Effects of circular gait training on balance, balance confidence in patients with stroke: a pilot study

SHIN-KYU PARK, PT, MS1), SUNG-JIN KIM, PT, MS1), TAK YONG YOON, PT, MS1), SUK-MIN LEE, PT, DDS, PhD1)*

1) Department of Physical Therapy, College of Health Science, Sahmyook University: 815 Hwarangro, Nowon-gu, Seoul 139-742, Republic of Korea

Abstract. [Purpose] This study aimed to investigate the effects of circular gait training on balance and balance confidence in patients with stroke. [Subjects and Methods] Fifteen patients with stroke were randomly divided into either the circular gait training (CGT) group (n=8) or the straight gait training (SGT) group (n=7). Both groups had conventional therapy that adhered to the neurodevelopmental treatment (NDT) approach, for 30 min. In addition, the CGT group performed circular gait training, and the SGT group practiced straight gait training for 30 min. Each intervention was applied for 1 h, 5 days a week, for 2 weeks. Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Activities-specific Balance Confidence (ABC) scale were used to test balance and balance confidence. [Results] After the intervention, both groups showed significant increases in balance and balance confidence. Significant improvements in the balance of the CGT group compared with the SGT group were observed at post-assessment. [Conclusion] This study showed that circular gait training significantly improves balance in patients with stroke.

Key words: Stroke, Circular gait training, Balance

INTRODUCTION

Recovery of walking ability for patients with stroke is one of the most important rehabilitation goals. Balance in the standing posture is important to achieve proper gait patterns. The balance of the standing posture is closely related to the ability to shift the body weight on one side limb. This is a prerequisite for functional mobility and daily living, and is important for activities, such as standing, transferring, walking, changing direction, and stair climbing. The problem of balance is a major factor in delaying the recovery of daily activities, reducing movements, and increasing risk of falls, which further prevents standing or walking. Patients with stroke need complex mobility to perform their daily activities in the home and community after discharge. Activities related to walking around the table, crossing obstacles, and turning on the road require walking ability in the curved pathway. The ability to walk around the corners and change direction around the obstacles is essential for successful locomotion in the home and community. During daily life, 20% to 50% of all steps were reported to be associated with turning. During straight walking, the coordination of the segments for body movement is symmetrical, but both lower extremity patterns of walking change unstably when walking with curves in daily living. A more diverse biomechanical reaction is required compared with the straight walking to perform smooth walking along the curved trajectory. However, patients with stroke are adversely affected from changing directions during walking due to lack of coordination ability and paralysis of the lower limb muscles. The 8-shaped track combines a pattern of curved walking in clockwise and counterclockwise directions between straight gait and is designed to assess the complex gait ability required.
for independent daily activities. In previous studies, walking on an 8-figure track has been suggested to evaluate complex walking ability9. However, to date, studies on training for independent walking in patients with stroke are focused on walking ability using treadmill or straight gait training, and studies on curved walking are rare. In addition, research on the training intervention of patients with stroke in the 8-figure track is limited, which has been used only as a tool to evaluate the balance and gait ability of the elderly. In this regard, this study investigates to determine the effect of circular gait training on balance and balance confidence of patients with stroke by dividing walking in straight and 8-shaped track.

**SUBJECTS AND METHODS**

The subjects of this research were 15 patients with stroke, hospitalized in the D rehabilitation hospital in Seoul, Korea and randomly assigned to 8 patients in the CGT group and 7 patients in the SGT group by using a table of random sampling numbers. This study was approved by the institutional review board of the Sahmyook University (IRB No. 2-1040781-AB-N-01-2016042HR), and all experimental procedures and contents were explained to each participant, who gave written informed consent to participate in the study. The inclusion criteria were: presence of hemiparesis, secondary to stroke that had occurred in less than 2 years; ability to walk 10 m independently with or without an assistive device or person; ability to communicate and understand, with a Mini-Mental Status Examination score of more than 24 points; no visual disorders or visual field deficit. Exclusion criteria were use of medication or other therapies for cardiovascular or metabolic disorder and known musculoskeletal conditions that would affect the ability to walk safely.

The CGT and SGT groups had training one hour a day, five times a week, for two weeks. The CGT group was trained using the 8-figure track, which was 121.9 cm in width and 152.4 cm in length and consisted of two corn-shaped markers, which were the returning points. The starting point was the middle of the 8-figure track. The SGT group was trained using the 20-m straight track and started at both sides. The main outcomes of this study were the balance and balance confidence scale. The balance was measured using the BBS and the TUG test. To evaluate balance confidence, the ABC scale was used.

In the statistical analysis of this study, means and standard deviations were calculated using PASW software 20.0 (SPSS Inc., Chicago, IL, USA). A paired t-test was conducted to compare the effects before and after the intervention of each group, and in order to look at differences between the groups, independent t-test was performed. The significance level was set at 0.05.

