Effects of Biofeedback Postural Control Training on Weight distribution rate and Functional Ability in Stroke

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ABSTRACT

This study examined the effects of biofeedback postural control training on the weight distribution rate and functional ability of subjects with stroke. A total of 30 stroke patients were enrolled in this study. Subjects were divided into a biofeedback postural training group (experimental group, n=15) and a dynamic balance training group (control group, n=15). Experimental subjects received biofeedback postural training and control subjects received dynamic balance training for 30 minutes per day, 5 times per week over a 6 week period. Weight distribution rate and functional ability were measured to identify the effect of the biofeedback postural training. Significant difference in weight distribution rate was observed in the experimental group, compared with the control group (p=0.05), and a significant difference in functional ability. The results of this study provide evidence in support of incorporating a biofeedback postural training for the improvement of weight distribution rate and functional ability of stroke patients.

Key words: *Postural Control Training, Weight Distribution rate, Functional Ability.*

1. INTRODUCTION

Stroke is a representative disease that causes disabilities, which degrades the quality of life as a persistent obstacle to survivors [1], and causes problems in functional activities [2]. Stroke patients show approximately two times larger postural sway than healthy persons when they move their weight within the bearing surface. To overcome the resultant instability, they move their weight to the non-paretic side, consequently reducing their balance ability due to uneven weight distribution occurring [3] because they place only 25~43% of the load on the paretic side [4]. For functional rehabilitation, the asymmetric weight bearing of the lower limbs should be evaluated before gait training and even weight bearing of the lower limb on the paretic side should be induced [5]. Functional ability is an essential ability defined by individuals for creating a meaningful life and maintaining physical and psychological well-being [6]. Among functional abilities, gaits are the most frequently used method of all moving methods and account for a large part of daily living activities [7]. Most stroke patients show changes in temporal and spatial gait characteristics in comparison to healthy persons [8]. Among diverse therapeutic intervention methods for overcoming these unstable gait characteristics and reducing dependence on others in life, training using biofeedback has been recently reported as being quite effective on stroke patients [9]. Therapeutic interventions using biofeedback have advantages over other intervention methods such as relatively easier environment control and selection, the provision of training based on abilities through stepwise control of the level of task difficulty, the provision of fast and accurate sense feedback to task performance [10], and the provision of opportunities for self-learning in safe environments [11] Treatment using biofeedback is advantageous in that diverse environments can be provided to cause changes in sensory inputs thereby enhancing treatment effects for stroke patients [12], motivation for task accomplishment and active participation are enabled through diverse feedback mechanisms [13], and patients can be intensively trained on diverse target tasks necessary for the improvement of their functions [11]. Biofeedback plays important roles for patients with balance and gait disorders. The visual and perceptual elements of biofeedback have been said to be effective for stroke patients having difficulties in understanding the locational relationships between objects and spaces to improve balance and gait abilities [14]. Biofeedback has a weakness of being unable to appropriately control problems such as abnormal postural control occurring due to

excessive effort required when tasks are performed and associative reactions. The purpose of the present study is to examine the effects of biofeedback postural control training on stroke patients' weight distribution rates and functional abilities in order to supplement the weakness of treatment using biofeedback.

2. SUBJECTS AND METHODS

2.1 Subjects

The subjects of this study were selected from among the patients who were diagnosed with stroke between January and March 2013 at M hospital located in Mokpo. The present study was conducted with 30 stroke patients (18 males and 12 females) whose dates of onset of stroke were at least one year earlier. Stroke patients for over one year and within two years are 25 persons, stroke patients for over two year and within three year are 5 persons. The patients provided written informed consent after being given a full explanation of the purposes of this study and the contents of the experiment. The criteria for participation of the subjects were as follows. Those who could walk at least 10 m independently, had no musculoskeletal disease that could affect the experiment, had no damage to hearing, the vestibular nerves, or the eyeball, had no neglect symptoms, could understand and follow instructions, and had sufficient abilities for communication and understanding to follow instructions during evaluation with 24 points or higher scores in the Mini-Mental State Examination-Korean version (Table 1).

