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The Effect of a Bridge Exercise Using the Abdominal Drawing-in Maneuver on the Balance of Chronic Stroke Patients

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Abstract. [Purpose] The purpose of this study was to examine the effect of a bridge exercise using the abdominal drawing-in maneuver (ADIM) on chronic stroke patients' balance. [Subjects] In this study, 21 hemiplegia patients diagnosed with stroke were divided into a bridge exercise group using the abdominal drawing-in maneuver (BEGADM, n=10) and a bridge exercise group (BEG, n=11). [Methods] We examined subjects' balance through sway area, sway path length, and sway max velocity. These values were compared and analyzed using a Balance Performance Monitor. [Results] At different points in time during the treatment period, the sway area (SA), sway path length (SPL), and sway max velocity (SMV) within the BEGADM and the BEG groups showed statistically significant differences. After 8 weeks of treatment, there were significant differences in the SA, SPL, and SMV between the two groups. [Conclusion] Bridge exercise using the abdominal drawing-in maneuver is an effective intervention for chronic stroke patients' balance.

Key words: Stroke, Bridge exercise, Balance

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INTRODUCTION

Strokes result from cerebrovascular diseases and are the greatest cause of mortality among single diseases. One of the most dominant characteristics of the damage that generally occurs after a stroke is the weakening of muscular strength that appears unilaterally[1)]. Since this weakening of muscular strength appears in the trunk muscles on the affected side, the trunk muscles and extremity muscles need to be strengthened to improve this condition. The stability of the trunk relies on the harmonized activities of numerous trunk muscles. Thus, muscles anterior, posterior and lateral to the vertebrae need to produce stable and strong contractile powers and need to contract in harmony to ensure stability in momentary postures, at different speeds, and under diverse load conditions imposed on the vertebrae[2)].

In order for stroke patients to maintain optimum balance, the muscles that are involved in lumbar stabilization exercise and training, the multifidus and the transversus abdominis, contract earlier than other muscles to maintain body balance in all movements of the human body[3)]. In addition to these muscles, the internal oblique abdominis, the external oblique abdominis and the quadratus lumborum also serve to stabilize and maintain the mobility.

Various studies related to lumbar stabilization or core-stabilization exercises aiming to find methods of improving the muscular strength and endurance of muscles around the vertebrae have been reported, including interventions that use physical therapy include PNF, Bobath, sling exercises, ball exercises and manual therapy. Among them, a bridge exercise using the abdominal drawing-in maneuver (ADIM) offers lumbar stabilization exercise training for lower back pain patients, which can train both the transversus abdominis and the multifidus muscles. It is also known to be effective for maintenance and control of stable postures[4)].

The bridge exercise using ADIM can also be safely performed by stroke patients who cannot walk easily, since it can be performed in the sitting position. It can also lessen risk factors of exposure to secondary problems such as falls, but its use has largely been limited to lower back pain patients. Consequently, this study was conducted to examine the effect of the bridge exercise using ADIM on chronic stroke patients' balance. The study monitored the effect of the exercise on patients' balance in order to obtain practical data to help chronic stroke patients recover proper balance.

SUBJECTS AND METHODS

The subjects of the study were 21 chronic stroke patients who were diagnosed with stroke at L Rehabilitation Hospital, Daegu Metropolitan City, Korea. The subjects were randomly divided into a bridge exercise group using

Table 1. Comparisons of SA, SPL, SMV within and between groups

	Group	Pre	4weeks	8weeks
SA (mm^2)	BEGADM*	1138.6 ± 705.8	521.5 ± 279.9	280.9 ± 127.8†
	BEG*	967.5 ± 738.6	516.7 ± 213.3	494.2 ± 200.9
SPL (mm)	BEGADM*	477.7 ± 100.9	422.3 ± 125.6	249.0 ± 60.3†
	BEG*	587.4 ± 486.4	486.4 ± 169.3	406.6 ± 108.9
SMV (mm/s)	BEGADM*	148.3 ± 70.0	66.1 ± 19.8	41.0 ± 8.1†
	BEG*	160.7 ± 110.4	72.3 ± 21.0	60.4 ± 21.1

Note. BEGADM: bridge exercise group during abdominal drawing-in maneuver . BEG: Bridge exercise group. *: repeated ANOVA, †:independent sample t-test, *,†: $p<0.05$. SA: sway area; SPL: sway path length; SMV: sway max velocity

the abdominal drawing-in maneuver (BEGADM, 6 males, 4 females) and a bridge exercise group (BEG, 7 males, 4 females). Subject' average age was 55.21 years (± 3.60), average height was 165.36 cm (± 2.15), and average weight was 60.00 kg (± 2.78) in the BEGADM group; and in the BEG group, subjects' average age was 56.30 years (± 1.93), average height was 166.08 cm (± 1.55), and the average weight was 63.00 kg (± 2.84). The time since onset of stroke was 17.00 month (± 2.06) in the BEGADM group, and 14.54 months (± 2.08) in the BEG group. The ratio of right paralysis to left paralysis was about 2:3. No significant differences were found between the two groups when a test of homogeneity was performed on the two groups ($p>0.05$).

The study subjects were selected from hemiplegia patients who could stand for one minute without any support, did not have an orthopedic disease in the pelvis or either lower extremity, did not have heart disease or a medical contraindication in relation to trunk exercises, understood the purpose of the study, and could voluntarily conducted the study. Physical therapists with over 10 years of clinical experience participated in this study.

