

Post-Stroke Rehabilitation Intervention: Effect of Spinal Stabilization with Visual Feedback on the Mobility of Stroke Survivors

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Abstract. [Purpose] This study aimed to find the effect of spinal stabilization with visual feedback on the mobility of stroke survivors. [Subjects and Methods] Twenty-one chronic stroke patients over 6 months since the onset of stroke were the subjects of this study. The experimental group performed a spinal stabilization exercise program for 30 minutes per day, 5 times per week, for a total of 8 weeks. The control group received conventional physiotherapy. The temporal and spatial gait parameters were measured using GAIT Rite (CIR System Inc, USA) instruments. [Results] There were significant differences between before and after the intervention in all spatiotemporal gait parameters of the experimental group, except the step length asymmetry ratio and the single support time asymmetry ratio. However, no statistically significant differences were found between the two groups when the pre- and post-intervention differences of the experimental group and the control group were compared. [Conclusion] This results of this study show that spinal stabilization with visual feedback is an effective intervention method for improving the mobility of chronic stroke patients.

Key words: Spinal stabilization, Visual feedback, Stroke survivors

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INTRODUCTION

Stroke, which is the most common cerebral circulation disorder, is one of the 3 major causes of death among humans along with malignant tumors and heart attacks¹⁾. In South Korea, it holds second place after malignant tumors in the list of causes of death in the elderly population over 65 years of age²⁾.

Neurological and functional recovery in most stroke survivors reaches its peak within 5 months after the onset of stroke, and some researchers even argue that no further improvements can be expected after that time³⁾. However, there are also researchers who have reported that aerobic capacity and mobility can be improved through exercise training even in chronic stroke hemiparetic patients⁴⁻¹¹⁾.

In order to allow stroke patients to maintain adequate mobility according to changing environments appropriate muscle power and endurance of the spinal muscles is very important¹²⁾. This is because the abdominal muscles and the spinal muscles are closely related to spinal stability and their function is essential in spinal movements and posture control¹³⁾.

Improvement in the muscle power and endurance of these

spinal muscles is possible through spinal stabilization exercise training, the application of which is currently limited to lower back pain patients. Spinal stabilization exercise training trains the transverse abdominis and multifidus simultaneously, and it is known to be effective for improving unstable posture maintenance and control¹⁴⁾.

There are few reports in the literature about the effect on the mobility of stroke patients of spinal stabilization exercise training with visual feedback. We wanted to find out whether spinal stabilization exercises are beneficial for stroke patients. Therefore, we conducted spinal stabilization training with visual feedback which is currently only administered to lower back pain patients, for stroke patients and studied the effect on their mobility.

SUBJECTS AND METHODS

The subjects of this study were 21 stroke patients receiving physiotherapy who understood the contents of this study and voluntarily agreed to participate. The study conformed to all standards related to the use of human subjects in research as outlined in the Helsinki declaration. The subjects were randomly divided into experimental

(male 7, female 2) and control groups (male 7, female 5). The average age was 56.33 years, average height was 166.55 cm, and average weight was 64.66 kg in the experimental group, and in the control group the average age was 56.77 years, average height was 164.66 cm, and average weight was 64.44 kg. Time since onset of stroke was 21.44 month (± 6.85) in the experimental group, and 21.55 month (± 6.24) in the control group. No significant differences were found between the two groups when a test of homogeneity was performed on the two groups ($p > 0.05$).

The visual feedback exercise performed by the experimental group uses a Biofeedback Unit Stabilizer. The exercise program consisted of abdominal muscle re-education in the four-foot kneeling position, curl exercise in the prone position, and abdominal muscle re-education in the righting position. The participants were instructed to perform isometric contractions of the transverse abdominis and multifidus muscles.

