The Effect of Balance Task-Related Circuit Training on Chronic Stroke Patients

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Purpose: This study investigated the efficacy of task-related circuit training aimed at improving balance in individuals discharged from rehabilitation facilities following a stroke.

Methods: We recruited 12 stroke patients (34-66 years of age) to participate in a task-related circuit training program. Baseline assessment included a history of stroke and an assessment using the Mini-Mental State Examination Korea (MMSE-K). After a baseline assessment, follow-up assessments were administered pre- and post-training. These included Berg Balance Scale (BBS), Functional Reach Test (FRT), and the Time Up & Go Test (TUG). Physiotherapists trained study subjects under the one-to-one supervision of students from the department of physical therapy. Circuit class study participants attended 90-minute treatment sessions, one day a week for 12 weeks (from September to December 2008). The program consisted of a light warm-up period (10 min), physical exercises for improving balance (20 min), tasks focused on improving balance (50 min) and a cool-down period (10 min).

Results: Scores for the BBS assessment increased significantly (from 43.2 to 49.7) after the training (p<0.05). Reach distance on the FRT increased substantially (from 27.7 cm to 47.0 cm), although the improvement was not significant (p>0.05). The average time on the TUG test decreased significantly (from 23.7 sec to 19.5 sec) after the training (p<0.05).

Conclusion: The task-related circuit training program improved the balance and mobility of subjects, indicating that such a group program is useful for stroke patients who are discharged from the hospital. More such task-related programs set in a community environment should be developed.

Keywords: Task-related circuit training, Balance, BBS, FRT, TUG

I. Introduction

Stroke is a major cause of disability and handicap in adults. It is not only an important health problem but also it imposes sociological and economic burdens on patients and caregivers. Furthermore, despite intensive therapy during the first six months post-stroke, many individuals are still significantly disabled and handicapped. Stroke patients not admitted to hospital receive significantly less rehabilitation than patients who are admitted, even if they...
need rehabilitation. After they leave the hospital, most cannot walk quickly or far and may stay at home and become isolated from society.

In the past decade, there has been an increased amount of interest in alternatives to in-hospital rehabilitation services for stroke patients. Early, supported discharge and home-based programs for stroke patients have been developed. The need for community-based rehabilitation is increasing, and many community-based rehabilitation programs are being developed.

Also, people with stroke have the high risk of falling and falls are common when people return home after stroke. Repeat fallers had greater mobility deficits and significantly reduced arm function and ADL ability. Important risk factors for falls are balance and gait deficits, attention deficits. The Stroke patients showed excessive postural sway and instability. So, Interventions addressing these deficits can be expected to prevent falls more successfully.

The effect of group programs on the chronic stroke community has been evaluated in Korea. However, few studies have investigated the benefit of community physiotherapy for patients with long-term problems after a stroke, and most studies have focused on the effects of mat and band exercises.

Group therapy is effective due to the interaction between members in the group. Classes are advantageous because they not only provide the opportunity for exercise and social interaction, but are also cost-effective with several individuals participating at the same time. Dean and Shepherd provided evidence of the efficacy of task-related motor training in improving the ability to balance during seated reaching activities after stroke. Yang et al. suggested that the dual-task-based exercise program is feasible and beneficial for improving walking ability in chronic stroke. Dean et al. found the efficacy of a task-related circuit class at improving locomotor function in chronic stroke. In these days, the effect of the circuit class program has been increasing. But, most of them focused the strength and the ability of gait. There are few article about task related circuit program, particular focusing on the balance.

Therefore, we selected a group-based program for our stroke patients in the hope that the group format would have a positive effect on the subjects. The main objective of this study was to investigate the efficacy of a circuit class aimed at improving the performance of balance-related tasks that can be expected to prevent falls in individuals discharged from rehabilitation following stroke. The class program focused on improving the balance of patients.

II. Methods

1. Subjects

A group of 21 subjects was recruited from S city. To be eligible to participate, subjects had to meet the following inclusion criteria: (1) discharged from all rehabilitation services and living at home; (2) able to walk 10 meters independently with or without an assistive device; (3) capable of understanding and following directions given by a researcher during the program; (4) should have completed at least three months post-stroke; and (5) score more than 24 on the Mini-Mental State Examination Korea (MMSE-K). Subjects were excluded if they had any medical condition that would prevent participation in a training program.

