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Original Article

# Effects of stair task training on walking ability in stroke patients

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**Abstract.** [Purpose] The aim of this study was to determine the effect of stair task training on gait abilities by conducting stair task training. In this training, step training is applied in various directions with hemiplegia patients. [Subjects and Methods] Thirty-six patients with stroke were selected on the basis of inclusion and exclusion criteria, and they were randomly divided into eighteen patients in the experimental group and eighteen patients in the control group via draw. [Results] In this study, the Dartfish program was used to measure gait capabilities. Experiment group showed a statistically significant improvement in the swing phase time of the affected lower extremity compared to control group. [Conclusion] It was found that the stair task training group had effective results in the swing phase time of the affected lower extremity compared with the group that applied weight support on the affected lower extremity and balance training.

**Key words:** Stroke, Stair task training, Walking ability

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## INTRODUCTION

Stroke patients experience difficulties with not only postural alignment but also gait abilities because of instability in their postural control and body balance, as well as reduced motor functions[1)]. They have an imbalance in body weight support, with 60–90% of their body weight leaning too much toward the normal side because of asymmetrical body weight support at standing position[2, 3)]. As a result, this imbalance affects their gait cycle; that of a normal person consists of 60% of the stance phase and 40% of the swing phase[4)]. Hemiplegic patients have a shorter cycle of the stance phase and a longer cycle of the swing phase in the affected side than in the normal side[5)].

In terms of clinical therapy for walking, treadmill walking training[6)], side walking training[7)], and unstable surface training[8)] have been introduced to improve weight movement capability. Traditionally, a variety of methods, such as using walkers or canes and ankle-foot orthosis, have been utilized to recover gait abilities[9, 10)]. These methods provide not only support of physical disability during the performance of an action but also methods for independent daily living[11)].

Most of the previous studies on improvements in gait abilities conducted with hemiplegia patients have focused on the determination or comparison of the effects of gait training on flat ground, slope ground and stairs.

In this regard, the present study aims to determine the effect of stair task training on gait abilities by conducting stair task training. In this training, step training is applied in various directions with hemiplegia patients.

## SUBJECTS AND METHODS

This study was conducted with patients who were diagnosed with stroke and admitted in C Hospital located in C City for their treatment. Forty patients with stroke were selected on the basis of inclusion and exclusion criteria, and they were

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**Table 1.** Pre-test and post-test comparison in each group (Mean ± SD)

| | Experimental group (n=18) | | Control group (n=18) | |
|---|---|---|---|---|
| | Pre-test | Post-test | Pre-test | Post-test |
| Stance phase duration (sec) | 1.48 ± 1.21 | 1.61 ± 1.17* | 1.89 ± 1.40 | 1.90 ± 1.33 |
| Swing phase duration (sec) | 0.49 ± 0.14 | 0.41 ± 0.11* | 0.44 ± 0.12 | 0.44 ± 0.12 |

*p<0.05

randomly divided into 18 patients in the experimental group and 18 patients in the control group via draw. All subjects provided written informed consent prior to participation according to the ethical standards of the Declaration of Helsinki.

The selection criteria were as follows: patients diagnosed with stroke and with a disease duration of more than six months, those who can walk 15 m or longer independently without assisted devices, with a below grade 2 Modified Ashworth Scale score in the lower extremity, with an MMSE-K (Mini-mental state examination Korean version) score more than 24, have no other diseases and orthopedic diseases in the lower extremity, and those who understood the purpose of this study and gave consent to participation in this research.

On the basis of the above-mentioned inclusion criteria, 36 patients were selected and divided into 18 members of the experimental group and 18 members of the control group for the conduct of the pre and post test, with the same measuring tools used by the same rater. Eighteen patients in the experimental group and eighteen patients in the control group conducted the training of 30 min per session, five times a week for six weeks. The measurement method used the Dartfish program, in which time at the stance and swing phases during gait were measured before and after the intervention.

The experimental group used 10 cm-high steps in the stair task training. This value was set on the basis of a previous study[2] stating that 10 cm-high steps were more stable and easier to perform for stroke patients and resulted in changes in muscle activity and increases in clinical balance abilities. With the use of 10 cm-high wooden blocks, a 40 cm ×40 cm wood block layout consisting of two 10 cm-high foot-step wooden blocks and one 20 cm-high block was fabricated to have a 10 cm block height difference between adjacent blocks. For safety, sliding prevention tapes were applied at the bottom of the wooden block, and the front of the arranged block had handrails, and 1 m-high desks were placed on the sides to prevent a fall; the handrails and desks can be supported, if needed, during the training. A single physiotherapist guided and supervised the training to prevent safety-related accidents.

