J. Phys. Ther. Sci.
27: 63–65, 2015

Original Article

The effects of a bridge exercise with vibration training and an unstable base of support on lumbar stabilization

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Abstract. [Purpose] The aim of this study was to examine the effects of a bridge exercise with vibration training and an unstable base of support on lumbar stabilization. [Subjects] This study assigned healthy adults in their 20s to a bridge exercise with a sling and vibration group (BESV, n=20) and a bridge exercise with a sling group (BESG, n=20). [Methods] Electromyography was used to comparatively analyze the activity of the internal obliques (IO), external obliques (EO), and rectus abdominis (RA) when local vibration was applied during a bridge exercise that used a sling as an unstable base of support. [Results] There were statistically significant increases in the activity of the IO and EO within each group after the intervention. The activity of the IO and the EO was significantly higher in the BESV group than in the BES group after the intervention. [Conclusion] The bridge exercise performed using vibration training on an unstable base of support increased the activity of the IO and the EO, which improved lumbar stabilization.
Key words: Bridge exercise, Vibration, Lumbar stabilization

(This article was submitted May 7, 2014, and was accepted Jul. 15, 2014)

INTRODUCTION

According to the 2011 data from Statistics Korea, lumbar pain is a chronic disease with a high incidence rate, 86.2%, in the population, with the rate being 86.9% for men and 85.5% for women[1)]. There are diverse factors related to lumbar pain, but self-treatment without help from an expert makes complete recovery difficult[2)]. The reason for this is that most people with lumbar pain reduce their activity in order to decrease their pain, and this decrease in activity leads to weakening of muscles and rigidity of the joints, which can lead to chronic back pain. Lee[3)] noted that when patients avoided bed rest for a long time and received appropriate therapeutic exercise during the acute phase, they obtained positive outcomes.

There are existing therapeutic treatment methods for lumbar pain, including Williams exercise, McKenzie exercise, Pilates exercise, and Feldenkrais exercise programs, but spinal stability exercises that enable patients to adjust to large and small movements of the joints, both consciously and unconsciously, have recently been researched[4)]. Dynamic spinal stability exercise program, which is an exercise treatment method for lumbar pain that was first used in the US in the 1980s, has recently been spotlighted. This exercise program provides special training of the muscles around the lumbar vertebrae, which are considered to play an important role in adjusting spinal segments and providing dynamic stability, with the treatment focus on the instability of the spinal segments[5)]. The effects of lumbar stabilization exercise on an unstable base of support have been verified in various studies, and recently, a sling exercise using a rope has been recognized as an effective exercise for stabilizing the spine[6)].

The vibration training provided as an intervention in this study is a type of isometric exercise, and it has been reported to have positive effects in terms of improving motor function and increasing energy metabolism and blood flow; as a result, this training has been drawing a lot of attention[7)]. Rittweger et al.[8)] observed that a group with lumbar pain that was treated with vibration and exercise together saw a decrease in pain and an enhanced ability to control nerve roots.

As shown above, research on the effects of exercise using a sling as an unstable base of support has been reported, but research on the effects of vibration training on lumbar stabilization is lacking. Accordingly, the aim of this study was to look at the effects of the bridge exercise with vibration training and an unstable base of support on stabilization of the lumbar region.

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SUBJECTS AND METHODS

The subjects of this study were randomly and equally allocated to a bridge exercise with a sling and vibration group (BESV group; n=20) and a bridge exercise with a sling group (BES group; n=20). Age, height, and weight in the BESV group were 21.5±2.5 years, 167.0±8.5 cm, and 62.4±11.2 kg, respectively, while they were 22.4±3.9 years, 170.8±7.9 cm, and 61.8±11.3 kg, respectively, in the BES group. No significant differences were found between the two groups when a test of homogeneity was performed on the two groups ($p>0.05$).

Those with neurological or orthopedic disease and those who could not perform supine/prone bridge exercise due to pain or other disease were excluded as subjects. All included patients understood the purpose of this study and provided written informed consent prior to participation, which is in accordance with the ethical standards of the Declaration of Helsinki.

The BESV group received vibration training using vibration equipment (Redcord® Stimula, Redcord AS, Norway) devised by Norwegian physical therapists at frequencies of 15 Hz, 20 Hz, and 30 Hz. The vibration equipment was installed on both ropes of the sling supporting the bilateral lower extremities, and local vibration was applied only during the bridge exercise. The exercise was repeated four times per session. The subjects conducted nine sessions of the supine/prone-position bridge exercise. They rested for 30 seconds after each session. For the first three sessions, a vibration of 15 Hz was applied; for the next three sessions, a vibration of 20 Hz was applied; and for the last three sessions, a vibration of 30 Hz was applied. The subjects conducted the supine-position bridge exercise first. Prior to the exercise, the subjects lay in a supine position on a table, supported both hands on the floor, maintained the hip joints and knee joints at 90 degrees, and put both ankles on the sling support. During the exercise, the subjects placed their weight on the bilateral lower extremities, and they raised their hips so that the trunk, pelvis, and lower extremities formed a straight line. Then, they performed the prone-position bridge exercise. Before the exercise, the subjects lay in a prone position on the table, maintained their shoulder and elbow joints at 90 degrees, rested their weight on their elbows, and raised their bilateral ankles on the sling. Here, the height of the sling was adjusted so that the lateral malleolus, hips and shoulders were level. During the exercise, the subjects rested their weight on their bilateral lower limbs and elbows, and they raised their hips, so that the trunk, pelvis, and lower extremities were level. The BES group conducted the exercises without the vibration equipment.

