An efficacy study on improving balance and gait in subacute stroke patients by balance training with additional motor imagery: a pilot study

YOUNG-HYEON BAE, PT, PhD1–3a, YOUNGJUN KO, MSc, PT1, 3a, HYUNGEUN HA, MSc, PT1, 3, SO YEON AHN, PT3, WANHEE LEE, PT, PhD3, SUK MIN LEE, PT, PhD3*

1) Department of Physical Medicine and Rehabilitation, Samsung Medical Center, Republic of Korea
2) Department of Physical Therapy, Angelo State University, USA
3) Department of Physical Therapy, Sahmyook University: 26-21 Gongneung 2-dong, Nowon-gu, Seoul, Republic of Korea.

Abstract. [Purpose] The few studies conducted on subacute stroke patients have focused only on gait function improvement. This study therefore aimed to confirm the effect of balance training with additional motor imagery on balance and gait improvement in subacute stroke patients. [Subjects and Methods] Participants were divided into an experimental or control group. The experimental group received balance training for 20 minutes/day with mental imagery for 10 minutes/day, three days/week, for four weeks. The control group received only balance training for 30 minutes. Before and after the 12 sessions, balance and gait ability were assessed by the researcher and a physical therapist. [Results] After completion of the 4-week intervention, Berg Balance Scale, Timed Up and Go test, Functional Reach Test, and Four Square Step test scores significantly increased in the experimental group. In the control group, Berg Balance Scale and Functional Reach Test scores significantly improved. Changes in the Timed Up and Go test, Functional Reach Test, and Four Square Step Test scores after intervention were significantly higher in the experimental than in the control group. [Conclusion] Specific balance training with additional motor imagery may result in better rehabilitation outcomes of gait and balance ability than balance training alone. 

Key words: Balance, Gait, Motor imagery

INTRODUCTION

Stroke can cause permanent disability in patients. Strokes can cause a combination of motor, sensory, cognitive and emotional impairments resulting in impairment of balance and gait ability in patients as well as impairment of the Activities of Daily Living (ADL)1). The major goals of rehabilitation in stroke patients are improving balance and gait ability2). Balance is the ability of an individual to maintain or move within a weight-bearing posture without falling3). Balance ability requires the person to maintain their body’s center of gravity within the base of support4). Many research studies have demonstrated a relationship between balance ability and gait speed, independence, and appearance of an individual and have demonstrated abnormal patterns5). Balance is an essential function in maintaining gait and normal movement in stroke patients6). Accordingly, various therapeutic methods have been used for the improvement of balance, such as core strength exercises7), visual feedback training8), and task-related training9).

Recently, several studies about a mental practice for rehabilitation of stroke patients have been reported10–12). Mental imagery (MI) is a rehabilitation method, which involves the use of motor imagery content with repetition of movement processes. Many previous research studies have reported that cortical functional reorganization following mental practice contributes to the improvement of hand function in stroke patients10, 13, 14). Additionally, several previous studies have shown that the MI in combination with physical therapy has been effective in improving balance and gait performance in stroke patients12). However, there have been divergent opinions about the effectiveness of MI on balance and gait function. There have been a few studies, which have investigated the influence of specific balance training with additional MI in stroke patients.

The importance of effective rehabilitation in the early stages for stroke patients is increasing. MI is a clinically practicable and cost-effective supplement that may enhance outcome in acute stroke patients15). However, most of the previous studies of MI training were conducted for chronic stroke patients12–14). There have been a few studies of subacute stroke patients, which have only focused on an improvement in gait function11). Therefore, this study was performed to confirm the effect of balance training with ad-
ditional MI on balance and gait improvement in sub-acute stroke patients.

SUBJECTS AND METHODS

Twenty subacute stroke patients (10 males and 10 females) participated in the study in the rehabilitation unit. The inclusion criteria for the present study were as follows:

1. A diagnosis of stroke (ischemic or hemorrhagic stroke) < 3 months after stroke onset
2. Korean mini-mental state examination score > 24
3. A capability to stand up, maintain standing balance, and walk more than 10 m independently.

We explained the purpose of this study to the patients and obtained their informed consent. The study was approved by the Human Ethics Committee of the Sahmyook University. All of the procedures in the study were conducted as per the Declaration of Helsinki.

Participants were divided into an experimental or control group (Table 1). The experimental group received balance training for 20 minutes/day with additional mental imagery for 10 minutes/day, three days/week, for a period of four weeks. The control group received balance training for 30 minutes/day. Before and after the 12 sessions, balance and gait ability were assessed by the researcher and a physical therapist. All participants received balance training, which consisted of four practices for 20 minutes as follows:

1. Standing on an unstable balance pad and then implementing a head flexion and extension and rotation to the left and right
2. Shifting the weight from left to right while standing on even floor
3. Standing on one leg for 5 seconds
4. Walking in a straight line.

