J. Phys. Ther. Sci.
27: 171–173, 2015

Original Article

The effect of a rehabilitational sliding machine and conventional neurological physical therapy on the balance of patients with hemiplegia

Gui-bin Song, MS, PT[1)], Gak Hwangbo, PhD, PT[1)*]

[1)] *Department of Physical Therapy, College of Rehabilitation Science, Daegu University: 15 Jillyang, Gyeongsan-si, Kyeongbuk 712-714, Republic of Korea*

Abstract. [Purpose] The purpose of this study was to investigate the effects of exercise using a rehabilitational sliding machine and conventional neurological physical therapy on the balance of stroke patients. [Subjects] Forty patients with hemiplegia resulting from stroke were divided into a rehabilitational sliding machine exercise group (ST group, n=20) and a conventional neurological physiotherapy group (C group, n=20). [Methods] The STG underwent training with a rehabilitation sliding machine for 30 minutes per day, five times per week for eight weeks. The CG underwent training with a conventional neurological physiotherapy for 30 minutes per day, five times per week for eight weeks. [Results] The balance ability of both groups significantly improved. Although there were significant differences between the groups, the CG showed weight bearing on the affected side, an anterior range within the stability limits standing, and a posterior range within the stability limits standing. [Conclusion] The results of this study suggest that conventional neurological physiotherapy is a more dedicated, effective intervention than rehabilitational sliding training methods.

Key words: Hemiplegia, Rehabilitational sliding machine training, Conventional neurological physical therapy

(This article was submitted May 27, 2014, and was accepted Aug. 3, 2014)

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 according to the area of the brain lesions[1)]. Hemiplegia is commonly associated with a decrease in balance ability. The balance of stroke is an important factor that can impede standing or gait, and their postural sway is twice as high as that of healthy people in their age range[2)]. The limit of stability (LOS) of stroke patients is defined as a decrease in the maximal distance to the center of gravity while maintaining balance without detaching the feet from the ground[3)].

Among the rehabilitation treatment methods for stroke patients, exercise is essential for functional recovery. There are many conventional treatments, such as neurodevelopmental treatment and sensory stimulation, which are designed to make patients shift their weight to the affected side. Currently, the exercise treatment that makes patients conduct diverse functions by stimulating normal exercise modes is performed in physical therapy rooms, and exercise treatment programs include a range of motion exercises, extension exercises, and muscle strengthening exercises[4)]. Moreover, a lot of equipment is available to improve the functions of stroke patients. In order to improve the muscle strength of the lower extremities of stroke patients, weight equipment[5)], elastic bands[6)], and isometric equipment[7)] have been employed. Using a tilt table composed of a rail system and a carriage with wheels, Trees et al.[8)] applied a weight load exercise to four patients with burns who had difficulty with weight load training in a standing position. They reported improvement in lower extremity muscle strength of the patuents. Byun et al.[9)] applied a rehabilitational sliding machine to the treatment of patients with hemiplegia resulting from stroke and reported that their muscle strength, spasticity, gait ability, balance ability, and daily activities improved.

Therefore, many treatment methods for reduction of problematic factors and improvement of balance and gait ability have been studied and developed. There are diverse methods for treatment of patients with hemiplegia resulting from stroke, and although many efforts have been made to improve the effect of each treatment method, research has not shown whether one treatment method is superior to others[10)]. Few studies have applied and compared treatment method using different equipment and existing neurological rehabilitation exercise. Therefore, it is necessary to compare the effects of exercises using equipment and one-on-one therapeutic exercises in stroke patient therapy.

*Corresponding author. Gak Hwangbo (E-mail: hbgak@daegu.ac.kr)

Table 1. Comparison of change in balance function in the training groups with values presented as the mean ± SD (Unit: cm^2)

	STG		CG	
	Pretest	Posttest	Pretest	Posttest
WB	45.9±1.2	46.2±1.4*	41.3±2.0	47.0±1.2*[a]
AL	680.8±186.2	920.6±210.1	1,085.6±248	1,807±258.1*[a]
PL	514.9±139.5	592.3±141.7	1,389.7±345.0	1,294.0±198.2*[a]

*Significant difference from the pretest at <0.05. [a] Significant difference in gains between two groups at <0.05. STG, sliding training group; CG, conventional neurological physical therapy group; WB: weight bearing on the affected side on standing; AL, anterior range within the limit of stability on standing; PL, posterior range within the limit of stability on standing

