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Original Article

Effects of active vibration exercise using a Flexi-Bar on balance and gait in patients with chronic stroke

Dong-Kyu Lee, PT[1)], Ji-Won Han, PT[2)*]

[1)] *Department of Physical Therapy, Sunhan Hospital, Republic of Korea*
[2)] *Department of Rehabilitation Science, Graduate School, Daegu University: 201 Daegudae-ro, Jillyang, Gyeongsan-si, Kyeongbuk 38453, Republic of Korea*

Abstract. [Purpose] This study aimed to investigate the effect of active vibration exercise using a Flexi-Bar on the balance and gait of chronic stroke patients. [Subjects and Methods] Twenty-two patients with chronic stroke were randomly assigned to an experimental or control group (n=11 each). The experimental group performed active vibration exercise using a Flexi-Bar. Balance was measured using the Berg Balance Scale and Functional Reach Test. Gait was measured with the 10-meter Walk Test and Timed Up and Go Test. [Results] Intragroup comparisons in the experimental group showed significant differences in Berg Balance Scale, Functional Reach Test, 10-meter Walk Test, and Timed Up and Go Test results, whereas intergroup comparisons showed significant differences in Berg Balance Scale, Functional test, 10-meter Walk Test, and TUGT results. [Conclusion] On the basis of these results, it was concluded that active vibration exercise using a Flexi-Bar effectively improves the balance and gait of patients with chronic stroke.

Key words: Vibration, Balance, Stroke

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INTRODUCTION

Stroke is a disease in which neurological damage occurs when the blood supply to the brain is inconsistent owing to ischemia or hemorrhage[1)]. Stroke causes difficulty performing daily life activities, such as exercise, senses, cognition, language, and deglutition[2)]. Patients with stroke have hemiplegic symptoms, in which one side of the body becomes paralyzed, and a subsequent decline in balance and walking ability occurs due to weakened sense and exercise ability[1, 2)]. Stroke patients who have damages in sensory and exercise functions experience unstable postures and difficulties in balance and walking due to asymmetrical postures. In stroke rehabilitation, the recovery of independent balance and walking ability becomes an important goal[3)]. A Flexi-Bar is a vibrating exercise equipment that uses 4.6-Hz vibrations generated by shaking a 153-cm stick and can help improve static and dynamic stability by controlling the vibration speed and amplitude generated actively by the subject rather than by manual vibration using a mechanical force[4, 5)]. An active vibration exercise using Flexi-Bar is effective for muscle coordination because it causes tonic vibration reflex in enthesis and stimulates the proprioceptive senses of joint, and because the vibration leads to contraction in turns on agonist and antagonist to adjust instability during an exercise. Vibration exercise using a Flexi-Bar is reportedly effective at improving trunk muscle thickness and balance[5)]. It has also been reported that exercise using a sling and Flexi-Bar is effective at reducing pain and increasing muscle activity in patients with rotator cuff repair[6)]. Passive vibration stimulation has limits since it is difficult to save vibration energy when applied for a long time. However, insufficient studies have investigated the effect of active vibration exercise using a Flexi-Bar on the balance and gait of chronic stroke patients. The purpose of this study is to investigate the effect of an active vibration exercise

*Corresponding author. Ji-Won Han (E-mail: damgeom@naver.com)

using a Flexi-Bar on the balance and gait of chronic stroke patients.

