Effects of Motor Control Exercise Vs Muscle Stretching Exercise on Reducing Compensatory Lumbopelvic Motions and Low Back Pain: A Randomized Trial

Kyue-nam Park, PhD,[a] Oh-yun Kwon, PhD,[b] Chung-hwi Yi, PhD,[c] Heon-seock Cynn, PhD,[c] Jong-hyuck Weon, PhD,[d] Tae-ho Kim, PhD,[e] and Houng-sik Choi, PhD[f]

Abstract

Objectives: The purpose of this study was to investigate the effectiveness of a 6-week motor control exercise (MCE) vs stretching exercise (SE) on reducing compensatory pelvic motion during active prone knee flexion (APKF) and intensity of low back pain.

Methods: Thirty-six people in the lumbar-rotation-extension subgroup were randomly assigned equally into 2 exercise groups (18 people in each an MCE or SE group). A 3-dimensional motion-analysis system was used to measure the range and onset time of pelvic motion and knee flexion during APKF. Surface electromyography was used to measure the muscle activity and onset time of the erector spinae and the hamstrings during APKF. The level of subjective low back pain was measured using a visual analog scale.

Results: The MCE group had more significant decreases in and delay of anterior pelvic tilt, pelvic rotation, and erector spinae muscle activity during APKF, as well as reduced intensity of low back pain compared with the SE group ($P < .05$).

Conclusions: For rehabilitation in patients in the lumbar-rotation-extension subgroup, MCE was more effective than SE in reducing compensatory pelvic motion and muscle activity during APKF and minimizing low back pain.

(J Manipulative Physiol Ther 2016;xx:1-10)

Key Indexing Terms: *Classification; Exercise; Low Back Pain; Muscle Stretching Exercises*

Introduction

Low back pain (LBP) is a prevalent musculoskeletal disorder, with approximately 70% to 90% of adults suffering from an episode of LBP sometime in their lives, 50% having a recurrent episode, and 5% to 10% developing chronic and potentially disabling LBP.[1,2]

To manage nonspecific LBP, subgrouping and classifying LBP by the movement direction–based mechanism of provocation or relief of symptoms has proven more valuable than performing a pathology-based diagnosis.[3-7] Sahrmann[5] and Van Dillen et al[8] developed a classification system based on movement impairment and divided LBP problems into 5 subgroups: lumbar flexion, lumbar extension, lumbar rotation, lumbar-rotation-flexion, and lumbar-rotation-extension.

The lumbar-rotation-extension subgroup is the most common among the 5 subgroups of LBP.[5,9] Patients are considered to be in the lumbar-rotation-extension subgroup

[a] Department of Physical Therapy Jeonju University, Jeonju, South Korea.
[b] Laboratory of Kinetic Ergocise Based on Movement Analysis, Department of Physical Therapy, Yonsei University, Wonju, South Korea.
[c] Department of Physical Therapy, Yonsei University, Wonju, South Korea.
[d] Department of Physical Therapy, Joongbu University, Geumsan, South Korea.
[e] Department of Physical Therapy, Daegu University, Gyeongsan, South Korea.
[f] Department of Physical Therapy, Hanseo University, Seosan, South Korea.
Corresponding author: Oh-yun Kwon, PhD, 234 Maeji-ri, Heungeup-Myeon, Wonju, Kangwon-Do, 220-710, South Korea. (e-mail: *kwonoy@yonsei.ac.kr*).

Paper submitted April 13, 2016; in revised form July 15, 2016; accepted July 31, 2016.
0161-4754

http://dx.doi.org/10.1016/j.jmpt.2016.07.006

if their LBP increases when the lumbar spine is positioned or moved into rotation with extension.[5] The increased frequency of lumbar rotation with extension may contribute to increased tissue stress in the lumbopelvic region, especially on the posterior articular facet joint.[5,10] With time, the increased tissue stress in the lumbopelvic region contributes to cumulative microtrauma and tissue failure in the lumbopelvic region, resulting in LBP with daily activity.[11]