For the control group, weight support and balance training for the affected leg was conducted, and a 10 min warm-up was applied at the sitting and standing positions. The weight support and balance training method for the affected legs was conducted in the following order: weight support on the affected side, climbing the stairs by placing the normal side in the front direction, and coming down the steps by placing the normal side from the block to the original position[12].

For kinematic motion analysis of the walking of hemiplegia patients, videos were recorded for all groups before the intervention and six weeks after the intervention, and the data were analyzed with Dartfish (Pro Suite, Dfkorea, Korea). It uses videos to analyze and interpret the motions and trace trajectories of the target subjects. All subjects did not wear shoes during measurements and were induced to walk freely and most comfortably on a walking path, about 15 m in length, to enable the accurate measurement of a step length. The video was shot from the 5 m point on the path, which was the middle point of the path. The analysis of gait with the use of the Dartfish program utilized only videos that showed a complete step cycle from initial contact of the heel to the next initial contact of the heel. A mean value was calculated from the performance of two sets of walking iteratively to increase the validity of the measurement.

In the statistical analysis of this study, means and standard deviations were calculated using SPSS/Windows (version 20.0). In order to examine the effects prior to and after the intervention of each group, a paired t-test was conducted, and in order to look at differences between the groups, independent t-test was performed. The significance level was set at 0.05.

## RESULTS

Comparative analysis of the experimental group's prior -test and post-test results showed statistically significant differences in the stance phase time and swing phase time (Table 1). For the control group, comparative analysis of the prior-test and post-test results had no significant differences statistically in stance phase time and swing phase time (Table 1). The comparison result between the two groups revealed that significant differences between groups were found in swing phase time (Table 2).

## DISCUSSION

In the clinical field, constant stair gait training can reduce the fall accidents of stroke patients and result in improvements in performing independent activities[13]. A study on stair gait conducted with 30 adult hemiplegia patients to determine changes in balance and muscle activity after gait training with different stair heights reported that the 10 cm-high stair gait

**Table 2.** Comparison of stance phase duration, swing phase duration between the groups (Mean ± SD)

| | Experimental group (n=18) | Control group (n=18) |
|---|---|---|
| Stance phase duration (sec) | 0.19 ± 0.23 | 0.01 ± 0.20 |
| Swing phase duration (sec) * | −0.08 ± 0.10 | −0.00 ± 0.02 |

*p<0.05

training group showed the most significant difference in balance abilities, as well as larger changes in muscle activities than stair gait groups with other heights[1)].

The results of this study indicate that stair task training improved walking ability and suggest the applicability of stair task training for clinical rehabilitaion. It was conducted on hemiplegia patients for six weeks and provided an approach to improve the mobility functions of stroke patients.

The findings showed that the stair task training group had effective results in the swing phase time affected lower extremity, compared with the group that applied weight support on the affected lower extremity and balance training.

In this study, the Dartfish program was used to measure gait capabilities. The changes in stance phase time before and after the training showed that the experimental group had a significant increase in stance phase time within the group, but no significant increase was found between groups ($p>0.005$). The control group showed no significant increase before and after the training. The comparison result on change in swing phase time before and after training showed that the experimental group had a significant increase in swing phase time. The comparison result between groups showed that the swing phase time of the experimental group was $-0.08 \pm 0.10$, and that of the control group was $-0.00 \pm 0.02$, which indicated a significant increase between groups ($p<0.005$). The control group showed no significant increase before and after the training. These results were due to the study subjects' adaptation to the performance of overpassing obstacles, such as steps[14)]. Furthermore, the central nervous system attempted to maintain body weight balance and apply the moving pattern strategically.

The limitations of this study were as follows. It was done with a small number of patients in a specific region. Furthermore, the effects of factors other than those used in the present measurement cannot be excluded, so these effects cannot be generalized to all stroke patients. Determining long-term effects is also difficult because of the short-term training period at six weeks.

This study proposes the use of stair task training because it is not limited spatially to stroke patients, it is economically efficient, and it can be applied more easily and safely than gait training methods by using general steps.

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