**RESULTS**

The general and clinical characteristics are described in Table 1. There were significant differences between the pre-training and post-training in BBS, TUG test and ABC scale within each group. The Comparison result between the two groups revealed that, a significant difference between the groups was found in the TUG test (Table 2).

**DISCUSSION**

Patients with stroke have more difficulty in changing directions, such as turning corners, rather than moving along a straight pathway, and are more likely to experience disproportion of weight support, loss of coordination between body segments and stiffness, and postural instability9. In previous studies, patients returning to the community without being sufficiently recovered to perform outdoor walking reported inefficient walking using a compensatory strategy that did not consider the biomechanical factors10. Patients should be able to pass through obstacles, such as stairs, ramps, roads, jaw, and must avoid conflicts with people in crowded places to achieve a successful walk in the community11). Research results have been recently reported with emphasis on walking in the community rather than walking in managed and restricted environment12). In the reliability study on the 8-figure track, walking evaluation for the elderly, walking velocity, cadence, and step length were evaluated. As a result, walking on the 8-figure track was reported to be an evaluation tool for the elderly to provide complex information on walking speed, mobility, and fall prediction. In this study, we performed gait training for stroke patients using this 8-figure track and evaluated balance and balance confidence13). In this study, BBS was used to evaluate the patient’s balance ability. Although the BBS has the disadvantage of making precise and delicate measurement difficult, such as the balance analysis method using the motion analysis system, it is easy, inexpensive, and possible to interpret the functional balance reflecting the daily life function. BBS showed statistically significant increases in both groups, but no statistically significant difference was found between the two groups. This indicates the result of the improvement of the flexibility of the ankle angle change and the improvement of the weight shifting ability with the 8-figure track training14). In this study, TUG test was used to measure the dynamic balance ability of patients with stroke. The TUG test included sitting and standing in a chair, straight walking, and turning in one direction. In this study, statistical improvement of TUG test was observed in each group and between both groups. In the SGT group, the time of the TUG test was decreased by the improved speed of straight walking, and the reduction of the TUG test time in the CGT group seemed to be improved by the curved gait training in both directions. In this study, the Korean version of ABC Scale was used. In previous studies, the better the balance ability, the higher the balance self-confidence. In this study, results also showed a significant improvement in the BBS, the TUG test, and ABC scale similar to the previous study15). Although a significant improvement in balance ability in all training groups and a significant improvement in balance self-confidence were observed, no significant difference was found between
Distinguish between the two tasks was speculated to be difficult because of the simplicity of the single task condition training program. In this study, we investigated the effect of an 8-figure track training on balance and balance self-confidence in patients with stroke. However, whether changes in the leg and trunk muscles result in a positive effect is still unclear, and neurological effects could not be precisely defined. Future research will require more long-term studies with more subjects, focusing on the kinetic and neurological aspects of curvilinear gait and direction change training using 8-shaped tracks. Moreover, fall efficacy should also be studied. In addition, developing various intervention programs using the 8-figure track for the treatment of patients with stroke and to prove the continuity of intervention effects would be necessary.

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**Conflict of interest**

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

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### Table 1. Comparison of the general characteristics of the subjects between the CGT and SGT groups

|                      | CGT group (n=8) | SGT group (n=7) |
|----------------------|-----------------|-----------------|
| Gender (male/female) | 4/4             | 3/4             |
| Age (years)          | 54.8 ± 9.41     | 61.0 ± 9.23     |
| Height (cm)          | 168.0 ± 9.87    | 167.5 ± 5.99    |
| Weight (kg)          | 64.8 ± 13.32    | 63.5 ± 6.13     |
| Lesion side (right/left) | 4/4           | 3/4             |

Data are expressed as mean ± SD.

### Table 2. Comparison of the balance and the balance confidence changes in the CGT and SGT groups

|                      | CGT group (n=8) | SGT group (n=7) |
|----------------------|-----------------|-----------------|
| BBS                  |                 |                 |
| Pre                  | 32.88 ± 3.98    | 33.43 ± 3.82    |
| Post                 | 35.50 ± 4.54*   | 34.71 ± 3.03*   |
| Post-Pre (Difference) | 2.62 ± 1.69    | 1.28 ± 1.11     |
| TUG                  |                 |                 |
| Pre                  | 32.54 ± 10.42   | 37.97 ± 10.25   |
| Post                 | 28.76 ± 10.05*  | 35.97 ± 9.97*   |
| Post-Pre (Difference) | −3.77 ± 0.97†   | −2.00 ± 1.81†   |
| ABC                  |                 |                 |
| Pre                  | 36.17 ± 13.93   | 41.53 ± 12.76   |
| Post                 | 42.19 ± 14.61*  | 44.69 ± 12.58*  |
| Post-Pre (Difference) | 6.01 ± 7.63     | 3.15 ± 3.16     |

BBS: Berg Balance Scale; TUG: Timed UP and Go test; ABC: Activities-specific Balance Confidence Scale.

Significant difference, paired t-test: *p<0.05; independent t-test: †p<0.05.
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