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Effects of a Bridging Exercise with Hip Adduction on the EMG Activities of the Abdominal and Hip Extensor Muscles in Females

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Abstract. [Purpose] This study compared the activities of the abdominal and hip extensor muscles between the bridging exercise (BE) and bridging exercise with hip adduction (BEHA) positions in women using electromyography (EMG). [Subjects] We recruited 14 healthy adult females with no history of low back pain. [Methods] The subjects performed bridging exercises with and without hip adduction. The EMG activities of the rectus abdominis (RA), external oblique (EO), internal oblique (IO), and gluteus maximus (GM) muscles were recorded. [Result] The EMG activities of all muscles were significantly increased during the BEHA compared to the BE. [Conclusion] The bridging exercise with hip adduction produced greater activation of the abdominal and hip extensor muscles.
Key words: Bridging exercise, EMG, Hip adduction

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INTRODUCTION

Individuals with back and hip pathologies are often taught to perform the bridging exercise (BE) in the hook-lying position, elevating the pelvis off the floor. This exercise is particularly useful for facilitating pelvic motions and strengthening the low back and hip extensors, and it enhances motor control of the lumbo-pelvic region[1)].

To prevent lumbo-pelvic instability and low back pain (LBP), healthy individuals should also do the bridging exercise, especially females, as they are quadriceps femoris dominant; i.e., the quadriceps femoris is the first muscle to activate in response to injury perturbations[2)]. A dominant quadriceps femoris causes poor endurance and delayed firing of the gluteus maximus muscle in subjects with lower extremity instability and LBP[3, 4)].

To increase the abdominal and hip extensor muscle activities, many clinicians have emphasized using unstable devices, such as a Swiss ball, ball cushion, or BOSU ball, and applying unilateral conditions[5–8)]. However, studies have reported inconsistent results regarding the activation patterns of the abdominal and hip extensor muscles during BE.

An efficient core maintains the length–tension relationship of functional agonists and antagonists. Baratta et al.[9)] showed that antagonists regulate stabilization in response to distraction forces generated by the agonist muscles. The abdominal muscles attach to the thoracic cage proximally, and act synergistically with the posterior paravertebral muscles to stabilize the symphysis[10)]. The hip adductor muscles stabilize the symphysis by bringing the lower extremity closer to the pelvis, and are antagonists of the abdominal muscles. Moreover, hip adductor contraction synergistically facilitates contraction of the pelvic floor and abdominal muscles, reinforcing the trunk muscles and contributing to spinal stability[11–13)]. However, these theories have not been tested experimentally, especially the effects of functional exercises such as bridging exercise with hip adduction (BEHA) on the abdominal and hip extensor muscles. Therefore, we investigated the effects of the BEHA on the EMG activities of the abdominal and hip extensor muscles in females. We hypothesized that BEHA generates increased abdominal and hip extensor muscle EMG activities compared to BE.

SUBJECTS AND METHODS

Fourteen healthy female university students volunteered to participate in this study. Health was defined as no history of any type of injury in the previous 6 months. Participants were excluded if they reported a history of LBP. Their mean age was 29.5 (range 25–35) years, their mean height was 160.21 (range 154–169.5) cm, their mean weight was 53.11 (range 43–63) kg, and their mean body mass index (BMI) was 20.68 (range 17.22–23.61) kg/cm^2. All of the protocols used in this study were approved by the University of Inje. Before participation, the procedures, risks, and benefits were explained to all the participants, who gave their informed consent. The participants' rights were protected according to the guidelines of the University of Inje.

Surface EMG data were collected using a Trigno Wireless EMG system with Trigno EMG Sensor (Delsys, Bos-

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ton, MA, USA) surface electrodes. The signal was full-wave rectified and the root mean square value was calculated over 100 millisecond intervals. Throughout the tests, the EMG data were sampled at a frequency of 2,000 Hz. The EMG data were filtered using standard band-pass filtering techniques with cutoffs of 20 and 450 Hz. The EMG data of each muscle were converted from analog to digital using the program EMG Works Acquisition and Analysis (Delsys).

The surface electrodes were placed over four muscle groups in a bipolar configuration on the right side of the body: the 1) the rectus abdominis (RA), centered on the muscle belly midway between the pubis and the umbilicus; 2) the external obliques (EO), 5 cm above the anterior superior iliac spine; 3) the internal obliques (IO), 2 cm medial to the anterior superior iliac spine; and 4) the gluteus maximus (GM), 33% of the distance between the second sacral vertebra and greater trochanter at the midpoint of the muscle bellies. Before testing, the selected electrode locations were secured before conducting two manual muscle tests (MMTs) for each muscle, and the protocols were explained to ensure the participants full understanding. The MMTs were used to identify the approximate maximum voluntary isometric contraction (MVIC) of each muscle and were performed following the techniques described by Kendall et al[14]. All MMTs consisted of a 5-s isometric contraction of each muscle, and the MVIC data of the first and last second of each contraction were discarded.

