group at the corresponding time.

ually reduce undesirable excessive activity of other muscles<sup>15</sup>). Another benefit of the CORE exercise program is the restoration of coordination and control of the trunk muscles to improve control of the lumbar spine and pelvis<sup>16</sup>). Brill's CORE exercise program, which was used in this study, controls tension of the lumbo-pelvic-hip joint, which maintains lumbar stability to strengthen muscles, increase endurance, and correct posture. Such exercises showed similar effects in decreasing pain intensity.

According to our results, the PPT in the CORE group increased significantly, while that in the control group did not. This result corresponds to the result of a study by Senthil, which confirmed a statistically significant increase in PPT after applying segmental stabilization exercise in CLBP patients<sup>17</sup>). Such a result shows that the CORE exercise program applied in CLBP patients is effective in reducing back muscle spasm. Back muscle spasm is a clinical feature of CLBP and is considered secondary pain<sup>18</sup>). In the case of chronic pain conditions, such as CLBP, abnormal pain processing due to central neuroplastic changes plays an important role. The changes are caused by continued stimulation rather than by inflammation or damage to peripheral structures. Therefore, patients experience increased sensitivity to pressure and to pain stimuli of a normal degree<sup>19, 20</sup>). In addition, CLBP patients suffer from muscle weakness in the lumbar spine<sup>21</sup>). According to the biomechanical model theory, weakened muscles cause mechanical irritation in the lumbar spine, thereby causing pain by stimulating pain-sensitive structures<sup>22, 23</sup>). Such continued stimulation serves as an initial cause of central sensitization and chronic pain<sup>24</sup>). The vicious cycle of pain causing spasm and spasm worsening pain is a generally accepted concept at the moment<sup>25</sup>). The CORE exercise program is based on transverse abdominis contraction that can strengthen spinal muscle and enhance lumbar stability by maintaining spinal balance<sup>9</sup>). It is assumed that the CORE exercise program can restore the function of weakened muscles in CLBP pa-

tients and augment the ability to support and control the spine and pelvis, thereby alleviating mechanical irritation and pain, ultimately reducing spasm in the low back region.

This study measured lumbar AROM after intervention, and the angles of flexion in the CORE group increased significantly compared with those before treatment. This is similar to the result of the study by Hicks, in which AROM was increased with application of stabilization exercise for 4 weeks in CLBP patients<sup>26</sup>). The CORE program includes hamstring stretching, which can increase the flexibility of the hamstring; the double knee to chest exercise, lying spinal twist, which stretches the lumbar region's muscles and soft tissues; and the cobra, which relieves tension on the back and disk pressure.

This study confirmed that the CORE exercise program applied to patients with CLBP was effective in reducing pain and increasing AROM. Based on our results, Brill's CORE exercise program could be used as an effective exercise method for managing patients with CLBP and promoting a healthy lifestyle.

## ACKNOWLEDGEMENTS

This work was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) and funded by the Ministry of Education, Science and Technology (MEST; 2011-0005415).

## REFERENCES

- 1) Luo X, Pietrobon R, Sun SX, et al.: Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. *Spine*, 2004, 29: 79–86. [Medline] [CrossRef]
- 2) Nykänen M, Koivisto K: Individual or group rehabilitation for people with low back pain: a comparative study with 6-month follow-up. *J Rehabil Med*, 2004, 36: 262–266. [Medline] [CrossRef]
- 3) Katz JN: Lumbar disc disorders and low-back pain: socioeconomic factors and consequences. *J Bone Joint Surg Am*, 2006, 88: 21–24. [Medline]

