

Original Article

The effect of bridge exercise accompanied by the abdominal drawing-in maneuver on an unstable support surface on the lumbar stability of normal adults

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Abstract. [Purpose] The present study sought to investigate the influence on static and dynamic lumbar stability of bridge exercise accompanied by an abdominal drawing-in maneuver (ADIM) performed on an uneven support surface. [Subjects] A total of 30 participants were divided into an experimental group (15 participants) and a control group (15 participants). [Methods] The experimental group performed bridge exercise on an unstable surface, whereas the control group performed bridge exercise on a stable surface. The respective bridge exercises were performed for 30 minutes, 3 times per week, for 6 weeks. The static lumbar stability (SLS) and dynamic lumbar stability (DLS) of both the experimental group and the control group were measured using a pressure biofeedback unit. [Results] In the comparison of the initial and final results of the experimental and control groups, only the SLS and DLS of the experimental group were found to be statistically significant. [Conclusion] The results of the present study show that when using bridge exercise to improve SLS and DLS, performing the bridge exercise accompanied by ADIM on an uneven surface is more effective than performing the exercise on a stable surface.

Key words: Bridge exercise, Abdominal drawing-in maneuver, Lumbar stability

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INTRODUCTION

Lumbago is one of the most common functional disorders in modern society, and is known to be primarily caused by decline of the most important muscle activities contributing to vertebral stability, low back and abdominal deep muscle activities¹⁾. Compared with normal persons, lumbago patients exhibit atrophied low back and abdominal deep muscles, which causes problems for lumbar stability. Such symptoms also cause lumbago recurrence. Consequently, the recovery of lumbar stability is important in the treatment and prevention of lumbago. Furthermore, improving lumbar stability is effective in the treatment and prevention of the recurrence of lumbago regardless of the cause.

Thus far, there have been many studies of vertebral stability, which is a testament to the importance of the issue. As the structure of the spine is unstable compared with that of other bones, the role of deep muscles is particularly important in the maintenance of spine stability²⁾. The representative deep muscles of lumbar stability include the transversus abdominis and multifidus³⁾.

Muscles associated with vertebral stability are largely categorized as global muscles and local muscles. These two groups of muscles interact through a mechanism called “co-working” to maintain the stability of the lumbar spine. Global muscles contribute to the overall trunk stability, whereas local muscles, which are situated in deep parts of the abdomen and lumbar spine, contribute to fine vertebral regulation and segmental stabilization^{4, 5)}. Muscles that contribute to lumbar stability include the transversus abdominis, multifidus, internal oblique abdominal muscle, external oblique abdominal muscle, quadratus lumborum, and pelvic floor muscles. In particular, among the global muscles the multifidus and transversus abdominis are activated before other muscles when the human body moves to regulate trunk balance and therefore play important roles in lumbar stability⁶⁾. Exercises for lumbar stability include lumbar flexion and extension exercises in the prone, supine, and proprioceptive bridging positions, which can be performed with a mat, ball, dumbbells, or balance pad⁷⁾. Among these, the bridge exercise is widely used in clinical settings for training the global muscles and the local muscles of the lumbar spine to coordinate in an appropriate manner⁵⁾. Designed to activate the abdominal muscles, the abdominal drawing-in maneuver (ADIM) allows a more effective performance of lumbar stability training and induces simultaneous contraction of the muscles. Furthermore, ADIM also reduces excessive lumbar lordosis and anterior pelvic tilt, which occur due to compensation, dur-

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ing bridging exercise⁸). For lumbar stabilization exercises, rather than performing the exercise in a static environment, the use of on an unstable support surface, such as the top of a gym ball, enhances proprioception and activity in the cerebral cortex⁹, leading to better balance and equilibrium.

In preceding studies that used bridging exercises in tandem with ADIM, or bridging exercises with a sling device on an uneven surface, the thicknesses of the abdominal muscles were compared using ultrasound imaging¹⁰. However, few studies have compared the lumbar stability improvement effect of bridging exercises in tandem with the ADIM method performed on different support surfaces.

