The Effects of Dual-Motor Task Training on the Gait Ability of Chronic Stroke Patients

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Abstract. [Purpose] This study examined the effects of consecutive training in dual motor tasks on the gait ability of chronic stroke patients. [Subjects and Methods] Conservative physical therapy was conducted for 29 subjects divided into two groups. The dual-motor task group was taught a basic motor task and additional motor tasks, whereas the single-motor task training group was taught consecutive single motor tasks. Both groups performed their programs five times a week for 30 minutes over a period of four weeks. For performance measurements, time-based gait variables and space-based gait variables were measured using GAITRite. [Results] The dual-motor task group exhibited statistically significant improvement in the temporal variables of cadence, gait velocity, step time, and cycle time, as well as in the spatial gait variables of step length and stride length. The single-motor task group exhibited significant improvements in cadence, gait velocity. Moreover, according to the comparison of training effects between in the two groups, the temporal gait variables of gait velocity and cycle time and the spatial gait variable of stride length revealed a statistically significant difference. [Conclusions] Compared to the single-motor task training, the dual-motor task training of stroke patients was more effective at improving gait ability.

Key words: Chronic strokes, Dual-motor task training, Gait performance

INTRODUCTION

Dual-task training involves performing a task while performing another task, or continuously performing two or more tasks, simultaneously1,2. Dual-motor task training consists of a basic motor task and additional motor tasks3,4. Dual-motor task training is assessed by examining postural sway, spatial balance indexes, or changes in gait performance. Patients pick up an object while walking on a treadmill or do exercises with a ball while maintaining postural balance5,6. Dual-motor task training is also assessed by examining changes in gait velocity and stride length when subjects move a plate or cup during gait4. Patients’ functional recovery is observed or prognoses are made after the training.

Generally, as the level of postural difficulty heightens (seating, standing, walking, and climbing stairs), stroke patients correspondingly face increasing difficulties performing postural tasks because of multiple functional disorders7. Consequently, they are more likely to be at risk of falling because of an increase in postural sway and a decline in gait ability. Previous studies have reported that the fear of falling in stroke patients leads to a lack of confidence, which subsequently becomes a hindrance to independent living, eventually deteriorating quality of life8,9.

Moreover, compared to normal people, stroke patients exhibit changes in temporospatial gait characteristics9,10. Titianova et al.8 noted that stroke patients experience decreases in step length, gait velocity, and stride length. Pohl et al.9 also reported that chronic stroke patients show decreases in gait velocity of one third and a decline in walking distance of 40% compared to normal adults. Therefore, stroke patients need interventional training in their rehabilitation treatments. Interventional training includes muscle strengthening, improving the of coordination in the lower limbs and weakened postures, and enhancing endurance in exercises.

Kusoffsky et al.10 reported that holding an object while standing up from a sitting position affected anticipatory postural control in body adjustment. Gergory et al.11 studied changes in gait in stroke patients after training of dual-motor task training that required concentrating of the postural task of walking while moving a dish or a cup. Dean et al.12 examined changes in gait after training continuous movement task training including upper and lower extremity training. Kwakkel et al.13 reported that performance of gait training that emphasized coordination of the upper and lower extremities resulted in increased gait speed. As a dual-task exercise, exercises that combine simple upper and lower extremity training with gait or a postural task are frequently used.

In this context, this study examined the effects of dual-motor task training on the gait ability of stroke patients by dividing the research subjects, who were of chronic...
stroke patients, into a dual-motor task training group that performed various tasks similar daily living activities and a single-motor task training group.

SUBJECTS AND METHODS

Subjects

This study was conducted at Hospital J in Daegu from January 3 to February 29, 2012. The subjects had been diagnosed with a stroke at least six months earlier by computed tomography (CT) or magnetic resonance imaging (MRI). They could walk independently and were not receiving medication for the relief of spasticity. In order for the subjects to understand and follow the researcher’s instructions, they also had to attain a score of 22 or higher in the Mini Mental State Examination Korean Version (MMSE-K) and have a Brunnstrom grade of more than level 4. Thirty subjects were divided equally dual-motor task (DMT) into a test group and a single-motor task (SMT) group. After a full explanation of this study was provided, the experiment was conducted with the patients who agreed to participate. During the course of the experiment, one subject was excluded because of a fall. Thus, 29 subjects completed in the measurements of gait performance. The general characteristics of the test and control groups are shown in Table 1.