For measurement, a pressure biofeedback unit (PBU, Chattanooga Stabilizer PBU, DJO Global Inc, Vista, CA, USA) was situated below the umbilicus between the subjects' lumbar region and the floor. An assistant set the pressure at 40 mHG according to the operating instructions book of the PBU[9)]. Then the subjects conducted a drawing-in maneuver within a range in which the PBU's gradation did not change, and their muscle activity was measured. For muscle activity measurement, wireless surface electromyography (EMG, TeleMyo DTS, Noraxon U.S.A. Inc., Scottsdale, AZ, USA) was used, and ground electrodes were attached to the internal obliques (IO), external obliques (EO), and rectus abdominis (RA). EMG signals were converted into %MVIC and then recorded. In addition, to reduce skin resistance at the electrode attachment site, the hair was removed using a razor, and the site was rubbed 3–4 times with fine sandpaper and with alcohol swabs to remove the corneum. Measurements were taken three times, and the average values were calculated.

Table 1. Changes in the Activity of the IO, EO, and RA in the BESV and BES groups (unit: %)

Muscle	Group	Pre	Post
IO	BESV*	12.0±6.8[a]	17.6±6.1[†]
	BES*	10.4±7.7	12.9±8.9
EO	BESV*	7.5±3.1	13.9±5.9[†]
	BES*	8.1±6.2	10.4±6.3
RA	BESV	5.9±5.6	6.0±3.4
	BES	6.4±3.0	7.3±3.7

IO, internal obliques; EO, external obliques; RA, rectus abdominis; BESV, bridge exercise with sling and vibration; BES, bridge exercise with sling; [a]Mean±SD; *$p<0.05$, paired t-test; [†]$p<0.05$, independent t-test

For statistical processing of the experimental results, SPSS 12.0 was used. In order to examine muscle activity within each group, a paired t-test was used, and in order to compare muscle activity between the two groups, an independent sample t-test was employed. The significance level was set at $\alpha=0.05$.

RESULTS

According to the study results, the activity of the IO and EO significantly increased in both the BESV group and BES group ($p<0.05$). In comparing the two groups after the intervention, the activity of the IO and EO was significantly higher in the BESV group than in the BES group ($p<0.05$) (Table 1).

DISCUSSION

The sling exercise is a closed-chain weight bearing exercise, and a closed-chain exercise enables exercise of multiple joints rather than a single joint, which makes the exercise motions unstable. Such movements lead to interaction between antagonistic two-joint muscles and enable changes in spinal form by maintaining the tension relationship between joint movements and muscle length[10)].

Kim and Kim[11)] reported that lumbar stabilization exercise in a quadruped position on an unstable base of support using a sling greatly increased the activity of the IO and EO, but it did not much enhance the activity of the RA; they noted that the RA did not contribute much to lumbar stabilization[12)]. Vera-Garcia et al.[13)] asserted that the curl-up exercise on a static base of support increased the activity of the RA, which made actual lumbar stabilization difficult, but that the curl-up exercise on an unstable base of support boosted the activity of the deep muscles, increasing lumbar stabilization. In the present study, as with previous research, the activity of the IO and EO increased in each group after the intervention, as did lumbar stabilization, but there was no significant difference in the RA in either group after the intervention. Choi and Kang[14] reported that the muscle activity of the internal oblique, the rectus abdominis, the multifidus, and the erector spinae increased more in a group that used manual vibrations on unstable surfaces using slings than in a group that did not use manual vibrations. Brumagne et al.[15] reported that local vibration applied to chronic lumbar pain patients during lumbar exercise enhanced their proprioceptive stimulation and deep muscle adjustment. Muceli et al.[16] observed that vibration for a short time period was effective in strengthening and stabilizing deep muscles. Therefore, it is considered that local vibration improved the proprioceptive stimulation and deep muscle adjustment in the BESV group, given that although there was no change in the activity of the RA, the activity of the IO and EO was significantly higher in the BESV group (which received local vibration) than in the BES group.

Based on the above results, the bridge exercise with a sling and vibration is considered to be effective for lumbar stabilization by increasing the muscle activity of the IO and EO, and it can be presented as an exercise intervention for patients who complain of lumbar pain. The effects of the frequencies used, 15 Hz, 20 Hz, and 30 Hz, for the vibration equipment on lumbar stabilization could not be identified. In future studies, the effects of each of the frequencies (15 Hz, 20 Hz, and 30 Hz) on muscle activity should be studied.

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