First, abdominal muscle re-education in the four foot kneeling position was carried out. Repetitions of abdominal wall drawing and drift were performed to promote deep muscle activation to enable the trunk and pelvic area to maintain its normal curvature. Next, in the prone position, the pressure sensor of the Biofeedback Unit Stabilizer was placed on the patient's inferior abdomen on the line connecting the right and left anterior superior iliac spines (ASIS). Then, the pressure gauge on the monitor of the Biofeedback Unit Stabilizer was inflated up to 70 mmHg. The patients were instructed to perform drawing movements of the lower abdomen, reducing the pressure displayed on the monitor by about 6–8 mmHg. A maximal pressure decrease of up to 10 mmHg was allowed. Abdominal muscle re-education in the righting position was done in sequential steps, in the sitting position and the upright position, and the patients were instructed to perform co-contraction of the transverse abdominal muscle and multifidus muscles.

The exercise was carried out after a specially trained therapist explained and demonstrated the exercise to the participants so that they would fully understand. It was performed for 30 minutes per day, and the patients were

allowed to take some rest before continuing the exercise when they felt fatigue or discomfort. The control group underwent conventional physiotherapy. After 8 weeks of therapeutic intervention, all the subjects were examined to ascertain the effects of therapeutic intervention in each group.

This study used GAIT Rite (CIR System Inc, USA) equipment to measure gait velocity, cadence, step length, step length asymmetry ratio, single leg support time asymmetry ratio, and functional ambulation profile of the participants. Gait Rite has an electronic foot plate 366 cm long and 61 cm wide, which collects data at a sampling rate of 80 Hz with 13,824 detection sensors. It sends the data to a computer via a serial interface cable for analysis.

In this study, the true leg length between the ASIS and the medial malleolus of the ankle joint was measured and entered into the GAIT Rite's program before measuring the gait parameters. Then the participants were instructed to walk comfortably over the sensor corridor, starting 2 m before the corridor, at verbal command of the examiner. Gait measurements were repeated 5 times to acquire a measurement value.

The data collected from 9 patients in the experimental group and 12 patients in the control group in this study were analyzed using the statistics program SPSS (version 14.0). The paired sample t-test was used for pre- and post-intervention significance tests in each group. The independent t-test was used for significance tests between the two groups. The significance level was chosen as 0.05.

RESULTS

The gait velocities of the experimental group and the control group were measured before and after the intervention. The experimental group showed significantly increased gait velocity after the intervention ($p < 0.05$). No significant increase or decrease was seen in the control group ($p > 0.05$). When the pre- and post-intervention mean differences were compared, no significant difference between the two groups was found ($p > 0.05$) (Table 1).

When the pre- and post-intervention cadences of the

Table 1. A comparison of pre- and post-intervention spatiotemporal gait parameters of each groups

Parameter	Group	Pre-test	Post-test	Mean difference
		Mean \pm SD	Mean \pm SD	
Velocity (cm/sec)	Exp.	36.27 \pm 13.42	37.08 \pm 13.37	0.80 \pm 0.82*
	Cont.	41.32 \pm 13.50	41.69 \pm 13.27	0.37 \pm 0.51
Cadence (steps/min)	Exp.	80.87 \pm 7.36	81.65 \pm 7.86	0.78 \pm 0.94*
	Cont.	85.41 \pm 12.91	85.97 \pm 13.29	0.55 \pm 1.49
Step Length (cm)	Exp.	27.39 \pm 13.39	31.58 \pm 11.67	1.32 \pm 1.45*
	Cont.	38.44 \pm 11.21	39.63 \pm 11.55	1.19 \pm 1.86
SLAR (%)	Exp.	0.282 \pm 0.255	0.267 \pm 0.252	1.53 \pm 7.87
	Cont.	0.285 \pm 0.212	0.256 \pm 0.180	2.95 \pm 6.45
SSAR (%)	Exp.	0.284 \pm 0.125	0.285 \pm 0.111	0.51 \pm 0.67
	Cont.	0.245 \pm 0.185	0.215 \pm 0.187	0.44 \pm 0.97
FAP(score)	Exp.	53.87 \pm 7.56	55.50 \pm 7.88	1.63 \pm 1.93*
	Cont.	55.86 \pm 11.34	56.70 \pm 10.80	0.83 \pm 1.83

Abb. Exp.: experimental group; Cont.: control group; SLAR: step length asymmetry ratio; SSAR: single support time asymmetry ratio; FAP: functional ambulation profile. * $p < 0.05$.

experimental group and the control group were compared, the experimental group showed a significant increase post-intervention ($p < 0.05$), whereas there was no significant difference in the control group ($p > 0.05$). When the pre- and post-intervention mean differences were compared, no significant difference between the two groups was found ($p > 0.05$) (Table 1).