Consequently, the present study sought to investigate the effect of bridging exercises in tandem with ADIM, which is easy and simple to conduct in a clinical setting. In particular, we investigated the influence of different support surfaces on the static lumbar stability (SLS) and dynamic lumbar stability (DLS) of the participants, after they had performed the exercises on stable or unstable support surfaces.

SUBJECTS AND METHODS

The present study enrolled 30 university students who were randomly assigned to the unstable bridging exercise group (UBEG) (15 participants: 2 males, 13 females) and the stable bridging exercise group (SBEG) or control group (15 participants: 2 males, 13 females). Participants that had muscular, skeletal, or nervous system problems, or could not perform bridging exercises because of knee or ankle pain, were excluded from the study. This study was approved by the Korea Nazarene University's institutional review board, and the subjects were safely protected during all experimental processes. All of the subjects understood the purpose of this study and provided their written informed consent before their participation in accordance with the ethical principles of the Declaration of Helsinki.

The average age, height, and weight of the participants in the UBEG group were 21.57±0.45 years, 162.44±3.52 cm, and 56.64±5.36 kg, respectively. In the SBEG group, the average age, height, and weight of the participants were 22.22±0.32 years, 161.74±3.65 cm, and 57.67±3.53 kg, respectively. The analysis of the sex differences of the participants was performed with the χ^2 test, whereas the analyses of age, height, and weight differences were performed with the independent t-test. As the above analyses did not reveal statistically significant differences ($p>0.05$), the 2 groups were deemed to be homogeneous.

The bridging exercise on the stable support surface was started with the participants in the supine position, with the knee joints flexed at 90 degrees and the hip joint flexed at 60 degrees. The feet were shoulder width apart, and both hands were placed on the chest in a crossed position. Additionally, proper posture of the head and neck was maintained, with participants' gaze pointing to the ceiling. Before the bridging exercise, the ADIM was performed. The abdomen was drawn in toward the navel to increase the intra-abdominal pressure by selectively contracting the transversus abdominis and internal oblique abdominis instead of the rectus

abdominis. In other words, the ADIM increases the intra-abdominal pressure enhancing the effect of the lumbar stabilization exercises and induces simultaneous contraction of the muscles to reduce excessive lumbar lordosis and anterior pelvic tilt⁸.

Upon the command of "pelvis up", the participant raised the pelvis to maintain a 0-degree hip joint flexion. At the command of "hold", the participant maintained the raised pelvic position for 15 s. Then, at the command of "pelvis down", the participant lowered the pelvis and rested for 10 s. Ten repetitions of the above procedures comprised a single set. The total exercise program was 6 weeks long, and 6 sets per session were performed 3 times a week.

Bridging exercises on an unstable support surface consisted of placing a balance pad (AIREX Balance Pad, AIREX, Switzerland) beneath the participant's feet to increase the intensity and the instability of the exercise. Thereafter, the bridging exercises proceeded in the same manner as that on the stable support surface.

To evaluate the SLS, the rate of contraction of the transversus abdominis was evaluated using a pressure biofeedback unit (Chattanooga Group, Australia, PBU). The PBU consists of an expandable, tensionless pocket connected to a pressure gauge. It is a simple apparatus designed to record and monitor pressure changes during pelvic spine movements. The pocket has a dimension of 16.7×24.0 cm and can measure from 0 to 200 mmHg. During the evaluation, an excessive pressure change is an indicator that the pelvic spine area movements are not being properly regulated. The SLS measurements were made by placing the PBU under the participant in a prone position, at the site of intersection of the anterior superior iliac spines beneath the navel. The baseline pressure began at 70 mmHg, and the participant was directed to decrease the pressure by drawing in the lower stomach without back or hip movement. Then, the participant was asked to maintain the same pressure for the next 10 s, and the resultant change in pressure was recorded¹¹.

To measure the DLS, bent knee fall out (BKFO) was performed. BKFO consists of placing the PBU under the participant in the supine position, 2 cm beneath the posterior superior iliac spines. To minimize the sway of the trunk, folded towels were placed at the sides of the PBU. The baseline pressure was set to 40 mmHg, and the pressure changes during 45 degrees abduction and external rotation movement, while the hip and knee were flexed and the feet were touching the floor, were measured¹².

