



Original Article

The effects of visual control whole body vibration exercise on balance and gait function of stroke patients

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Abstract. [Purpose] This study aims to verify the effects of visual control whole body vibration exercise on balance and gait function of stroke patients. [Subjects and Methods] A total of 22 stroke patients were randomly assigned to two groups; 11 to the experimental group and 11 to the control group. Both groups received 30 minutes of Neuro-developmental treatment 5 times per week for 4 weeks. The experimental group additionally performed 10 minutes of visual control whole body vibration exercise 5 times per week during the 4 weeks. Balance was measured using the Functional Reach Test. Gait was measured using the Timed Up and Go Test. [Results] An in-group comparison in the experimental group showed significant differences in the Functional Reach Test and Timed Up and Go Test. In comparing the groups, the Functional Reach Test and Timed Up and Go Test of the experimental group were more significantly different compared to the control group. [Conclusion] These results suggest that visual control whole body vibration exercise has a positive effect on the balance and gait function of stroke patients.

Key words: Visual control whole body vibration exercise, Balance, Gait

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INTRODUCTION

The stroke is infarct and bleeding issue in cerebrevascular terrains and causes reduction of movement and sensational function with neurological problems¹⁾. The reduction of movement causes the imbalance on left and right side when stroke happens and serious problem with controlling posture²⁾. Having trouble in balancing and controlling posture gives disability for gait and in daily life³⁾. As gait and balance function is closely related to performance in everyday life, it must be sure that gait and balance function is always improved^{2, 3)}. Through training for developing balancing ability of patients with stroke, it can boost physical functions such as by increasing physical ability, preventing falling and improving ability of controlling posture²⁻⁴⁾. These are really important in rehabilitation of patients with stroke⁴⁾.

Current methods to improve the balance and gait capability of stroke patients include muscle strengthening exercises, task oriented training, and auditory and visual feedback exercises using unstable surfaces, whole body vibration exercise, and weight movement training⁵⁻⁸⁾. Recently, visual control whole body vibration exercise has been used as a new form of vestibular sensory stimulation⁸⁾.

Visual control whole body vibration exercise causes changes in the cerebral hemispheres through stimulating afferent fibers⁹⁾. While receiving the vibration stimulus, muscles experience small changes in length⁹⁾. Vibration also excites the spinal reflex through enhancing connections between short spindle-motor neurons and motor nerves¹⁰⁾. Activation of muscle

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spindle receptors by vibration impacts muscles directly receiving the vibration stimulus and adjacent muscles^{9, 10}. Whole body vibration exercise has been reported to improve the balance and gait of the elderly, stroke patients, and patients with Parkinson's disease^{8, 11, 12}.

We aim to study the effects of visual control whole body vibration exercise on balance and gait function of stroke patients, since there is currently insufficient data on this topic in the literature.

SUBJECTS AND METHODS

A total of 22 individuals who were diagnosed with strokes at least 6 months prior to the study based on computed tomography and magnetic resonance imaging results gave informed consent to participate in the study. Participants were randomly assigned to 2 groups: 11 (8 males and 3 females) to the experimental group and 11 (7 males and 4 females) to the control group. All subjects were able to perform tasks totaling over 24 points on the Korean version of Mini-Mental Status Examination (MMSE-K), independently walk over 10 meters, and not have any cognitive or visual impairment or orthopedic disease. All participants were informed about the research purpose and provided informed consent before the experiment. All subjects provided written informed consent prior to participation according to the ethical standards of the Declaration of Helsinki. Overall conditions of the subjects are as shown in Table 1. For the experimental group, the mean age was 50.9 ± 8.2 years, height was 164.1 ± 5.5 cm, weight was 59.7 ± 7.4 kg, MMSE-K score was 27.7 ± 2.1 points, and onset was 12.3 ± 10.1 years. For the control group, the mean age was 52.2 ± 12.3 years, height was 161.0 ± 8.0 cm, weight was 63.7 ± 9.6 kg, MMSE-K score was 27.5 ± 1.7 points, and onset was 10.6 ± 6.8 years.

Both groups received 30 minutes of Neuro-developmental treatment 5 times per week for 4 weeks. In addition, the experimental group performed 10 minutes of visual control whole body vibration exercise wearing an eye patch for visual blockage 5 times per week during the 4 weeks. Visual control whole body vibration was performed using a Galileo tilt table (Novotec Medical, Germany). Subjects maintained a squat posture with a slightly bent hip joint, knee joint, and ankle joint on the footplate of the whole body vibration exercise machine. While standing, the distance between heels was 16.8 cm and the extorsion angle was 9 degrees. The vibrating amplitude was 5 mm and the frequency was set to 25 Hz. For safety, a chest belt was used while performing whole body vibration exercises to prevent falling.