Table 1. General characteristics of the subjects

	BPCT (n=15)	DBT (n=15)	F	p
	Mean±SD	Mean±SD		
Gender	Male 9 Female 6	Male 9 Female 6		
Age (year)	54.06± 1.71	52.60± 1.90	.286	.597
Height (cm)	167.86± 2.28	169.60± 2.30	.082	.777
Weight (kg)	63.93± 2.11	68.33± 1.75	.822	.372
Onset (month)	16.06± 0.80	15.8± 1.04	2.604	.118

BPCT: biofeedback postural control training
DBT: dynamic balance training

2.2 Methods

The study subjects received intervention by physical therapy for the nervous system that included muscle strengthening training and gait training for 30 minutes and the experimental group(n=15) additionally received biofeedback postural control training using Balance trainers (Medica Medizintechink GmbH, Germany) for 30 minutes while the control group(n=15) received dynamic balance training removed of biofeedback using Balance trainers. The intervention was given for 30 minutes per time, five times per week for six weeks. The balance trainer used in the biofeedback postural control training has a mechanical joint with a degree of freedom of two and is connected to the subject with knee pads that support the knee and a pelvic support that stabilizes the pelvis. The mechanical joint of the postural control training machine allows physiological movements of the standing person while the person performs tasks and provides feedback of the degree of movements on the screen of the monitor connected to the machine [Figure 1].

Fig. 1. Balance trainer

2.3 Measurement tools

The Biorescue (RM Ingenierie, France) for analyzing weight distribution rates consists of a movable rectangular force plate for standing with both feet and a graduated ruler is marked on the force plate for appropriate foot positions. The weight distribution rate of the weight supported by two feet. It is simple to measure, evaluates the variation in the ability to support body weight before and after treatment, and serves as standards that are useful for studying normal and abnormal posture [15]. Weight distribution rates were measured when the subject was standing on both feet in a natural posture looking at the monitor in front of him/her. In the evaluation, the resultant mean values were obtained by measuring weight distribution rates three times [Figure 2].

To measure functional abilities, timed 10 meter walking tests, timed up and go tests, and Berg Balance Scale tests were conducted. The timed 10 meter walking test is a test method of evaluating the gait velocity and balance of hemiplegic patients by measuring the time to walk a straight-line distance of 10 m which can be used as a scale of the recovery of mobility of hemiplegic patients [16]. The timed up and go test is for examining the dynamic balance ability and gait ability of hemiplegic patients. In this test, the time for the subject to stand up from a sitting position on a 46cm high chair with armrests laid on a flat floor, go 3 m, come back and sit on the chair again was measured three times and the average time was used [17]. Berg Balance Scale was developed by Berg K et al. [18] and can be used to objectively evaluate static and dynamic balance abilities. This scale is divided into three areas: sitting, standing up and postural changes.
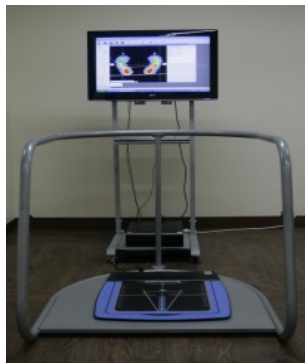
Fig. 2. Biorescue

2.4 Statistical methods

The data obtained in the present study were statistically processed using SPSS Windows 17.0. Analyses of covariance (ANCOVA) were conducted to compare weight distribution rates and functional abilities between different intervention methods. All the statistical significance levels used were 0.05.

3. RESULTS

The weight distribution rates on the paretic side of the biofeedback postural control training group and the dynamic balance training group before and after the intervention were compared. The results showed significant differences in both groups as the rates were changed from 44.83±3.54 % to 46.80±4.28 % in the biofeedback postural control training group and from 45.26±1.87 % to 46.28±6.61 % in the dynamic balance training group (p<0.05).