SUBJECTS AND METHODS

In this study 22 patients who were diagnosed with stroke >6 months prior according to computed tomography and magnetic resonance imaging findings were randomly assigned to two groups: 11 (five men, six women) in the experimental group and 11 patients (six men, five women) in the control group. All subjects scored at least 24 points on the Mini Mental Status Examination, were able to perform tasks, walked independently for >10 m, had no visual impairments, and had no orthopedic problems in either lower extremity. The participants were fully informed about the study purpose and methods and participated after providing written consent. This study complied with the ethical standards of the Declaration of Helsinki. The ethics committee of Daegu University approved this study. For the experimental group the average age was 69.2 ± 4.6 years, the average height was 166.2 ± 5.1 cm, and the average weight was 66.8 ± 6.8 kg. For the control group the average age was 68.4 ± 3.7 years, the average height was 167.2 ± 3.7 cm, and the average weight was 66.2 ± 5.6 kg. There was no significant difference in the general characteristics of the subjects between the groups. The experimental group performed an active vibration workout for 20 min a day, five times a week, for 4 weeks using a Flexi-Bar (FLEXI-BAR®; Flexi-Sports, Germany). A Flexi-Bar is a stick that is 1,520 mm long and weighs 719 g. The middle part of the stick has a rubber handle measuring 17.9 cm long, whereas the ends consist of weighty rubber, so the hands and arms transfer approximately 5-Hz vibrations when holding the middle handle and shaking the stick. The subject held the Flexi-Bar with both hands while standing and performed an up-and-down vibration exercise. The control group maintained their usual daily activities during the study period and did not exercise regularly until the end of the study. Balance was measured using the Berg Balance Scale (BBS) and Functional Reach Test (FRT). The BBS consists of 14 total items divided into three areas: sitting, standing, and posture change. The total possible score is 56; the higher the score, the better the balance. FRT measured the distance between the start and end points by raising the arm to 90 degrees in a relaxed standing position and extending the arm as far as possible without losing balance. Gait was measured with the 10-Meter Walk Test (10MWT) and Timed Up and Go Test (TUGT). The 10MWT was used to assess gait speed and involved making patients walk 14 m and measuring the time it took to walk 10 m after exclusion of the beginning and end of the walk (2 m each). TUGT was used to assess functional mobility, measuring the time from sitting on a chair with armrests to the time it takes to sit on a chair, walking 3 m from the chair, and returning from the chair in the interval. Collected data was analyzed using SPSS 12.0. Descriptive statistics were used to compare the subjects' general characteristics, while the paired t-test was used to compare values before and after the experiment. An independent t-test was conducted to compare the intergroup differences in changes before and after the experiment. The statistical significance level was set at α=0.05.

RESULTS

The intragroup comparison showed significant differences in BBS, FRT, 10MWT, and TUGT values in the experimental group ($p<0.05$) (Table 1). The intergroup comparison showed that the differences in BBS, FRT, 10MWT, and TUGT within the experimental group were significant relative to the control group ($p<0.05$) (Table 1).

DISCUSSION

The purpose of this study is to investigate the effect of active vibration exercise using a Flexi-Bar on the balance and gait of chronic stroke patients. In this study, BBS and FRT of the experimental group were a significantly different after compared with before the experiment. In addition, compared with the control group, the experimental group showed meaningful differences in BBS and FRT. The Flexi-Bar exercise reportedly effectively improved balance in football players[7]. Moreover, applying this exercise to normal people effectively improved trunk muscle and balance ability[5]. Active vibration exercise us-

Table 1. Comparison of the results of the BBS, FRT, 10MWT and TUGT between the experimental and control groups

	Experimental group (n=11)			Control group (n=11)		
	Pre	Post	Post-Pre	Pre	Post	Post-Pre
BBS (scores)	42.0 (1.5)	45.2 (0.8) *	3.2 (1.9) †	39.0 (2.5)	39.8 (2.4)	0.8 (0.8)
FRT (cm)	18.4 (1.8)	22.2 (1.3) *	3.8 (1.6) †	19.8 (0.8)	20.2 (0.8)	0.4 (0.5)
10MWT (sec)	16.4 (0.5)	11.8 (1.7) *	−4.6 (1.8) †	15.8 (1.4)	15.4 (0.5)	−0.4 (2.7)
TUGT (sec)	23.4 (1.1)	19.2 (2.1) *	−4.2 (2.7) †	21.2 (0.8)	20.8 (0.8)	−0.4 (1.1)

Values are mean (standard deviation).
BBS: Berg Balance Scale; FRT: Functional Reach Test; 10MWT: 10 Meter Walk Test; TUGT: Timed Up and Go Test.
*$p<0.05$: Significant differences between pre- and post-test,
† $p<0.05$: Significant differences between the experimental and control groups.