SUBJECT AND METHODS

The subjects of this study were 40 patients diagnosed with hemiplegia resulting from stroke by a rehabilitation doctor practicing at N Hospital located in Daegu, South Korea. They were randomly and equally assigned to a rehabilitational sliding machine training group (STG: 10 males, 10 female) and a conventional neurological physical therapy group (CG: 11 males, 9 female). The mean ± SD age, height, and weight of the STG was 51.4±40.6 years, 167.0±9.5 cm, and 64.1±13.1 kg, respectively. Eleven of the patients had right hemiplegia, and nine had left hemiplegia. The onset period was 14.8±6.1 months. The mean ± SD age, height, and weight of the CG was 50.8±5.5 years, 165.9±8.6 cm, and 63.9±5.2 kg, respectively. Nine of the patients had right hemiplegia, and 11 had left hemiplegia. The onset period was 13.4±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, ability to understand and perform the exercise as instructed by the researcher, and a score of 24 or higher on the Korean version of the Mini Mental State Exam (MMSE). All the subjects understood the purpose of this study and provided written informed consent prior to their participation in the study in accordance with the ethical standards of the Declaration of Helsinki.

The STG underwent training with the rehabilitational sliding machine for 30 minutes per day, five times per week for eight weeks. We used a rehabilitational sliding machine. This machine had a rail system, a patient-supporting carriage, a footplate that moved up and down, and a leg elevation device that was connected to the patient support carriage. The footplate could be moved up and down to change the maximal angle of knee flexion. The goniometer showed the degree of inclination of the sliding board, and Velcro straps were fixed to the patient's body and ankles for safety. We fixed the degree of inclination of the sliding board at 30°[9]. The exercise program for the CG was based on a training program proposed by Gjelsvik[4]. This method is widely used for the rehabilitation of patients with hemiplegia resulting from stroke and includes a range of motion exercises, muscle extension exercises, exercises for hip joint stability, leg joint exercises, knee joint exercises, bridging exercises, sitting to standing exercises, weight supporting exercises, and forward walking exercise in a standing position. This experiment was conducted for 30 minutes, five times per week for a total of eight weeks.

For the measurement of balance ability, a biofeedback analysis system (AP1153 BioRescue, RM lngenierie, Rodez, France) was used to determine weight bearing, anterior range LOS, and posterior range LOS in the affected side in a static standing position.

The experimental results were statistically analyzed using SPSS 12.0 KO (SPSS lnc., Chicago, IL, USA). After the general characteristics of the subjects were determined, a paired t-test was used to compare the variations in weight bearing on the affected side when standing, the anterior LOS standing, and the posterior LOS standing. The significance of differences between the two groups was investigated using an independent t-test. Statistical significance was accepted for values of $p<0.05$.

RESULTS

The results for the weight bearing rates on the paretic side in each group were as follows. According to analysis of the results of the weight load rate, there were significant differences in each group before and after the experiment, and there were significant differences within the CG after the experiment ($p>0.05$) (Table 1).

According to a comparison of the anterior and the posterior range of stability in a standing position before and after the experiment, there were significant differences in the CG before and after the experiment, and there were significant differences within the CG after the experiment ($p>0.05$) (Table 1).

DISCUSSION

Heo[11] studied a group by conducting a one-on-one sit-to-stand exercises focusing on external feedback, such as verbal instruction. Manual contact with a therapist showed a significant increase in the weight load rate on the paretic side compared with another group instructed to do sit-to-stand exercises with a task-oriented approach that focused on internal feedback[12]. Shin et al.[13] noted that the weight support ability of stroke patients was correlated with functional performance ability, and moving the weight left or right in a standing position was related to motor function,

an independence in daily life, and the length of time until the patient returned home. The reason for this was that the ability of the stroke patients to move weight left or right was directly related to gait. In the present study on weight bearing in the affected side when standing, the forward and backward movement LOS in a standing position were compared, and the results showed a significant effect in the CG and statistically significant differences between the two groups. Gouglidis et al.[14] applied visually induced weight movement exercises to subjects and found significant differences in stability ranges. In the present study, visual elements were not used, but an increase in forward and backward movement LOS in a standing position improved the proprioceptive senses of the patients in the ankle joints, increasing their balance in the forward and backward movement range. The symmetrical weight bearing exercise influenced the stability of stance phase and gait. Song[15] reported that convenient neurological physiotherapy had a greater effect than functional electrical therapy on gait ability for chronic stroke patients. Ma[16] reported that convenient neurological physiotherapy had a greater effect on the balance ability of stroke patients.