The functional abilities of the biofeedback postural control training group and the dynamic balance training group before and after the intervention were compared. The results showed significant differences in the timed 10 meter walking tests in both groups as the times changed from 33.16±9.54 seconds to 28.74±5.28 seconds in the biofeedback postural control training group and from 31.98±2.67 sec. to 28.28±4.27 seconds in the dynamic balance training group. The results showed significant differences in the timed up and go tests in both groups as the times changed from 21.01±2.04 seconds to 17.61±1.92 seconds in the biofeedback postural control training group and from 20.80±9.47 seconds to 18.94±7.53 seconds in the dynamic balance training group. The results also showed significant differences in the Berg Balance Scale in both groups as the times changed from 42.13±3.49 seconds to 47.86±2.47 seconds in the biofeedback postural control training group and from 42.80±3.07 seconds to 44.93±2.57 seconds in the dynamic balance training group (p<.001)(Table 2). The average values of pre-tests were slightly different statistically but, according to the homogeneity test, did not show the significant differences.

Table 2. A comparison of measurements between pre- and post-intervention each group

Test	BPCT Group		DBT Group		p
	Pre-test	Post-test	Pre-Test	Post-test	
WD (%)	44.83± 3.54	46.80± 4.28	45.26± 1.87	46.28± 6.61	.011
10MWT (sec)	33.16± 9.54	28.74± 5.28	31.98± 2.67	28.38± 4.27	.000
TUGT (sec)	21.01± 2.04	17.61± 1.92	20.80± 9.47	18.94± 7.53	.000
BBS (score)	42.13± 3.49	47.68± 2.47	42.80± 3.07	44.93± 2.57	.000

The values with same word are significant differences (p<0.05) by ANCOVA test.
BPCT: biofeedback postural control training
DBT: dynamic balance training
WD: weight distribution, 10MWT: 10 m walking test,
TUGT: timed up and go test, BBS: berg balance scale

4. DISCUSSION

Due to abnormal postural control, stroke patients show large postural sway when moving their weight and show reduced ability to maintain stable postures within bearing surfaces. As a result, their reduced balance ability restricts their functional activities [2]. Kim [19] revealed that weight moving training through visual feedback enhanced the weight distribution rate of the paretic side of the patients and gait velocity of the patients. The present study confirmed that the group receiving biofeedback postural control training showed significant increases in weight distribution rates and gait abilities. It's considered postural control training using biofeedback promotes motor learning so weight distribution rate and gait ability increase. Van Peppen et al. [20] reported that when balance trainings using general physical therapy and visual biofeedback were implemented, biofeedback based balance training showed significant increases in weight distribution rates and temporal variables. This report was also consistent with the results of the current study in that both weight distribution rates and functional gait abilities improved in the biofeedback postural control training group. The weight distribution rates and functional gait abilities are considered to have improved because information on the subjects' movements while they were performing dynamic tasks was provided and used as feedback to lead immediate behavioral revision in the performance of the next movement. In a study conducted to improve stroke patients' motility, Heller et al. [21] reported that the patients' gait ability improved more in training using visual and perceptual biofeedback compared to general physical therapy for the nervous system. In the present study the postural control training group based on biofeedback also showed significant differences in timed 10 meter walking tests and timed up and go tests. In the results of a study of the effects of virtual reality on stroke patients, Walker et al. [22] demonstrated that the Berg balance scale score increased from 43.8 to 48.8. The results of the present study also showed increases in Berg balance scale scores as with the previous

study. Given these results, biofeedback training is considered to be related to weight distribution rates and functional abilities.

In the present study, the effects of biofeedback postural control training of stroke patients on their weight distribution rates and functional abilities of their paretic side were analyzed and the results indicated that biofeedback postural control training was more effective for the improvement of the weight distribution rates and functional abilities of the lower limb. Therefore, if biofeedback postural control training is added to general physical therapy, stroke patients' rehabilitation effects can be enhanced further. Thus, biofeedback postural control training using sight and perception should be actively utilized in treatment of stroke patients in clinics.

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