ing the Flexi-Bar can help improve static and dynamic stability, as the subject can control vibration speed and amplitude[4, 8]. Active vibration exercise using the Flexi-Bar might help increase balance by activating core muscles in the deep part of the trunk. In this study, the 10MWT and TUGT values of the experimental group differed significantly after the experiment compared to before. Also, compared to the control group, the experimental group showed meaningful differences in 10MWT and TUGT values. In and Song[9] showed that the application of vibration exercises in stroke patients improved walking ability. Gu[10] demonstrated that vibration in the horizontal and vertical directions using a body blade in stroke patients showed a significant difference between 10MWT and TUGT values. Vibration stimulation helps strengthen the muscles involved in stability by improving one's sense of innate receptivity with strong sensory stimuli[9, 11]. It has also been reported that vibration stimulation affects the ability to regulate nerve fibers[12]. Vibration stimulation applied on muscle tendon repetitive proprioceptive senses and acts strongly on α-exercise nerve, causing reflexive muscular contraction on muscle belly. These advantages are expected to be helpful for improving the walking ability of stroke patients. These results suggest that active vibration exercise using the Flexi-Bar effectively improves the balance and gait ability of patients with chronic stroke. Since this study had relatively short period (4 weeks) and a small number of subjects, the generalizability of our results in all stroke patients. It would be difficult to explain the long-term effects from this study as continuous tracking observation was not performed after study completion. Henceforth, considering this aspect, further studies with large numbers of subjects and long follow-up observation periods are needed.

Conflict of interest

None.

REFERENCES

1) Prange GB, Jannink MJ, Groothuis-Oudshoorn CG, et al.: Systematic review of the effect of robot-aided therapy on recovery of the hemiparetic arm after stroke. J Rehabil Res Dev, 2006, 43: 171–184. [Medline] [CrossRef]
2) Mercier L, Audet T, Hébert R, et al.: Impact of motor, cognitive, and perceptual disorders on ability to perform activities of daily living after stroke. Stroke, 2001, 32: 2602–2608. [Medline] [CrossRef]
3) Maguire C, Sieben JM, Frank M, et al.: Hip abductor control in walking following stroke—the immediate effect of canes, taping and TheraTogs on gait. Clin Rehabil, 2010, 24: 37–45. [Medline] [CrossRef]
4) Mileva KN, Kadr M, Amin N, et al.: Acute effects of Flexi-bar vs. Sham-bar exercise on muscle electromyography activity and performance. J Strength Cond Res, 2010, 24: 737–748. [Medline] [CrossRef]
5) Lee SJ: The effects of flexi-bar exercise on trunk muscle thickness and balance in healthy adults. Nambu University, Dissertation of Master's Degree, 2015.
6) Kim JW, Kim YN, Lee DK: The effect of combined exercise with slings and a flexi-bar on muscle activity and pain in rotator cuff repair patients. J Phys Ther Sci, 2016, 28: 2890–2893. [Medline] [CrossRef]
7) Um KM, Wang JS: Effect of flexi-bar exercise on postural alignment and balance ability in juvenile soccer players. JKAIS, 2015, 16: 5296–5303.
8) Buteau JL, Eriksrud O, Hasson SM: Rehabilitation of a glenohumeral instability utilizing the body blade. Physiother Theory Pract, 2007, 23: 333–349. [Medline] [CrossRef]
9) In TS, Song CH: The effects of whole body vibration on knee extensor strength, and balance and walking ability with chronic stroke. J Korean Soc Phys Med, 2010, 5: 675–683.
10) Gu SY: The effect of vertical and horizontal oscillation of the blade on balance of patients with hemiplegia. Daegu University, Dissertation of Master' Degree, 2013.
11) Yang X, Wang P, Liu C, et al.: The effect of whole body vibration on balance, gait performance and mobility in people with stroke: a systematic review and meta-analysis. Clin Rehabil, 2015, 29: 627–638. [Medline] [CrossRef]
12) Abercromby AF, Amonette WE, Layne CS, et al.: Vibration exposure and biodynamic responses during whole-body vibration training. Med Sci Sports Exerc, 2007, 39: 1794–1800. [Medline] [CrossRef]