According to the results, conservative exercise treatment with verbal instructions from and manual contact with a therapist resulted in a more significant improvement. The present study showed that for functional improvement of patients with hemiplegia resulting from a stroke, factors affecting conservative exercise treatment should be taken into account, such as the personal characteristics, muscle strength, endurance, senses, proprioceptive senses, cognition, and motives of the patients. In addition, when exercise treatment is conducted in a hospital, intervention by a therapist using an instrument that allows individual stroke patients to adjust their characteristic movement pattern and abnormal tension is considered necessary during an exercise. A rehabilitational sliding machine can be effectively used to increase the balance and gait ability of inpatients during free time and at time when they are not receiving treatment time.

REFERENCES

1) Mahabir D, Bickram L, Gulliford MC: Stroke in Trinidad and Tobago: burden of illness and risk factors. Rev Panam Salud Publica, 1998, 4: 233–237. [Medline] [CrossRef]
2) Nichols DS: Balance retraining after stroke using force platform biofeedback. Phys Ther, 1997, 77: 553–558. [Medline]
3) Park JH, Hwangbo G, Kim JS: The effect of treadmill-based incremental leg weight loading training on the balance of stroke patients. J Phys Ther Sci, 2014, 26: 235–237. [Medline] [CrossRef]
4) Gjelsvik BE: The Bobath Concept in Adult Neurology. Stuttgart: Thieme, 2008, pp 56–62.
5) Sullivan KJ, Brown DA, Klassen T, et al. Physical Therapy Clinical Research Network (PTClinResNet): Effects of task-specific locomotor and strength training in adults who were ambulatory after stroke: results of the STEPS randomized clinical trial. Phys Ther, 2007, 87: 1580–1602. [Medline] [CrossRef]
6) Krebs DE, Scarborough DM, McGibbon CA: Functional vs. strength training in disabled elderly outpatients. Am J Phys Med Rehabil, 2007, 86: 93–103. [Medline] [CrossRef]
7) Sharp SA, Brouwer BJ: Isokinetic strength training of the hemiparetic knee: effects on function and spasticity. Arch Phys Med Rehabil, 1997, 78: 1231–1236. [Medline] [CrossRef]
8) Trees DW, Ketelsen CA, Hobbs JA: Use of a modified tilt table for preambulation strength training as an adjunct to burn rehabilitation: a case series. J Burn Care Rehabil, 2003, 24: 97–103. [Medline] [CrossRef]
9) Byun SD, Jung TD, Kim CH, et al.: Effects of the sliding rehabilitation machine on balance and gait in chronic stroke patients—a controlled clinical trial. Clin Rehabil, 2011, 25: 408–415 [CrossRef]. [Medline]
10) Dickstein R, Hocherman S, Pillar T, et al.: Stroke rehabilitation. Three exercise therapy approaches. Phys Ther, 1986, 66: 1233–1238. [Medline]
11) Heo JY: The effect of a task-oriented approach sit to standing practice on mobility in stroke patients. J Sport Leis Stud, 2005, 25: 339–352.
12) Shumway-Cook A, Woollacott M: Motor control: translating research into clinical practice, 3rd ed. Philadelphia: Lippincott Williams & Wilkins, 2007.
13) Shin WS, al Lee SW: Effects of training on balance of hemiplegic stroke patients. J Phys Ther Sci, 2011, 23: 639–643. [CrossRef]
14) Gouglidis V, Nikodelis T, Hatzitaki V, et al.: Changes in the limits of stability induced by weight-shifting training in elderly women. Exp Aging Res, 2011, 37: 46–62. [Medline] [CrossRef]
15) Song CH, Lee JS: Effects of electrical stimulation and therapeutic exercise on the walking of stroke patients. Korea Sport Res, 2004, 15: 2333–2345.
16) Ma SY, Hwang YT, Park RJ: The effects of PNF and FES on improvement of functional gait in patients with stroke. J Spec Educ Rehabil Sci, 2008, 47: 283–298.