A single-group repeated measures design was used to collect muscle activation data for the right RA, EO, IO, and GM muscles. EMG data were collected during BE and BEHA. A minimum 2-min rest between each contraction was enforced to minimize the effects of muscle fatigue. Three trials of each exercise were performed. A pause of at least 15 s was allowed between trials.

The participants performed BE in the supine position. The hip joint was maintained in neutral rotation using the procedure recommended by Hölmich et al[15]. For the 45° hip flexion position, the knee joint was maintained in 60° of flexion with the feet on the floor, toes pointed forward, and hands on the floor by the subjects' sides, palms down. The subjects lifted their pelvis until 0° of hip flexion was reached with the pelvis in neutral alignment. The position was held for 5 s.

Participants performed the BEHA using a pressure biofeedback unit (Stabilizer, USA) to control the force of hip adduction. The biofeedback cuff was placed between the knees. The participant was instructed to perform hip adduction to maintain a pressure of 60 mmHg. Then, with the hip joint in full extension and a neutral position, the EMG was recorded for 5 s.

Data of each muscle were normalized as percentages of MVIC. Statistical analysis was performed using SPSS ver. 18.0 for Windows (SPSS, Chicago, IL). The paired *t*-test was used to evaluate differences in EMG activities between BE and BEHA. All statistical tests were performed at the 5% level of significance.

Table 1. Electromyography activities of abdominal and leg muscles during abdominal bridge exercise without hip adduction and with hip adduction isometric contraction (N=14)

Muscle	Mean %MVIC (SD)	
	BE	BEHA
RA	5.59 (3.59)	10.43 (9.90)*
EO	11.30 (5.06)	22.11 (13.40)*
IO	17.82 (17.63)	26.97 (18.41)*
GM	20.40 (8.90)	26.88 (11.04)*

RA: Rectus abdominis; EO: External obliques; IO: Internal obliques; GM: Gluteus maximus; BE: bridging exercise; BEHA: bridging exercise with hip adduction
$^*p<0.05$

RESULTS

The activation of each abdominal and hip extensor muscle during BE and BEHA is summarized in Table 1. For the BEHA, the EMG signal amplitude (mean ± SD) increased significantly in RA (10.43 ± 9.9% *vs.* 5.59 ± 3.59% MVIC), EO (22.11 ± 13.4% *vs.* 11.3 ± 5.06% MVIC), IO (26.97 ± 18.41% *vs.* 7.82 ± 17.63% MVIC), and GM (26.88 ± 11.04% *vs.* 20.4 ± 8.9% MVIC).

DISCUSSION

This study evaluated the muscle activities of females performing BEHA. The exercises investigated are thought to be of help in stabilizing the lumbar spine region. When prescribing exercise therapy, it is important to understand the muscle activities of healthy individuals.

The results show that performing hip adduction increased the EMG activities of RA, EO, IO, and GM muscles during the bridging exercise. A possible explanation for the greater muscle activity during performance of BEHA is that the hip adductors originate proximal to the inferior aspect of the body and ischium and insert distally on the femur, affecting the control of the trunk muscles attached to the pelvis. They are linked to the trunk muscles to support the trunk or fix the trunk muscles and play a role in promoting contraction of the internal abdominal muscles[11, 16]. Hip adductor contraction appears to contribute to the increased abdominal muscle activity observed during the bridging exercise.

The gluteus maximus plays a major role in stabilizing the pelvis during upright activities and might theoretically influence the development of LBP[17, 18]. Oliver et al.[19] reported that GM activity increased during hip abduction. However, our results show that the EMG activity of the GM muscle increased during BEHA. Although the hip adductors are located on the inner thigh, the posterior fibers of the adductor magnus activated the powerful hip extensors[20]. However, we did not measure EMG activity of the adductor magnus.

This study had several limitations. First, our results cannot be generalized to other populations, as all subjects were healthy young females. Second, the subjects applied the same pressure during hip adduction. Future studies should evaluate the effects of different pressures on trunk and leg muscle activities.

Our results suggest that bridging exercise with hip adduction strengthens RA, EO, IO, and GM and could be used clinically to prevent LBP.

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