- [CrossRef]
- 4) Puolakka K, Ylinen J, Neva MH, et al.: Risk factors for back pain-related loss of working time after surgery for lumbar disc herniation: a 5-year follow-up study. *Eur Spine J*, 2008, 17: 386–392. [Medline] [CrossRef]
  - 5) Willson JD, Dougherty CP, Ireland ML, et al.: Core stability and its relationship to lower extremity function and injury. *J Am Acad Orthop Surg*, 2005, 13: 316–325. [Medline]
  - 6) Danneels LA, Vanderstraeten GG, Cambier DC, et al.: CT imaging of trunk muscles in chronic low back pain patients and healthy control subjects. *Eur Spine J*, 2000, 9: 266–272. [Medline] [CrossRef]
  - 7) Rainville J, Hartigan C, Martinez E, et al.: Exercise as a treatment for chronic low back pain. *Spine J*, 2004, 4: 106–115. [Medline] [CrossRef]
  - 8) Akuthota V, Nadler SF: Core strengthening. *Arch Phys Med Rehabil*, 2004, 85: S86–S92. [Medline] [CrossRef]
  - 9) Brill P: *The Core Programme: Fifteen Minutes Exercise A Day That Can Change Your Life*: Ebury Digital; 2010.
  - 10) Hirayama J, Yamagata M, Ogata S, et al.: Relationship between low-back pain, muscle spasm and pressure pain thresholds in patients with lumbar disc herniation. *Eur Spine J*, 2006, 15: 41–47. [Medline] [CrossRef]
  - 11) Grönblad M, Hurri H, Kouri JP: Relationships between spinal mobility, physical performance tests, pain intensity and disability assessments in chronic low back pain patients. *Scand J Rehabil Med*, 1997, 29: 17–24. [Medline]
  - 12) Juhl C, Lund H, Roos EM, et al.: A hierarchy of patient-reported outcomes for meta-analysis of knee osteoarthritis trials: empirical evidence from a survey of high impact journals. *Arthritis*, 2012, 2012: 136245.
  - 13) Goldby LJ, Moore AP, Doust J, et al.: A randomized controlled trial investigating the efficiency of musculoskeletal physiotherapy on chronic low back disorder. *Spine*, 2006, 31: 1083–1093. [Medline] [CrossRef]
  - 14) Koumantakis GA, Watson PJ, Oldham JA: Trunk muscle stabilization training plus general exercise versus general exercise only: randomized controlled trial of patients with recurrent low back pain. *Phys Ther*, 2005, 85: 209–225. [Medline]
  - 15) Hides JA, Jull GA, Richardson CA: Long-term effects of specific stabilizing exercises for first-episode low back pain. *Spine*, 2001, 26: E243–E248. [Medline] [CrossRef]
  - 16) Hodges PW: Core stability exercise in chronic low back pain. *Orthop Clin North Am*, 2003, 34: 245–254. [Medline] [CrossRef]
  - 17) Kumar SP: Efficacy of segmental stabilization exercise for lumbar segmental instability in patients with mechanical low back pain: a randomized placebo controlled crossover study. *N Am J Med Sci*, 2011, 3: 456–461. [Medline] [CrossRef]
  - 18) van Tulder MW, Touray T, Furlan AD, et al.: Muscle relaxants for non-specific low back pain. *Cochrane Database Syst Rev*, 2003, (2): CD004252. [Medline]
  - 19) Butler DS, Matheson J, Boyaci A: *The sensitive nervous system*: Noigroup publications Unley; 2000.
  - 20) Mense S: Biochemical pathogenesis of myofascial pain. *J Musculoskeletal Pain*, 1996, 4: 145–162. [CrossRef]
  - 21) Cooper RG, St Clair Forbes W, Jayson MI: Radiographic demonstration of paraspinal muscle wasting in patients with chronic low back pain. *Br J Rheumatol*, 1992, 31: 389–394. [Medline] [CrossRef]
  - 22) Doctor P: *A multidimensional manual therapy model for managing patients with chronic non-specific low back pain*. University of Pretoria.
  - 23) Panjabi MM: The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement. *J Spinal Disord*, 1992, 5: 383–389, discussion 397. [Medline] [CrossRef]
  - 24) Woolf CJ: Central sensitization: implications for the diagnosis and treatment of pain. *Pain*, 2011, 152: S2–S15. [Medline] [CrossRef]
  - 25) Simons DG, Mense S: Understanding and measurement of muscle tone as related to clinical muscle pain. *Pain*, 1998, 75: 1–17. [Medline] [CrossRef]
  - 26) Hicks GE, Fritz JM, Delitto A, et al.: Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. *Arch Phys Med Rehabil*, 2005, 86: 1753–1762. [Medline] [CrossRef]