The BEGADM used a Pressure Biofeedback Unit (Chattanooga Group Inc, USA). First, the Pressure biofeedback Unit (PBU) was placed on the patient's inferior abdomen, on the line connecting the right and left anterior superior iliac spines in the prone position. Then the pressure of the PBU was inflated up to 70 mmHg. The patients were instructed to draw the navel upward and backward (toward the subject's lumbar vertebra) of the lower abdomen, decreasing the pressure gauge of the monitor by about 6–7 mmHg. A maximal pressure decrease up to 10 mmHg was allowed. Then with subjects in supine position, the PBU was placed between the lumbar spine area and the floor and an investigator asked the subject to draw the navel upward and backward (toward the subject's lumbar vertebra) so that the abdomen would sink a little during each expiration. The subject was also requested to increase a respiration volume by 10 mmHg when it was 40 mmHg and maintain that state. The subject was encouraged to contract the multifidus and the transversus abdominis in harmony. Finally, in the supine position with subjects maintaining ADIM, a bridge exercise was performed by flexing the knee joints to 90° while an investigator held the subjects' knees. Subjects raised the pelvis when the measurer gave the instruction, 'Raise your hips', and maintained the posture for 5 seconds in accordance with the instruction, 'Maintain the posture'. The BEG group received conventional physiotherapy and only performed the bridge exercise. The BEGADM and the BEG groups performed exercises four times a week for eight weeks in 30 to 35 minute sessions. Each motion was maintained for five seconds and was followed by a rest of 4–5 seconds.

A Balance Performance Monitor (SMS Health care Inc, England) was used to collect balance related clinical data. Subjects were instructed to place both arms at the side of the trunk and look at a 3-cm -diameter spot marked at a point 15° upward from the center of a wall 1 m away from the subject. The position of the subjects' feet on the foothold was arranged so that the line of gravity of body passed through a distance the ankle joint and met the line marked on the foothold at right angles in all measurements, with a distance of 10 cm separating the two feet[5]. During each measurement, subjects were instructed not to move the body for 30 seconds. Each subject's balance ability was measured three times and the average used in the analysis.

In this study, repeated ANOVA was conducted for statistical analysis in order to examine changes in balance ability within each group over the treatment period. The independent sample t-test was conducted to examine the significance of differences between the groups and the resultant data were processed using SPSS 12.0 for Windows with a chosen significance level of 0.05.

RESULTS

Within both the BEGADM and the BEG groups there were statistically significant differences in the sway area (SA), sway path length (SPL), and sway max velocity (SMV) of each group after 4 weeks of treatment ($p<0.05$). At the end of 8 weeks of treatment, there were significant differences in the SA, SPL and SMV between the two groups ($p<0.05$) (Table 1).

DISCUSSION

In this study, a bridge exercise using ADIM was shown to be effective for chronic stroke patients' balance. Kisner and Colby (2002)[6] reported that bridging exercises are used in clinical practice to enhance the muscular strength of hip extensors, that is, the gluteus maximus and hamstring muscles. Kavcic et al.[7] showed that, for healthy people, a side bridging exercise of light isometric side support, a bridging exercise with a right leg lift, and a general bridging exercise are all affect the rectus abdominis. Stevens et al.[8] argued that, in bridging stabilization exercises for healthy people, the internal abdominal oblique muscles are enhanced more than the rectus abdominis. Moreover, Konrad et al.[9] reported that, in bridging exercises, the muscular activity of the erector spinae muscle in the back and the thorax was 14% lower than that of hip extensors, showing a statistically significant difference.

Teyhan[10] conducted ADIM with a group of lower back pain patients and reported that the transversus abdominis became twice as thick. Oh et al.[11] showed that the muscular activity of the erector spinae muscle and anterior pelvic tilt decreased significantly when a subject lay face down and did a hip extension exercise along with ADIM, while the muscular activity of the gluteus maximus and medial hamstring muscles increased significantly. Kim (2008)[12] conducted ADIM with healthy people, and the height of their anterior superior iliac spine and greater trochanter was lowered significantly, while the trunk extension angle increased significantly. Also, muscular activity of the rectus abdominis, internal oblique abdominis, external oblique abdominis, medial hamstring muscle, and lateral hamstring muscle increased significantly, while the muscular activity of the erector spinae muscle declined significantly.

From the results, we infer that, in BEGADM, ADIM stimulates the transversus abdominis and multifidus muscles. Since muscle contraction is induced simultaneously, it prevents excessive lordosis and pelvic anterior tilt. Also, the bridging exercise enhanced the muscular power of the rectus abdominis, internal oblique abdominis, hip extensors, gluteus maximus and hamstring muscle stabilizing the vertebrae and keeping the body's balance. BEG greatly enhanced superficial muscles, but compared to BEGADM, it seems to have affected deep muscles to a lesser degree. Our research findings show that BEGADM was more effective than BEG at reducing SA, SPL and SMV after eight weeks of treatment.

ADIM and bridging exercises help enhance lumbar stabilization and are essential for treating lower back pain patients. Many previous studies have compared the extent of pain, muscular activity and muscular area between healthy people and lower back pain patients, but few have examined the muscular activity of the paraspinal muscles, deep muscles and lower limb muscles of chronic stroke patients. Accordingly, it is hard to find objective data on the balance of chronic stroke patients. This research presents that BEGADM can significantly improve SA, SPL and SMV, and it will be necessary to conduct further research on muscular activity.

Our research had several limitations. First, the experiment was conducted with a small number of patients undergoing physical therapy at a single rehabilitation facility in Korea. Consequently, the findings cannot be generalized to chronic stroke patients. Second, the muscular activity of the paraspinal muscles, deep muscles and lower limb muscles were not observed separately, and it is hard to decide exactly which part was affected by the exercise. Third, individual patient's exercise abilities, adaptability and health conditions cannot be ruled out when analyzing the impact of ADIM on chronic stroke patients. Future research needs to examine how ADIM using PBU changes the muscular activity of the paraspinal muscles and deep muscles in relation to the lumbar stabilization of chronic stroke patients.

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