Methods

Twenty-nine stroke patients received conservative physical therapy from a physical therapist who had more than five years of professional experience. The therapy was performed in the same manner for all patients for 30 minutes before their training. The subjects were trained in their respective tasks five times a week over a four-week period. Each training session lasted 30 minutes. The dual-motor task training consisted of a basic motor task with additional motor tasks in consecutive order. These tasks included rising from a chair from the sitting position while picking up plastic cups that lay in front of the feet, then slowly walking forward, sideways, and backward on a flat surface while holding a 100-g sandbag against to the affected wrist, and going up and down a ramp or stairs while transferring cups from tables of different heights located beside the ramp or stairs in consecutive order. The single-motor task training consisted of rising from a chair, walking naturally on a flat surface forward, backward, and sideways, and going up a slope and stairs.

In order to measure the gait performances of the subjects, GAITRite (CIR systems Inc. Clifton, NF 07012) was used before and after the intervention to measure the temporal variables of cadence, gait velocity, step time and cycle time, and the spatial variables of step length and stride length. Each subject in both groups was measured with an instrument whose validity and reliability has been demonstrated in a number of studies, for gait ability while s/he walked three times at a self-chosen speed. The average of the three measurements was selected for the analysis. SPSS Win 12.0 was used for the data analysis. The Paired t-test was used to compare gait performance before and after the training in each group. The differences between the two groups were analysed using the independent t-test. Statistical significance was accepted for values of p<0.05.

RESULTS

The gait ability of the stroke patients in the DMT group after the intervention showed statistically significant improvements in the temporal gait variables of cadence, gait velocity, step time, and cycle time, and the spatial gait variables of step length and stride length (p<0.05). The SMT group exhibited significant improvement in cadence, gait velocity after the intervention (p<0.05); however, the other measures showed no statistically significant improvements (p>0.05) (Table 2).

According to the comparison of the effects of the respective training programs between the two groups, the temporal gait variables of gait velocity, cycle time, and the spatial gait variable of stride length exhibited statistically significant differences (p<0.05) (Table 2).

DISCUSSION

A task-oriented method based on motor learning theory poses tasks requiring interaction among task, environment, and individual which involve the processes of perception, cognition, and action for their completion. The task-oriented method consists of training programs that focus on specific functional tasks that require the combined activity of the musculoskeletal or neuromuscular systems.

Wolf et al. reported that active exercises that include task-oriented training and repetitive functional movements had a positive effect in therapeutic interventions for stroke patients. Dean et al. emphasized the effectiveness of task-oriented training, reporting that after performing the functional training related to mobility of the lower and upper limbs of the subjects, patients’ gait velocity and endurance increased, and their mobility functions improved due to an enhanced ground reaction at the lower limb on the paralyzed side. Moreover, You et al. suggested that the repetitive practices of daily-living tasks assist the brain’s reorgani-
zation for proper functioning. The functional recovery of stroke patients is more effective when their treatments are accompanied by intensive training in tasks similar to the actual tasks encountered in daily living activities, as it leads to the voluntary use of specific motions and functions.\(^\text{16}\)

In this study, the consecutive tasks that were applied as an intervention for chronic stroke patients included rising from a from after a sitting posture, for symmetry and active control of the lower limbs and the trunk, and slowly walking forward, sideways, and backward, for active control of the lower limbs and various muscle activities. Furthermore in order to train active lower-limb control and improve gait velocity and coordination, intensive training that included obstacle walking, such as ascending stairs or a slope, and walking backwards on flat ground at maximal speed was conducted\(^\text{14, 17, 18}\). In addition, this study had subjects perform continuous motions encountered in daily life, such as holding a cup while standing up from a sitting position, walking while holding a 100 g weight, and climbing up and down a ramp or stairs while moving a cup as described in previous studies of dual-task training the usefulness of which was demonstrated in walking while making a phone call using a cellular phone or holding objects\(^\text{16}\).

Given that the gait improvement in stroke patients is an important goal for rehabilitation and an essential element in the functional independence of patients, an objective evaluation is required for the analysis of the various postural differences between the two groups, p<0.05.

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**Table 2. Comparison of gait performance abilities of the dual-motor task and single-motor task groups**

<table>
<thead>
<tr>
<th>Test group</th>
<th>Control group</th>
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<tbody>
<tr>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Cadence (steps/min)</td>
<td>74.7 ± 16.9</td>
</tr>
<tr>
<td>Gait velocity (cm/sec)</td>
<td>49.3 ± 3.1</td>
</tr>
<tr>
<td>Step time (sec)</td>
<td>1.0 ± 0.1</td>
</tr>
<tr>
<td>Cycle time (sec)</td>
<td>1.8 ± 0.0</td>
</tr>
<tr>
<td>Step length (cm)</td>
<td>30.1 ± 2.8</td>
</tr>
<tr>
<td>Stride length (cm)</td>
<td>59.6 ± 3.7</td>
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Values are Mean ± SE; *p<0.05; a: Significant difference from pre-intervention, p< 0.05. a: Significant difference between the two groups, p<0.05.

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**REFERENCES**

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