

Original Article

# Effect of the class and individual applications of task-oriented circuit training on gait ability in patients with chronic stroke

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**Abstract.** [Purpose] This study aimed to determine differences in gait abilities by comparing class-based task-oriented circuit training (CTCT) and individual-based task-oriented circuit training (ITCT). [Subjects and Methods] The subjects were 30 patients who were diagnosed with hemiplegia due to stroke more than six months previously. They were divided into Group I (n=10), which received conventional physiotherapy, Group II (n=10), which received conventional physiotherapy and ITCT, and Group III (n=10), which received conventional physiotherapy and CTCT. To determine the qualitative aspect of gait ability, a GAITRite (CIR Systems Inc., Sparta NJ, USA) was employed, while a two-minute walking test (2MWT) was conducted to determine the quantitative aspect. [Results] The gait ability showed significant differences in velocity, cadence, and 2MWT between groups in the significance test. As a result, the Bonferroni post test showed that gait velocity was significantly different between Groups I and II and between Groups I and III, while cadence showed a significant difference between Groups I and III. In the 2MWT, Groups I and II and Groups I and III also showed significant differences. [Conclusion] Both the individual and class applications task-oriented circuit training were effective for improving gait ability. This result indicates that CTCT can improve the physical ability of stroke patients as much as ITCT.

**Key words:** Gait, Stroke, Task-oriented circuit training

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## INTRODUCTION

A stroke is a neurological disease caused by an abnormal supply of blood to brain and is characterized by a high incidence rate<sup>1)</sup>. It causes muscle weakness, spasticity, sensory changes, abnormal movements, pain, a reduction in posture and balance ability, and various psychological problems, such as depression<sup>2)</sup>.

One of the physical methods that can improve gait ability after stroke is task-oriented circuit training (TOCT). TOCT is based on the motor learning theory proposed by Forghany et al.<sup>3)</sup>, and consists of tasks that can help motion abilities for daily living. It has been proposed to be an effective therapy method for early stroke patients, and application of TOCT in patients who experienced a stroke within one year previously has been shown to result in improvements in walking distance and gait velocity<sup>4)</sup>.

Class-based training can improve motivation, provide encouragement, and enhance health awareness and communication between people<sup>3)</sup>. Thus, it can promote patient

psychological well-being, which is deficient in one-to-one therapy, and help improve physical functional activities. Recently, a number of studies were conducted to determine the effect of class-based task-oriented circuit training that employed a circulation mode by combining the ideas of class therapy and TOCT<sup>5)</sup>. However, although related previous studies have attempted to determine the CTCT effect, in some cases they did not utilize a control group. Even if a control group was utilized, other intervention methods were applied, so it was hard to decide whether TOCT or class-based training was more effective.

Therefore, this study aimed to determine a difference in gait abilities when TOCT, which is based on the motor learning theory, was applied by groups or individually.

## SUBJECTS AND METHODS

This study was conducted in patients with hemiplegia who were diagnosed with stroke at C and S hospitals. The study was approved by the hospital, and all the participants provided written informed consent. The general characteristics of Group I, Group II, and Group III were as follows: their average ages were 62.78±9.97 years, 64.10±8.61 years, and 59.28±5.23 years; average heights were 158.00±6.28 cm, 164.78±6.84 cm, and 161.16±5.00 cm; and average weights were 61.22±6.42 kg, 64.60±4.23 kg, and 60.00±7.23 kg, respectively. In terms of duration of illness, Group I, Group

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**Table 1.** Changes in gait after task-oriented training

	Group I		Group II		Group III	
	Pre	Post	Pre	Post	Pre	Post
Velocity (cm/s)	62.9±21.9 <sup>a</sup>	64.5±25.1*	42.6±21.8	57.5±28.7 <sup>†</sup>	53.8±20.4	69.2±29.5 <sup>††</sup>
Cadence (step/min)	94.1±18.6	91.8±15.8*	76.0±23.4	85.6±18.8 <sup>†</sup>	90.5±16.5	99.9±15.7
StPSP (%)	0.1±0.1	0.1±0.1	0.1±0.1	0.2±0.1	0.2±0.1	0.2±0.1
SwPSP (%)	0.4±0.3	0.4±0.3	0.7±0.4	0.6±0.4	0.6±0.5	0.5±0.5
SLSP (%)	0.2±0.1	0.2±0.2	0.5±0.4	0.3±0.2	0.2±0.2	0.2±0.2
2MWT (m)	76.6±33.1	71.4±27.0**	51.0±24.1	64.0±26.0 <sup>†</sup>	57.6±20.5	73.9±27.2 <sup>††</sup>

<sup>a</sup>Means (SD).

Group I, GT (conventional therapy); Group II, GT + ITCT; Group III, GT + CTCT.

StPSP, stance phase symmetry profile; SwPSP, SWing phase symmetry profile; SLSP, step length symmetry profile; 2MWT, 2-minute walking test.

Significance was tested by ANCOVA.

\*: Between group comparison ( $p < 0.05$ ), \*\*: Between group comparison ( $p < 0.01$ ).

Significance for multiple comparisons was tested by the Bonferroni multiple comparisons test.

