A Comparison of the Effects of Overground Gait Training and Treadmill Gait Training According to Stroke Patients’ Gait Velocity

In-mo Park, PT, MSc1), Yeon-seop Lee, PT, PhD2), Byeong-mu Moon, PT, MSc3), Sun-mi Sim, PT, MSc4)
1) Major in Physical Therapy, Department of Public Health, The Graduate School of Konyang University
2) Department of Physical Therapy, Konyang University: 158 Gwanjeodong-ro, Seo-gu, Daejeon, Republic of Korea. TEL: +82 42-600-6324, FAX: +82 42-600-6424
3) Department of Rehabilitation Science, Graduate School, Daegu University
4) Department of Rehabilitation Center, Youseong Wellness Hospital

Abstract. [Purpose] The purpose of this study was to compare the effects of overground gait training (OGT) and treadmill gait training (TGT) on walking speed, gait endurance, and balance ability of subjects with stroke. [Subjects and Methods] The study subjects were 40 patients with stroke. They were randomly divided into two groups, the OGT group and the TGT group, and further categorized according to their individual walking speeds (slow <0.5 m/s and fast >0.5 m/s). The groups performed exercises 10 times for a week. Pre- and post-test assessments involved the measurement of walking speed, walking endurance, and balance ability, as assessed by the 10-m walking time, the 6-min walking distance, and the Berg Balance Scale (BBS). [Results] The 10-m walking times, 6-min walking distance, and BBS scores of both the OGT group and the TGT group significantly improved, but there were no significant differences between the two groups. In the slow walking speed group, the OGT subjects showed significant improvement compared to the TGT subjects in the 6-min walk test. [Conclusion] Overall, we conclude that OGT was more effective at improving the gait endurance of stroke patients than TGT. Further research is needed to verify the generalizability of these findings and to identify which stroke patients might benefit from OGT.

Key words: Stroke, Overground, Treadmill

INTRODUCTION

Around 80% of stroke patients are able to walk but require continuous rehabilitation treatment in order to improve their gait functions, e.g. gait velocity5). Problems experienced by stroke patients include muscle weakness, abnormal muscle tension, and motor control disorders resulting from abnormal movement. In particular, slow gait velocity and reduced gait endurance may cause many difficulties with gait and the recovery of gait ability, and overcoming these difficulties is a crucial objective of stroke patient rehabilitation5). Many studies have reported treatment methods for improving the gait ability of stroke patients5).

Recent research examining rehabilitation and exercise guidelines for stroke patients has advocated gait exercise based on a task-oriented approach5). This encourages the re-learning of the muscle activities necessary for performing tasks by repeatedly training individuals in meaningful exercise tasks. This approach is based on evidence that functional activities, such as gait, may be restored through exercise related to gait5). Numerous tasks for the treatment of stroke patients have become diversified and specified6), and two methods for the improvement of gait ability include overground gait training (OGT) and treadmill gait training (TGT)7).

Although much research has been done on the improvement of gait velocity of stroke patients, there has been no research which has differentiated between stroke patients with slow gait velocity and fast gait velocity. Accordingly, this study divided stroke patients according to their gait velocity, recorded at the initial evaluation into slow velocity and fast velocity groups8). Gait velocity is a measure that evaluates patients’ functional level, and this study examined changes in gait velocity, gait endurance, and balance when different treatment methods were administered to stroke patients having to different initial gait velocities. Selective exercise methods according to patients’ gait velocities were also appraised.

SUBJECTS AND METHODS

Subjects

The subjects of the study were 40 stroke patients. The criteria for participation were: onset of stroke six months or more prior to the study; ability to walk for 10 meters or
more without any aid; a score of 23 or higher on the Korean
Version of the Mini-Mental State Examination; no other
neurological or orthopedic lesions; and subjects’ consent to
participation in the study.

Table 1 shows the general characteristics and clinical
features of the subjects. There were no statistically signifi-
cant differences in gender, age, paretic side, lesion duration,
lesion types, or overall functional levels using functional
movement elements between the OGT group and the TGT
group within the slow group (p>0.05), or between the OGT
and the TGT group within the fast group (p>0.05).

### Methods

The effects of OGT and TCT on stroke patients with dif-
frent gait velocities were compared in terms of gait velocity,
gait endurance, and balance.

In order to evaluate gait velocity, the 10-m Walking Time
(10mWT) was measured\(^9, 10\). Patients were asked to walk as
fast as possible, and the time taken to cover 10 m was mea-
sured using a stop watch. The gait speed was expressed as
m/s.

In order to assess gait endurance, patients’ 6-min walk-
ing distance (6MWD) was measured\(^11\). The patients were
instructed to walk as fast as possible for 6 min\(^12\), and the
distance covered in 6 min on a 30-m circuit, marked every 2
m, was recorded.

The Berg Balance Scale (BBS) was conducted in order to
evaluate balance ability\(^13\). Fourteen items were evaluated.
For each item, the minimum score is zero and the maximum
score is 4, and the items cover the three areas of sitting,
standing, and postural change. The maximum score is 56
points\(^14\), and a higher score indicates better balance ability.

The patients who participated in this study were equally
assigned to the slow gait group and the fast gait group, and
they were randomly allocated to either the OGT group or
the TCT group by selecting a card from a box containing
two cards.

