

# The effects of bridge exercise with the abdominal drawing-in maneuver on an unstable surface on the abdominal muscle thickness of healthy adults

MISUK CHO, PhD, PT<sup>1)</sup>

<sup>1)</sup> Department of Physical Therapy, Korea Nazarene University: 48 Wolbong-ro, Seobuk-gu, Cheonan-si, Chungcheongnam-do 330-718, Republic of Korea

**Abstract.** [Purpose] The purpose of this study was to determine the impact of a bridge exercise with an abdominal drawing-in maneuver (ADIM) performed with different surface conditions on abdominal muscle thickness. [Subjects] Thirty subjects were randomly divided into an unstable bridge exercise group (UBE group, n=15) and a stable bridge exercise group (SBE group, n=15). [Methods] After 6 weeks of performing bridge exercises accompanied by ADIM, the change in the muscle thicknesses of the transverse abdominis (TrA) and internal oblique abdominis (IOA) muscles was assessed using ultrasonography. [Results] After 6 weeks of exercise, the TrA was significantly altered in the SBEG, and the TrA and IOA were both significantly changed in the UBEG. [Conclusion] When performing bridge exercises to increase the TrA and the IO muscle thicknesses, exercising on an unstable surface is recommended.

**Key words:** Transversus abdominis, Bridge exercise, Abdominal drawing-in maneuver

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## INTRODUCTION

Patients with lower back pain have weaker deep muscles compared with those without such pain. Loss of position sense due to deterioration in proprioception causes spinal instability and subsequent pain<sup>1)</sup>. Therefore, stability exercise is clinically applied as a treatment for lower back pain. The purpose of the stability exercise is to recover control, and a high level of local muscle exercise maintains appropriate torso stability<sup>2)</sup>.

The bridge exercise (BE), a closed kinetic chain weight-bearing exercise, is applied to improve the muscle strength of the gluteus maximus and hamstring, which are hip extensors. It is also used clinically to improve lumbar stabilization in patients with lower back pain<sup>3)</sup>. Furthermore, the bending positions of the knee and hip joints during the BE are pain-alleviating positions for patients with lower back pain<sup>4)</sup>. However, if deep muscle co-contraction is not performed first, excessive lumbar lordosis can occur to compensate for the lack of muscle co-contraction. To prevent excessive lumbar lordosis, this exercise must be preceded by the abdominal drawing-in maneuver (ADIM)<sup>3)</sup>. Such activation of the abdominal muscle is required for stability of the pelvis, as it counters the pulling of the hip joint muscles<sup>5)</sup>.

There have been many studies on building deep muscles while performing the ADIM in a supine position and on building deep muscles and lower extremity muscle strengthening while performing BE<sup>3, 6, 7)</sup>. However, there is an insufficient number of studies on the ADIM and BE as a combination exercise based on surface conditions. Therefore, the objective of this study was to determine the impact of BE with the ADIM performed under different surface conditions on abdominal muscle thickness.

## SUBJECTS AND METHODS

Thirty male and female university students were selected as subjects. The subjects were randomly assigned to one of two groups: 15 students (2 male, 13 female) to the unstable bridge exercise group (UBEG) as the experimental group and 15 students (2 male, 13 female) to the stable bridge exercise group (SBEG) as the control group. Subjects with muscle, frame, or nervous system issues, those with lower back and pelvic pain, and those unable to engage in BE due to knee or ankle pain were excluded from the study. This study was approved by Korea Nazarene University's Institutional Review Board, and the safety of all subjects was protected during all parts of the experiment. All subjects understood the purpose of this study and provided written informed consent prior to participation in accordance with the ethical standards of the Declaration of Helsinki.

The age, height, and weight ranges of subjects in the SBEG were 21.7±0.3 years, 162.8±5.3 cm, and 56.3±8.2 kg, and in the UBEG, they were 22.6±0.4 years, 162.1±3.5 cm, and 55.5±7.6 kg, respectively. The  $\chi^2$  test was used for sex analysis, and the independent t-test was used to analyze

Corresponding author. Misuk Cho (E-mail:mscho@kornu.ac.kr)

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**Fig. 1.** Measurement of abdominal muscle thickness

ages, heights, and weights. These analyses showed statistically insignificant ( $p > 0.05$ ) differences between the groups, and the two groups could therefore be considered homogeneous.

The starting position for the BE on the stable surface was the supine position with the knees bent at  $90^\circ$ , hip joints bent at  $60^\circ$ , legs shoulder width apart, hands resting crossed on the chest, head and neck straight, and eyes on the ceiling. The BE was preceded by the ADIM. The Inter-abdominal pressure increased during abdominal hollowing, selectively contracting the transverse abdominis (TrA) and internal oblique abdominis (IOA) rather than the rectus abdominis (RA).

At the cue “pelvis up”, the subjects lifted their pelvises while keeping the hip joint at  $0^\circ$ , maintained the position for 15 seconds at the cue “hold”, and then brought down their pelvises at the cue “pelvis down” for 10 seconds of rest. The routine was designed to repeat 10 times per set. Six sets of each exercise were performed 3 times a week for 6 weeks. The BE on an unstable surface was performed in the same way but with a balance pad (Balance-pad, AIREX, Sins, Switzerland) under the feet to increase the degree of exercise intensity and instability.