<sup>†</sup> I-II ( $p < 0.05$ ), <sup>††</sup> I-III ( $p < 0.05$ ).

II, and Group III had durations of illness of 36.67±15.12 months, 30.70±14.68 months, and 27.66±19.35 months.

This study aimed to determine the change in gait abilities in patients after CTCT, so the subjects (40 in all) were divided into three groups. Ten patients were excluded from the pool of subjects due to health problems, so the remaining subjects were randomly assigned to Group I (n=10) as a conventional physiotherapy group, Group II (n=10) as a ITCT group, and Group III (n=10) as a CTCT group. All subjects received conventional therapy for 30 minutes a day, five times a week; the subjects in Groups II and III received TOCT for 30 minutes a day, three times a week for four weeks. Measurements were conducted before and after the intervention.

The TOCT proposed by Salbach et al.<sup>4)</sup> was modified into a circular mode. The training tasks were sitting in chair and walking, walking over obstacles, carrying goods, turning the goods upside down, and walking fast in a circle. Group III was divided into two groups, each consisting of four to six persons under the supervision of two physiotherapists with more than 10 years of physiotherapy experience each. Group II performed the same task done by Group III under the supervision of one physiotherapist with more than 10 years of physiotherapy experience.

A GAITrite (CIR Systems Inc., Sparks, NJ, USA) was employed to measure temporal and spatial variables to test gait abilities. The subjects walked from a place 2 m away from the electronic walking mat start point to a place 2 m away from the end position to reduce the acceleration and deceleration effect<sup>6)</sup>. This study measured velocity, cadence, stance phase symmetry profile, swing phase symmetry profile, and step length symmetry profile.

To determine the walking endurance, a two-minute walking test (2MWT) was conducted<sup>7)</sup>. A 50 cm-high cylinder was placed 1 m and 9 m away from the start point, and the subjects walked with a comfortable velocity around the two cylinders for the 2MWT<sup>8)</sup>. A researcher recorded the number of times that each subject walked around the cylinders, which was subsequently converted into a distance. He then added a distance from the heel of the subject to the

cylinder at the completion of the 2MWT to calculate the final walking distance.

The statistical analysis in this study was done by using SPSS 12.0 for Windows<sup>®</sup>. The general characteristics of the subjects were analyzed by descriptive statistics. ANCOVA was used to analyze whether gait abilities were different between groups, and the Bonferroni method was used as a post test. The statistical significance level  $\alpha$  was set to 0.05.

## RESULTS

To determine the difference in gait velocity between groups, ANCOVA was conducted, and the results showed a statistically significant difference ( $p < 0.05$ ). The Bonferroni post-test results showed a significant difference between Groups I and II and Groups I and III ( $p < 0.05$ ), while no significant difference was shown between Groups II and III. To compare the difference in cadence between groups, ANCOVA was conducted, and the results showed a statistically significant difference ( $p < 0.05$ ). After the Bonferroni post test, the results showed a significant difference only between Groups I and III ( $p < 0.05$ ). No significant difference was shown between Groups I and II and Groups II and III (Table 1).

To compare the difference in symmetry profiles in the stance and swing phases between groups, ANCOVA was conducted, and the results showed no statistically significant difference.

To compare the difference in step length symmetry profiles between groups, ANCOVA was conducted, and the results showed no statistically significant difference.

To determine the difference in the 2MWT between groups, ANCOVA was conducted, and the results showed a statistically significant difference ( $p < 0.01$ ). Using the Bonferroni post test, a significant difference was found between Groups I and II ( $p < 0.05$ ) and between Groups I and III ( $p < 0.01$ ). No significant difference was found between Groups II and III (Table 1).

## DISCUSSION

This study conducted a modified form of the task-oriented training proposed by Salbach et al.<sup>4)</sup>. In order to measure spatiotemporal gait variables, the GAITRite used by Titianova et al.<sup>9)</sup> was employed to measure changes in gait velocity, cadence, stance and swing phases, and step length symmetry profiles. The measurement results showed no significant difference in the stance and swing phase and step length symmetry profiles between groups, while a significant difference was found in gait velocity and cadence between groups after the intervention. With regard to gait velocity, a significant difference was found in Groups II and III compared with Group I. This result was similar to that in the study by Sherrington et al.<sup>5)</sup>, in which TOCT was applied to subjects with mobility problems, resulting in an improvement in the gait velocity of the subjects in 6 m walking tests. It is also similar to a result of a study by Dean et al.<sup>10)</sup>, in which class-based TOCT was applied to patients with chronic stroke, resulting in a significant difference in the gait velocity of the patients in 10 m walking tests compared with the control group. Therefore, subsequent tasks of ever-increasing difficulty in CTCT, such as walking, carrying, and fast walking, were deemed to cause a significant increase in gait velocity and cadence. In the same manner, these tasks were also deemed to affect the individual training group. On the other hand, no significant difference was shown in the stance and swing phase and step length symmetry profiles. This is because the training program focused on quantitative gait abilities rather than on gait pattern function.

This study showed that the the application of TOCT was effective in both the individual and group contexts in terms of physical recovery. Therefore, CTCT training had a positive effect on the gait abilities of stroke patients, meaning that CTCT can be effective for training programs that aim

to change physical functions in clinical practice.

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