

The effect of modified bridge exercise on balance ability of stroke patients

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Abstract. [Purpose] The purpose of this study was to verify the effects of a modified bridging exercise on stroke patients with improvement in weight bearing on the affected side in standing and static balancing ability. [Subjects] Thirty patients who had a stroke were randomly allocated into a supine bridge exercise group (SBG, n=10), a supine bridge exercise on a TOGU balance pad group (SBTG, n=10), and a unilateral bridge exercise group (UBG, n=10). [Methods] The SBG patients underwent supine bridge exercise, the SBTG patients underwent supine bridge exercise with a TOGU balance pad, and the UBG patients underwent unilateral bridge exercise. All groups received 20 minutes of training per day, five times per week, for four weeks. [Results] All groups showed significant changes in weight bearing in a standing position after the intervention. The SBTG and UBG groups showed significant changes in balance ability. [Conclusion] According to the results of this study, bridge exercise was effective in improving weight bearing in a standing position and improving balance on stroke patients. The bridge exercise with a TOGU balance pad and the unilateral bridge exercise were especially more effective in anterior, posterior length in limit of stability following on standing.

Key words: Bridge exercise, Stroke, Balance

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INTRODUCTION

A stroke is a very serious disease and is accompanied by motor disturbance, sensory disturbance, perceptual disturbance, language disturbance, cognitive disorder, and urinary incontinence depending on the area of the brain lesion¹⁾. Hemiplegia is commonly associated with a decrease in balance ability. Stroke patients' balance acts as an important factor in impeding their ability to stand or their gait, and their postural sway is twice as high as that of healthy people in their age range²⁾. Stroke patients' limit of stability is defined as the maximal distance to move the center of gravity while maintaining balance without detaching their feet from the ground³⁾. Balance is diminished in people with hemiplegia⁴⁾, and hemiplegia can cause a reduction in patients' limits of stability, which is defined as the maximal distance that an individual can shift his or her weight in any direction without loss of balance³⁾. For improving balance ability, the patients have to increase their trunk stabilization. The stabilization of the trunk is necessary for the stability of the spine and the pelvis when they are in a functional position, to increase stability during movement, to enhance muscle strength, and

to adjust muscle movements and balance⁵⁾. The principal trunk stabilization exercises are pelvic tilt exercises, quadruped exercises, abdominal hollowing exercises, and bridging exercises⁶⁾. It can be used as a low intensity weight bearing exercise, as it is an important posture to perform, loading weight on the knee and at the same time it develops coordination from a sitting to a standing position⁷⁾.

Bridging exercises (BE) are commonly used therapeutically for lumbopelvic stabilization⁸⁾. Doing BE on a plinth lowers the patient's center of gravity, which reduces fear and the instability of weight bearing during gait, and allows exercise in a secure posture⁹⁾. BE helps to coordinate global and local muscle development⁸⁾. Although a number of studies on the effects of BE with various postures on the activation of trunk muscles and changes in the activity ratio between global and local muscles have been conducted¹⁰⁻¹²⁾, no studies have been done to prove the effects of weight shifting abilities on the paretic side while on the static state.

Bridging exercise is a method that is often used clinically, and much research has been conducted using diverse methods and modifications. Recently, attention has focused on changes in the activities of the trunk muscles during bridging exercises, and many studies have attempted to identify an efficient method for enhancing the activities of the trunk muscles. The conventional bridging exercise is conducted in a supine position, and most other exercises are modifications of this exercise. To the best of our knowledge, very little research on prone bridging exercises has taken place.

The purpose of this study was to verify the effects of a modified bridging exercise on the static balance of a stroke

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Table 1. Comparison of change in balance function in the training groups with values presented as mean \pm standard deviation

	SBG		SBTG		UBG	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
WB (%)	45.9 \pm 1.2	46.2 \pm 1.4*	41.3 \pm 2.0	47.0 \pm 1.2*	42.8 \pm 1.5	47.0 \pm 1.3**a
AL (mm)	980.8 \pm 186.2	1,020.6 \pm 210.1	1,072.7 \pm 550.4	895.9 \pm 678.5*	971.7 \pm 348.5	689.5 \pm 269.7**a
PL (mm)	914.9 \pm 139.5	992.3 \pm 141.7	1,389.7 \pm 345.0	1,294.0 \pm 198.2*	1,059.6 \pm 429.5	788.5 \pm 124.6**a