Muscle thickness of the TrA and IOA was measured using ultrasound imaging (MySono U5, Samsung Medison, Seoul, Republic of Korea). During measurement, the subjects were in a relaxed supine position with a relaxed abdomen, and the measurer positioned the probe parallel to the top of the iliac crest and then moved it to the center of the abdomen. When the external oblique abdominis (EOA), IOA, and TrA were visible in their entirety, the screen was put on hold. The muscle thickness of the IOA and TrA was measured 13 mm away from the meeting point of the IOA and TrA muscles<sup>8)</sup> (Fig. 1). All measurements were performed by a single skilled measurer trained in operating the ultrasonography imaging system.

The measured data were analyzed by the SPSS 12.0 KO statistical program, and the collected data are presented as means and standard deviations. The paired t-test was used as a significance test in each group before and after the experiments, and an independent t-test was used as a significance test for between-group differences. The significance

**Table 1.** Comparison of the pre- and post- intervention thicknesses of the TrA and IOA (mean $\pm$ SD) (Unit: cm)

Category	Group	Pre-intervention	Post-intervention
TrA	SBEG*	0.3 $\pm$ 0.1	0.4 $\pm$ 0.1
	UBEG*	0.3 $\pm$ 0.1	0.4 $\pm$ 0.2
IOA	SBEG	0.5 $\pm$ 0.2	0.6 $\pm$ 0.1
	UBEG*	0.5 $\pm$ 0.1	0.7 $\pm$ 0.1

\*  $p < 0.05$ . SBEG: stable bridge exercise group, UBEG: unstable bridge exercise group, TrA: transversus abdominis, IOA: internal oblique abdominis

**Table 2.** Comparison of the thicknesses of the TrA and IOA between the SBEG and UBEG (mean $\pm$ SD) (Unit: cm)

	Category	SBEG	UBEG
Pre-intervention	TrA	0.3 $\pm$ 0.1	0.3 $\pm$ 0.1
	IOA	0.5 $\pm$ 0.2	0.5 $\pm$ 0.1
Post-intervention	TrA	0.4 $\pm$ 0.1	0.4 $\pm$ 0.2
	IOA	0.6 $\pm$ 0.1	0.7 $\pm$ 0.1
Change between pre- and post-intervention	TrA	0.0 $\pm$ 0.0	0.1 $\pm$ 0.1
	IOA	0.1 $\pm$ 0.2	0.2 $\pm$ 0.1

\*  $p < 0.05$

level,  $\alpha$ , was set at 0.05.

## RESULTS

According to the pre- and post-intervention comparisons in the SBEG and UBEG, only the TrA was significantly altered in the SBEG, while both the TrA and IOA changed significantly in the UBEG ( $p < 0.05$ ) (Table 1). According to the pre- and post-intervention comparison and changes between the pre- and post- intervention measurements in the SBEG and UBEG, there was no statistical significance in any areas ( $p > 0.05$ ; Table 2).

## DISCUSSION

Stability is the musculoskeletal system's ability to maintain balance during a shake or small movement<sup>9)</sup>. The IOA and TrA, which are responsible for lumbar stability, provide fine-tuning and spinal segmental stability. McGill et al. reported<sup>10)</sup> that regulating the mobilization method of the superficial and deep muscles, that is, the first mobilization of the deep abdominal muscles, is important for maintaining lumbar stability.

According to the pre- and post-intervention comparison in the SBEG and UBEG, only the TrA was significantly altered in the SBEG, but both the TrA and IOA showed significant changes in the UBEG. This means that the BE on a stable surface has an impact on building the TrA muscle only, while the BE on an unstable surface has an impact on building both the TrA and IOA. It is considered that the co-contraction of muscles occurs across body segments to maintain balance on unstable surfaces. Furthermore, exer-

cising in an unstable surface environment stimulates proprioceptors and areas of the cerebrum responsible for locomotion, maximizing the sense of equilibrium and ability to maintain balance and resulting in improved core stability<sup>11)</sup>. The findings of no statistically significant differences between the SBEG and UBEG in the pre- and post- intervention measurements and in the changes between the pre- and post- intervention measurements indicate that while unstable BE is effective, it is insufficient to generate statistically significant changes when compared with the BE on a stable surface. Stevens et al.<sup>12)</sup> reported that when healthy subjects are performing the BE, the IOA and EOA exhibit proportionally higher activation than the RA, a large muscle group. In addition, Ha et al.<sup>13)</sup> reported that during the BE, application of the ADIM selectively activates the abdominal core muscles.

The BE accompanied by the ADIM is helpful for muscle activation as a stability exercise. However, performing the BE for the purpose of building both the TrA and IOA muscles is more effective on an unstable surface than on a stable surface and is thus recommended for stability exercise in the clinical setting for the purpose of strengthening deep abdominal muscles.

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