When the step lengths of the experimental group and the control group before and after the intervention were compared, there was a significant increase in the post-intervention results of the experimental group ($p < 0.05$), whereas the control group did not show any significant change ($p > 0.05$). When the pre- and post-intervention mean differences were compared, no significant difference between the two groups was found ($p > 0.05$) (Table 1).

There were no significant differences in the pre- and post-intervention results of the step length asymmetry ratio and single leg support time asymmetry ratio for both groups ($p > 0.05$). When the pre- and post-intervention mean differences were compared, no significant difference between the two groups was found ($p > 0.05$) (Table 1).

When the functional ambulation profiles of the experimental group and the control group before and after the intervention were compared, a significant increase in the post-intervention results of the experimental group was found ($p < 0.05$), whereas no significant differences were found for the control group ($p > 0.05$). When the pre- and post-intervention mean differences were compared, no significant difference between the two groups was found ($p > 0.05$) (Table 1).

DISCUSSION

This study was conducted to reveal the effect of spinal stabilization with visual feedback on the mobility of stroke survivors. The results showed significant changes in all spatiotemporal parameters of the experimental group except the step length asymmetry ratio and the single leg support time asymmetry ratio: i.e. the gait velocity, cadence, step length, and functional ambulation profile.

Similar results have also been reported in other studies. Walker et al.⁽⁸⁾ reported that standing balance exercises using visual feedback resulted in increased gait velocity of stroke patients. There was also a report by Winstein et al.⁽⁹⁾ which stated that the gait velocity and cadence as well as the step length increased in hemiparetic patients after visual feedback training. Shumway-Cook et al.⁽¹⁰⁾ reported that 2 weeks of weight shift training with visual feedback by 8 of 16 hemiparetic patients significantly increased the symmetry of weight load on both legs in the experimental group compared to the control group.

Furthermore, Srivastava et al.⁽¹¹⁾ reported that visual feedback balance training using force plates by 45 chronic stroke patients significantly improved the patients' balance and ambulation capabilities. Weiss et al.⁽⁴⁾ reported increased leg muscle power, balance and mobility after subjects performed 12 weeks of gradual resistance exercise training using 70% weight of 1 RM of leg muscle. Teixeira-Salmela et al.⁽⁵⁾ reported increased muscle power and

mobility after chronic stroke patients at more than 9 months after stroke onset performed gradual resistance exercise, treadmill, stepping machine, or stationary cycle exercises parallel. Dean et al.⁽⁶⁾ reported increased leg muscle power and gait velocity after stroke patients at more than 3 months after the onset of stroke performed task-oriented circuit training. A recent study by Bastille and Gill-Body⁽⁷⁾ reported that mobility and balance were improved after chronic stroke patients at more than 9 months after the onset of stroke performed yoga for 1 hour per session 2 times per week for 8 weeks. The results of previous studies and the present study indicate that even for chronic stroke patients who had a stroke incident more than 6 months ago and whose brain spasticity would have stopped, exercise training is effective for improving their mobility.

All exercises share the characteristic of showing a decrease in their effects after a certain point. Since the effect of the exercise will ultimately disappear, it is necessary to modify the exercise intensity at an adequate time or to modify the pattern or program of the exercise according to the patient's physical abilities. From this point of view, this study had the limitation of having applied a uniform course of spinal stabilization exercises for 8 weeks without any modification during the program. Also, the number of subjects was too small to generalize the results to other chronic stroke patients.

Despite the limitations of this study, the results of spinal stabilization with visual feedback showed that it has a positive effect on the mobility of stroke patients. Therefore, for an effective intervention that can improve patients' mobility, physicians who treat stroke patients should not only conduct training that stimulates the proprioceptors of patients' soles and joints, but should also implement spinal stabilization with visual feedback training for patients who have difficulties in standing or in all stages of standing training. This study provides data that will serve as objective evidence for physicians who treat stroke patients in clinics.

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