*Significant difference from pre-test at <0.05 . ^asignificant difference in gains between three groups at <0.05 . SBG: Supine bridge exercise group, SBTG: Supine bridge exercise on togu group, UBG: Unilateral bridge exercise group, WB: Weight bearing in affected side on standing, AL: Anterior length in limit of stability following on standing, PL: Posterior length in limit of stability following on standing

patient with improvement in weight bearing on the affected side in standing and static balancing ability.

SUBJECTS AND METHODS

The subjects of this study were 30 patients diagnosed with hemiplegia resulting from stroke by a rehabilitation doctor practicing in N Hospital located in Daegu, South Korea. They were randomly and equally assigned to a supine bridge exercise group (SBG: 4 males, 6 females), a supine bridge exercise on a TOGU balance pad group (SBTG: 6 males, 4 females), and a unilateral bridge exercise group (UBG: 7 males, 3 females). The mean \pm SD age, height, and weight of the SBG group was 52.4 \pm 40.6 years, 165.0 \pm 9.5 cm, and 66.1 \pm 13.1 kg, respectively. Eight of the patients had right hemiplegia and two had left hemiplegia. The onset period was 10.8 \pm 6.1 months. The mean \pm SD age, height, and weight of the SBTG group was 50.8 \pm 5.5 years, 165.9 \pm 8.6 cm, and 63.9 \pm 5.2 kg, respectively. Six of the patients had right hemiplegia and four had left hemiplegia. The onset period was 13.4 \pm 8.2 months. The mean \pm SD age, height, and weight of the UBG group was 50.8 \pm 5.5 years, 165.9 \pm 8.6 cm, and 63.9 \pm 5.2 kg, respectively. Seven of the patients had right hemiplegia and three had left hemiplegia. The onset period was 13.4 \pm 8.2 months.

The inclusion criteria were as follows: no visual field defect, no abnormality in the vestibular organs, no orthopedic disease, an unrestricted range of motion, the ability to understand and perform the exercise as instructed by the researcher, and a score of 24 or higher on the Mini-Mental State Examination-Korean version. Prior to participation, all participants were required to read and sign an informed consent form, in accordance with the ethical standards of the Declaration of Helsinki. The protocol for this study was approved by the local ethics committee.

The subjects in the SBG group did the supine bridge exercise. In the starting position of the bridging exercise in the subjects bent their knee joints at 90 degrees and spread both arms at about 30 degrees position with both hands on the ground. They kept their head and neck in a straight position, with their eyes looking at the ceiling. The SBTG group did the supine bridging exercise on TOGU balance pads. The subjects adopted the same position as that of the SBG group, but they placed their feet on TOGU balance pads. The UBG group did the unilateral bridging exercise. Again, adopting the same position as that of the SBG group, the subjects raised their hemiplegic-side leg.

The exercises were done for 20 minutes each time, five times per week, for a total of four weeks.

For the measurement of balance ability, a biofeedback analysis system (AP1153 Biorescue, France) was used to determine weight bearing, anterior length in limit of stability, and posterior length in limit of stability on the affected side in a static standing position.

The experimental results were statistically analyzed using SPSS 12.0 KO (IBM, IL, USA). After the general characteristics of the subjects were determined, a one-way ANOVA was used to compare the variation in the weight bearing on the affected side in standing, the anterior length in limit of stability following standing, and the posterior length in limit of stability following standing. Tests were conducted between the pre- and post- intervention within each group. The significance of the differences between the three groups was investigated using the independent t-test. Statistical significance was accepted for values of $p < 0.05$.

RESULTS

The analysis results of each group's weight bearing rate on the paretic side are as follows. According to the analysis results of the weight load rate on the paralyzed side, there were significant differences in each group before and after the experiment, and there were significant differences in the UBG after the experiment ($p > 0.05$) (Table 1). According to the results of the comparison of the forward and backward movement range in limit of stability in a standing position before and after the experiment, there were significant differences between the SBTG group and the UBG group after the experiment ($p > 0.05$) (Table 1).