The OGT group and the TCT group received gait train-
ing for 30 min twice a day, before noon and after noon for
five days, 10 times in total. The OGT group walked in a
treatment room where a 30-m track was installed, under the
supervision of a therapist who walked behind them, and the
TGT group walked at a comfortable speed on a treadmill
(Kobe-950, Kobe, Korea) following the method presented
by Langhammer and Stanghelle\(^15\). The treadmill speed
started at the lowest velocity and was increased within
1 min in line with each patient’s gait level. Measurement
was made prior to the training and after 4 weeks of training.
The same procedures were followed for both the fast group
and the slow group.

SPSS 18.0 for Windows was employed for statistical
analysis. The paired t-test was conducted to evaluate chang-
es in gait velocity, endurance, and balance after the training
conducted for the OGT and the TGT groups, and the inde-
pendent t-test was performed to examine the significance of
differences in the OGT and TGT group results. Significance
was accepted for values of α<0.05.

### Table 1. Characteristics of study participants

<table>
<thead>
<tr>
<th></th>
<th>Slow walking group (n=20)</th>
<th>Fast walking group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OGT group (n=10)</td>
<td>TGT group (n=10)</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>6/4</td>
<td>7/3</td>
</tr>
<tr>
<td>Age (years)</td>
<td>51.3±11.0(^a)</td>
<td>51.9±8.9</td>
</tr>
<tr>
<td>Paretic side (rt/lt)</td>
<td>5/5</td>
<td>6/4</td>
</tr>
<tr>
<td>Onset (months)</td>
<td>16.5±8.8</td>
<td>23.4±6.4</td>
</tr>
<tr>
<td>Type (infarction/ICH)</td>
<td>6/4</td>
<td>7/3</td>
</tr>
<tr>
<td>FAC(^b)</td>
<td>4.0±0.6</td>
<td>4.2±0.6</td>
</tr>
</tbody>
</table>

\(^{a}\) Mean±SD; \(^{b}\) FAC, Functional Ambulatory Category
OGT, overground gait training; TGT, treadmill gait training

### Table 2. Comparison of 10mWT, 6MWD, and the Berg Balance Scale prior to and after the groups
training

<table>
<thead>
<tr>
<th></th>
<th>Slow walking group (n=20)</th>
<th>Fast walking group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OGT Group (n=10)</td>
<td>TGT Group (n=10)</td>
</tr>
<tr>
<td>10mWT (m/s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.2±0.0</td>
<td>0.3±0.0</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.3±0.0**</td>
<td>0.3±0.0**</td>
</tr>
<tr>
<td>6MWD (m)</td>
<td></td>
<td></td>
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<tr>
<td>Pre-test</td>
<td>92.5±19.9</td>
<td>106.5±14.2</td>
</tr>
<tr>
<td>Post-test</td>
<td>121.0±26.1**</td>
<td>128.8±18.7**</td>
</tr>
<tr>
<td>BBS (score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>43.5±5.3</td>
<td>44.5±5.5</td>
</tr>
<tr>
<td>Post-test</td>
<td>45.8±4.6**</td>
<td>46.6±4.6**</td>
</tr>
</tbody>
</table>

Paired t-test: *, p<0.05; **, p<0.001. Independent t-test: †, p<0.05
RESULTS

The results of the 10mWT, 6MWD, and BBS significantly increased after the four-week training in the TGT and OGT groups both the fast gait group and the slow gait group (p<0.01). BBS significantly differed between the TGT slow gait group and the TGT fast gait group (p=0.05) (Table 2). For 6MWD of the slow gait group, the OGT group’s improvement was 31.10 ± 8.46%, and the TGT group’s improvement was 20.86 ± 4.28%. The OGT group’s improvement was statistically more significant than that of the TGT group (p<0.01).

DISCUSSION

Stroke patients require sufficient gait velocity, endurance, and balance ability in order to achieve optimal gait20). Treadmill gait training enhances the muscle strength and balance ability of the lower extremities17, 18), and has been reported to be a more effective method than classic approaches stressing independent elements of gait19, 20). However, there have been conflicting reports about the effects of treadmill gait training. Nilsson et al.21) reported that treadmill gait exercise was effective at improving endurance, but additional positive effects were not observed. In a recent comparison between TGT and ordinary OGT, both groups showed significant improvements in gait velocity, endurance, and balance ability, with OGT being more effective than TGT at improving gait endurance3).

OGT improves the body’s ability to generate muscle strength in the lower extremities and ground reaction force during movement22), while TGT enhances gait symmetry, coordination ability, and muscle strength of the lower extremities through repetitive movement of the lower extremities19, 20). This study conducted OCT and TGT after dividing the subjects into a slow gait group (0.5 m/s or slower) and a fast gait group (faster than 0.5 m/s)3). To evaluate gait function, 10mWT and 6MWD were measured to evaluate gait velocity and endurance, and the BBS was assessed in order to evaluate balance ability.

In the slow gait group, the gait velocities of the OGT group and the TGT group increased significantly after training, and there was no difference between the groups. In the fast gait group, gait velocity of the OGT group and the TGT group significantly increased after training, and there was no difference between the groups. In the comparison of the gait velocity improvement rates, there was no significant difference between the OGT and the TGT groups improved after training, but there was no significant difference in improvement rate between the groups. These results are consistent with Mudge et al.28) who showed that treadmill gait training improved balance as measured by the TUG test, another balance test, and that both gait and treadmill training improves balance29).

Gait velocity of stroke patients is a measure of their functional ability, and a therapist may select treatment methods based on it. According to the results of our present study, patients with fast gait speed showed an improvement in gait velocity, gait endurance, and balance following both OGT and TGT, and those with low gait speed showed an improvement in gait endurance following OGT. Therefore, overground training is recommended for slow gait patients rather than treadmill training.

REFERENCES