Balance was measured using the Functional Reach Test (FRT) to measure the distance between a start and end point while the subject is raising an arm to a 90 degree angle, stretching to maximum without losing balance. Gait was measured using the Timed up and Go Test (TUGT) to estimate functional motility by measuring time while a subject sitting on an armchair stands up, walks 3 m, and returns to sitting.

Statistical analyses were performed using SPSS 19.0 (SPSS, Chicago, IL, USA) software. Overall characteristics of the subjects were analyzed using descriptive statistics. The paired t-test was used to compare results before and after the experiment in each group. An independent t-test was conducted to determine differences between the two groups in terms of change before and after the experiment. The significance level was set to $\alpha=0.05$.

RESULTS

Changes in FRT and TUGT are shown in Table 2. The in-group comparison in the experimental group showed significant differences in FRT and TUGT ($p<0.05$). In the intergroup comparison, the differences in FRT and TUGT within the experimental group appeared significant relative to the control group ($p<0.05$).

DISCUSSION

This study investigated the effects of visual control whole body vibration exercise on balance and gait of stroke patients. The in-group comparison in the experimental group showed that the balance change was significantly different using the FRT. In comparison between groups, the FRT of the experimental group was significantly improved compared to the control group. Van Nes et al.⁸ showed that whole body vibration exercise is an effective method to enhance posture control and balance in chronic stroke patients. Han and Shin¹³ evaluated balance in stroke patients that received balance training with visual blockage and showed that this group experienced significant balance improvement compared to a group allowed vision. These results are consistent with the results of the current study and suggest that visual blockage helps develop other sensory systems that control balance^{14, 15}. It suggests that blocking eyesight could advance the postural control capabilities in stroke patients¹⁶. Visual control whole body vibration exercise excites muscle spindles through somatosensory stimulation and activates α -motor neurons, so it is effective in balance improvement¹⁷. Accordingly, whole body vibration exercise with visual cue deprivation seemed to enhance the balance of stroke patients.

Gait is one indicator for measuring stroke patients' capability for daily activities and body function and predicting prognosis^{18, 19}. In this study, gait changes in the in-group comparison in the experimental group showed significant differences using the TUGT. Comparison between groups revealed that the TUGT of the experimental group showed significant improvement compared to the control group. Kim and Kim²⁰ showed that treadmill flank walk training with blocked vision resulted in gait improvement in stroke patients. External signals using vibration also has been reported to enhance the gait of stroke

Table 1. General characteristics of subjects

	EG (n=11)	CG (n=11)
Gender (male / female)	8/3	7/4
Paretic side (right / left)	7/4	4/7
Age (years)	50.9 ± 8.2 ^a	52.2 ± 12.3
Weight (kg)	59.7 ± 7.4	63.7 ± 9.6
Height (cm)	164.1 ± 5.5	161.0 ± 8.0
MMSE-K (score)	27.7 ± 2.1	27.5 ± 1.7
Onset (years)	12.3 ± 10.1	10.6 ± 6.8

^aMean ± SD, EG: experimental group, CG: control group, MMSE-K: Korean Version of Mini-Mental Status Examination

Table 2. Comparison of the results of the FRT and TUGT between the experimental and control groups

	Group	Pre	Post	D-value
FRT (cm)	EG	20.3 ± 5.0	26.8 ± 5.1*	6.4 ± 2.5 [#]
	CG	18.6 ± 11.1	19.4 ± 9.9	0.7 ± 4.1
TUGT (sec)	EG	29.9 ± 15.1	20.8 ± 13.8*	-9.0 ± 4.0 [#]
	CG	29.9 ± 17.2	28.5 ± 15.9	-1.4 ± 4.0

Mean ± SD, *p<0.05: Significant differences between pre- and post-test, [#]p<0.05: Significant differences between the EG and the CG groups, D-value: Difference value, EG: experimental group, CG: control group, FRT: Functional Reach Test, TUGT: Timed Up and Go Test

patients²¹). Performing visual control whole body vibration exercise with blocked vision allowed stimulation of the proprioceptive senses, which is expected to contribute to improve the gait of stroke patients. In conclusion, visual control whole body vibration exercise is effective in improving balance and gait function in stroke patients.

This research has limitations in generalizing the interpretation to all stroke patients since it was conducted within a small pool of subjects. Follow-up studies were not performed, so the after-experiment effects are unknown. Further study is needed with a larger number of patients for a longer time period with follow-up.

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