DISCUSSION

Balance is the ability to maintain body equilibrium and influences most motions performed in daily living¹³. Balance can be defined as the ability to maintain the body's center of mass over its base of support and maintain equilibrium constantly during body movements¹⁴.

Stroke patients, who are at a relatively early stage post-onset, show a marked deficit in weight shifting to the affected leg¹⁵. Shin et al.¹⁵ noted that stroke patients' weight support ability was correlated with functional performance ability, and moving the weight left or right in a standing position was related to motor function, an independent life, and the amount of time it took to go back home from the

hospital. The reason was that stroke patients' ability to move their weight left or right was directly related to gait. In the current study, weight bearing on the affected side in standing and the forward and backward movement range in limit of stability in a standing position were compared, and the results showed a significant effect in the unilateral bridge exercise group and statistically significant differences between the three groups. Latash et al.¹⁶⁾ used the center of pressure (COP) as a measure of postural control, and measuring the variables of COP represented changes in the locations where the ground reaction forces were composite, which referred to the weight average of all the pressure points that contacted the ground. Kim et al.¹⁷⁾ reported that the characteristics of COP-based variables were utilized widely as a tool to diagnose a patient's prognosis related to balance disabilities and to assess treatment effects.

Bridging exercises with the feet on an unstable surface are effective for increasing dynamic balance, especially for the prevention of spinal damage¹¹⁾. Kavcic et al.¹⁸⁾ reported that a bridging exercise with the right leg lifted was very closely associated with the activity of the rectus abdominis in the side bridging exercise when healthy adults performed lumbar stabilization exercise. Park et al.¹⁹⁾ reported that a bridge exercise using vibration training under an unstable support that used sling equipment significantly increased the muscle activities of the internal and external oblique muscles of healthy subjects.

The results of the current study suggest that the position adopted in the UBG group is useful for weight bearing on the feet and increasing balance ability. In this study, three groups performed modified bridging exercises, thereby determining the weight bearing ability on the affected side, changes in forward weight shifting, and changes in backward weight shifting. With regard to weight bearing, all three groups (SBG, SBTG, and UBG) increased weight bearing to 46.2 ± 1.4 , 47.0 ± 1.2 , and 47.0 ± 1.3 . With regard to the COM shifting effect, not only the AL direction but also the PL direction showed that SBTG 895.9 ± 678.5 and UBG 689.5 ± 269.7 had more significant results than SBG 1020.6 ± 210.1 . In particular, the UBG group experienced the highest body weight bearing ability and COM shifting of PL and AL. That is, the UBG group's exercise was concluded to be the most suitable balance control ability. Bridging exercise has been applied in many previous studies already, and it has been modified variously. Hong et al.²⁰⁾ reported that changes in muscle activity and muscle endurance can be obtained over unstable ground surfaces more than on stable ground surfaces, based on their studies on the application of bridging exercises over various support surfaces. This result is consistent with those of the current study in which bridge exercise on the unstable base significantly increased ($p < 0.05$) dynamic and static lumbar stability relative to bridge exercise on the unstable base²¹⁾.

Many patients have difficulty bearing weight on the hemiplegic side and in forward and backward body movement. Because patients with hemiplegia after stroke normally use a hip strategy instead of an ankle strategy due to changes in the ground reaction force and the increased muscle tone of the hip flexors, they feel they will fall down when moving a little bit forward or backward. Therefore, regaining the

ability to move forward and backward is very important for maintaining posture in standing as well as in walking. In the final assessment, the increases in the subjects' anterior and posterior stability limits were meaningful, indicating that they had gained more efficient postural control. The subjects especially needed more strength and proprioceptive senses in the ankle joints when they did the bridge exercise with the balance pad and the unilateral bridge exercise.

This study has some limitations. There were only 30 participants, making it difficult to generalize the results to the general population. Moreover, not only anterior and posterior COG adjustments, but internal and external adjustments were also important for balance abilities. Thus, future studies will be conducted to determine how the correlation of internal and external shifting and anterior and posterior shifting as well as weight bearing increases on the affected side and postural control improvement are functionally related to one another.

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