The recorded data were analyzed using SPSS 12.0 KO (SPSS, Chicago, IL, USA). The collected data are presented as averages and standard deviations. The significance of differences between the pre-intervention and post-intervention data of the respective participant groups were examined using the paired t-test. To evaluate the significance of differences between the 2 participant groups, the independent t-test was used. The significance level was chosen as 0.05.

RESULTS

In the comparison of the pre-intervention and post-in-

Table 1. Comparison of SLS and DLS between pre- and post-intervention in each group (mean±SD) (unit: mmHg)

Category	Group	Pre-intervention	Post-intervention
SLS	SBEG	2.41±2.06	3.25±1.42
	UBEG*	3.41±3.14	4.58±2.81
DLS	SBEG	2.25±0.45	1.75±1.05
	UBEG*	2.33±0.98	1.50±0.67

* p<0.05, SBEG; stable bridge exercise group, UBEG; unstable bridge exercise group, SLS; static lumbar stability, DLS; dynamic lumbar stability

tervention data of the SBEG and UBEG, the UBEG exhibited statistically significant SLS and DLS changes (p<0.05) (Table 1). In the comparison of the changes between pre- and post-intervention of the SBEG with that of the UBEG, none of the changes were found to be statistically different (p>0.05) (Table 2).

DISCUSSION

The present study investigated the effect on SLS and DLS of performing bridge exercise on an unstable surface after ADIM. The bridge exercise is easy to perform and stabilizes the trunk. Consequently, it is often used in clinical settings. Improved vertebral stability reduces damage to and instability in the muscles around the spine, protects the vertebral joints, and improves spinal adjustment capability. Therefore, bridging exercise has been used in lumbago treatment, as it increases the stability of the spine by inducing cooperative contraction of the trunk muscles⁵).

Lehman reported that when a conventional exercise was performed on an unstable support surface, more muscles were activated. In exercises performed on wood balance pad and air cushion support surfaces, it was reported that bridge exercises on top of air cushions were more effective in the rehabilitation of lumbago patients, the air cushion support surface was shown to be more effective¹³). Brill stated that core stabilization exercises not only contract the transversus abdominis but also maintain the balance of the spine, and increase lumbar strength and stability¹⁴). In the study of Endleman, 18 normal adult females and 8 normal adult males perform 6 months of intensive Pilates exercises focusing on the core. In the measurement of the transversus abdominis and internal oblique abdominis after the intervention, the transversus abdominis exhibited a significant difference, demonstrating that training the core area had a positive influence on abdominal strength and trunk stability¹⁵).

In the comparison of the pre-intervention and post-intervention data of the SBEG and UBEG, it was found that the SLS and DLS changes in the UBEG were statistically significant. These results indicate that the use of an unstable support surface for performing bridge exercises led to better co-working of the transversus abdominis and internal oblique abdominis resulting in increases in SLS and DLS. This result of the present study is similar to the result of

Table 2. Comparison of SLS and DLS between SBEG and UBEG (mean±SD) (unit: mmHg)

	Category	SBEG	UBEG
Pre-intervention	SLS	2.41±2.06	3.41±3.14
	DLS	2.25±0.45	2.33±0.98
Post-intervention	SLS	3.25±1.42	4.58±2.81
	DLS	1.75±1.05	1.50±0.67
Change between pre- and post-intervention	SLS	0.83±1.58	1.16±0.93
	DLS	0.50±1.31	0.83±1.19

* p<0.05

a previous study that showed that use of a sling as an unstable support surface for a bridge exercise led to increases in the thicknesses of the transversus abdominis and internal oblique abdominis due to the simultaneous contraction of the core, and the training of surface muscle coordination¹⁰).

In the comparison of the changes between pre-intervention and post-intervention of the stable bridge exercise group and the unstable bridge exercise group, significant differences were not found. This result shows that although an unstable bridge exercise is effective, it is not significantly more effective than a stable bridge exercise at improving SLS and DLS. However, it does show that in the case of performing bridge exercises for the purpose of increasing SLS and DLS, the unstable bridge exercise accompanied by ADIM is more effective than a standalone stable bridge exercise. This indicates that when performing bridge exercises to treat and prevent lumbago, different types of unstable support surfaces should be used to increase the effectiveness of the exercise.

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