Active prone knee flexion (APKF) is commonly used as a movement test when classifying the lumbar-rotation-extension subgroup. People in the lumbar-rotation-extension subgroup had compensatory anterior pelvic tilt and pelvic rotation and excessive erector spinae muscle activity during APKF, inducing LBP.[11,12] Previous studies have speculated that increased passive stiffness of the rectus femoris muscle is one of the causative factors of compensatory anterior pelvic tilt and rotation during unilateral APKF.[9,12] The rectus femoris attaches from the anterior inferior iliac spine to the quadriceps tendon and therefore can move both the pelvis and lower leg.[5] The rectus femoris is susceptible to increased stiffness in people with LBP, and increased tightness of the rectus femoris can pull the pelvis during APKF, resulting in increased anterior pelvic tilt and muscle activity of erector spinae.[5,11,12] Therefore, stretching exercise (SE) of the rectus femoris muscle has been recommended to decrease the compensatory anterior pelvic tilt during APKF and reduce the intensity of LBP for people in the lumbar-rotation-extension subgroup.[12]

Another possible causative factor of compensatory lumbopelvic motion during APKF is altered motor control. People in the lumbar-rotation-extension subgroup have insufficient ability to control compensatory lumbopelvic motion during APKF.[9,12] In people in the lumbar-rotation-extension subgroup, the pelvic anterior tilt and rotation were initiated at the initial phase during APKF before reaching the end range of knee flexion compared with people without LBP.[10] A previous study revealed that the abdominal drawing-in maneuver (ADIM) using a pressure biofeedback unit was effective as a motor control exercise (MCE) to reduce and delay compensatory lumbopelvic motion in people in the lumbar-rotation-extension subgroup.[12] Park et al[12] suggested that the long-term effect of MCE using ADIM while moving the lower leg in people in the lumbar-rotation-extension subgroup should be determined.

Although MCE and SE of the rectus femoris muscle were recommended as effective pain management techniques for people in the lumbar-rotation-extension subgroup,[5,10] there has been no randomized direct comparison of MCE and SE. Thus, the more effective option for people in the lumbar-rotation-extension subgroup remains unclear. The purpose of this study trial was to compare the efficacy of 2 exercise programs—MCE and SE—in patients in the lumbar-rotation-extension subgroup. We hypothesized that there would be differences between the 2 exercise programs[1] in delaying and decreasing the anterior pelvic tilt and pelvic rotation,[2] in delaying and decreasing the superficial erector spinae activity, and[3] in decreasing the level of LBP in daily activity.

Table 1. *Participant Characteristics*

Parameter	MCE Group	SE Group
Gender, male/female	10/8	12/6
Age, y	23.5 ± 2.5	23.7 ± 3.2
Body mass, kg	68.8 ± 3.9	68.9 ± 4.2
Height, cm	173.1 ± 4.6	172.6 ± 4.7

Data are expressed as mean ± standard deviation unless otherwise specified.
MCE, motor control exercise; *SE,* stretching exercise.

Methods

Participants

For this randomized trial, 58 participants with LBP were initially screened from Yonsei University, Korea; 36 participants in the lumbar-rotation-extension subgroup were eligible to participate in the study (Table 1). The inclusion criteria for this study were proposed by Sahrmann[5] and Van Dillen et al[9] for classifying the lumbar-rotation-extension subgroup. The examiner in this study had 6 years of experience in the assessment and treatment of musculoskeletal disorders and had often used a classification method of movement system impairments for evaluating people with LBP.[12] A 2-step procedure (primary and secondary test) was used to classify the lumbar-rotation-extension subgroup. When the primary test provoked symptoms and LBP in the patients, a secondary test was performed as confirmation, with a modified movement pattern of patients that decreased lumbar-rotation-extension to determine whether the symptoms and LBP were decreased or eliminated.[5] The tests used to determine the diagnosis of lumbar-rotation-extension subgroup are presented in Table 2.[5,8,13] The reliability of examination and classification were established in a previous study.[8] On a visual analogue scale (VAS) ranging from 0 to 100 mm, a score >30 mm when performing daily activities was considered LBP. The duration of LBP in this study was >7 weeks since the onset of an LBP episode to recruit the participants with chronic LBP.[6] The exclusion criteria included past or present neurologic diseases, specific LBP with radiating pain, knee joint contractures, and a strain injury of the rectus femoris muscle within the previous 2 months. Before this study, the principal investigator explained all procedures to the participants in detail and gave participants 1 week to make a decision regarding participation in this study. All participants signed an informed consent form. This study was approved by Yonsei University Wonju institutional review board (IRB registration number: Protocol 2013-07) and was registered with the Clinical Research Information Service in the WHO Registry Network (registration number: KCT0000780).