After the balance training session, MI was implemented in subjects in the experimental group in an isolated, quiet room. The MI was recorded by a physical therapist using standard Korean language. The MI program was composed of guided balance training. The participants performed the MI while they were in a comfortable condition, sitting in a comfortable seat, with an armrest and backrest. Before the 10-minute MI, the participants were guided to a state of relaxation by deep breathing for 2 minutes.

Before and after training, balance ability was evaluated using the Berg Balance Scale (BBS). Since the BBS has been shown to have excellent validity and outstanding intra-rater and inter-rater reliability (intraclass correlation = 0.99), it is extensively used as a measurement tool for balance function. BBS is correlated well with other clinical balance scales and inter-rater reliability (intraclass correlation = 0.99), it is shown to have excellent validity and outstanding intra-rater reliability. Using the Berg Balance Scale (BBS), the participants were guided to a state of relaxation by deep breathing for 2 minutes.

The General characteristics of the participants, age, height, weight, duration after onset, and Mini Mental State Examination-Korean (MMSE-K) score, are described in Table 1.

Table 1. General characteristics of the subjects

| Parameters                        | Experimental group | Control group |
|-----------------------------------|--------------------|---------------|
| Gender (male/female)              | 5/5                | 5/5           |
| Age (years)                       | 67.1 ± 9.2         | 67.2 ± 7.8    |
| Height (cm)                       | 170.0 ± 12.1       | 168.2 ± 12.2  |
| Weight (kg)                       | 73.6 ± 12.0        | 74.2 ± 10.7   |
| Duration of onset (days)          | 13.4 ± 4.5         | 14.1 ± 4.8    |
| Ischemic/Hemorrhagic stroke       | 5/5                | 5/5           |
| Right sided lesion/Left sided lesion | 5/5               | 5/5           |

Values are presented as the mean ± SD

Functional Reach Test (FRT) is an upper-extremity balance task used in this study. The subject stood comfortably and perpendicularly to a wall. A yardstick, which was horizontally attached to the wall, was applied at the subject’s acromion level. The subjects extended their fisted hands along the yardstick. The position of the third metacarpal was recorded before and after a maximal forward reach. The mean score of three successful trials was calculated.

The Four Square Step Test (FSST) is a clinical test of dynamic standing balance that measures the time taken to step over four walking sticks, which are placed in a cross-configuration on the ground by using a set movement sequence. The combination of cognitive and physical demands is a key attribute of this test. Scores on the FSST have been found to be reliable, valid, and sensitive to change post-stroke. A score of 15 s or more, or the inability to perform the FSST may also identify the risk of falls in people after stroke. In this study, the FSST was conducted as per a standardized protocol, which has been used previously in post-stroke patients.

We analyzed the data using SPSS version 21.0 software (SPSS for windows; SPSS Inc., Chicago, IL, USA). The Wilcoxon Signed-Rank test was used to compare the BBS, TUG, FRT, and FSST scores before and after the intervention. The Mann-Whitney U-test was used to compare the changes in the scores of the tests after the intervention between the groups. P < 0.05 was considered to indicate statistical significance.

RESULTS

The general characteristics of the participants, age, height, weight, duration after onset, and Mini Mental State Examination-Korean (MMSE-K) score, are described in Table 1. The comparison of BBS, TUG, FRT, and FSST scores between before and after the intervention within groups is summarized in Table 2. After the completion of the 4-week intervention, BBS, TUG, FRT, and FSST scores significantly increased in the MI group (p < 0.05). In the control group, BBS and FRT scores showed significant improvement (p < 0.05). Changes in the TUG, FRT, and FSST scores after the intervention were significantly higher in the MI group than in the control group (p < 0.05).
In our study, the change in the TUG test score was greater in the balance training with additional MI group than in the balance training alone group in subacute stroke patients. Similar to the previous studies on subacute stroke patients, significant differences were found in the scores between the two groups. The results of the walking test showed greater improvement in the physical therapy with additional MI group, who were guided with vivid kinesthetic imagery, than in the patients of the muscle relaxation group. In another study, gait training with additional MI improved balance and gait abilities significantly more than only gait training in subacute stroke patients. Engagement in gait training with additional MI may increase self-efficacy, thus having a positive influence on motivation and self-confidence[11]. In a previous study on chronic stroke patients, Dickstein et al. reported that gait speed was enhanced in the 6 weeks physical therapy with additional MI group[22]. In addition, Hwang et al., demonstrated that the walking velocity increased after MI training for 4 weeks[21].

The current study found that specific balance training with additional MI may have a better effect than balance training alone on gait and balance ability. These findings almost coincide with previous studies that have investigated the influences of balance training with additional MI on gait and balance ability in chronic and subacute stroke patients. Balance training with additional MI may therefore have the effect of enhancing gait and balance ability. This study has some limitations. First, this study only involved a small number of subjects. Second, the severity of the condition of the subjects was relatively mild as the subjects in this study were able to walk more than 10 m independently. Third, this study used a short-term duration of training. Further studies with a greater number of subjects and long-term follow-up will be required to investigate the effects of balance training with additional MI.

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