2. Design

Before beginning the circuit training program, the purpose and procedures were fully explained to participants, and informed consent was obtained from each participant for this study. All subjects were evaluated individually pre- and post-training; they were tested using the following measurements.

1) Measurements

Participants were evaluated by two physiotherapists (with three years experience as a physiotherapist). Baseline assessment included history of stroke and administration of the MMSE-K. After the baseline assessment, follow-up assessments were administered pre and post-training. The equipment used for the tests were a step stool, a chair with arms, a tape measure, a stopwatch, and a pen.

(1) Functional Reach Test (FRT)

The FRT was used to assess balance in all participants and was defined as the maximal distance the individual could
reach forward beyond arm's length, while maintaining a fixed base of support in the standing position. The participants flexed their unaffected arm to 90 degrees with the elbow extended and the hand fist, while standing with legs about shoulder width apart. Before the subjects were evaluated, a physiotherapist explained and demonstrated how to perform the test. An initial measurement was made by the physiotherapist and then the subject leaned as far forward as possible without losing balance or taking a step. A second measurement was taken and then subtracted from the initial measurement.

(2) Berg’s Balance Scale (BBS)
The balance assessment consisted of 14 subtests performed in a standard order. Each task was scored on a five-point scale (0-4) according to the quality of the performance or the time taken to complete the task, as ranked by the test developers. The maximum possible score for this assessment was 56. The BBS is a psychometrically sound measure of balance impairment for use in post-stroke assessment.

(3) Time Up & Go Test (TUG)
From a starting position of sitting on a chair with arms, the subjects were asked to turn around 3 m and then sit on a chair. Physiotherapists recorded the time to complete the task, using a stop watch. The subjects practiced the task once, and then were timed three times. The mean of the three values was used in the analyses.

2) Intervention
The subjects attended the circuit class for 12 weeks. The aim of the task related circuit training program was to educate participants themselves and caregiver and improve participants’ balance. A physiotherapist trained participants under the one-to-one supervision of students in the Department of Physical Therapy. Circuit class participants attended the 90-minute treatment session one day a week. The functional exercise program comprised a light warm-up period (10 min), physical exercises for improving balance (20 min), tasks focused on improving balance (50 min) and a cool-down period (10 min). Task-related circuit training program was designed as follows. First, we started just 5 tasks and then we suggested more task as the participants worked well. In addition, participants were challenged by being asked to complete increasingly difficult tasks and increasing time for performing task every week.

(1) The physical exercises
The physical exercises were a modified version of the National Rehabilitation Center recommendations for older individuals. The aim of the activity was to improve the balance ability.

(2) Walking along a ladder laid out on the floor and walking on a line
(3) Walking on a parallel bar
(4) Turning in a circle
(5) Walking on a different surface (sand, gravel, a small rock)(Figure 1)

Figure 1. Walking on a different surface (sand, gravel, a small rock): Left fig.
3. Data Analysis

Information from all participants was entered into a computerized database and analyzed by using the SPSS statistical package (version 12.0) with a significance level of \( \alpha \) equal to 0.05. Data obtained from the evaluations (pre- and post-training) were compared using the paired t-test.

1. General Characteristics of the Subjects

This study was conducted between September and December 2008. In total, 21 stroke patients were recruited and had consented to participate. However, five participants quit the program in favor of individual treatment. Therefore, 16 participants completed the pre-training test. Two participants withdrew from the circuit class after week 4 due to health concerns, and two participants did not participate in the post-training test because they were absent on the final day of the program. Thus, a total of 12 participants completed the pre- and post-training evaluations. The attendance rate was 75% for the entire 12-week training program. All participants were able to perform the exercises as planned.

Among the 16 participants who completed the pre-training test, 14 were male (87.5%) and two were female (12.5%). The average age of the participants was 56.44 years, and the average time post-stroke was 4.69 years. There were 11 participants with right-side paralysis (68.8%), four participants with left-side paralysis (25.0%), and one participant with olivoponto atrophy (6.3%)(Table 1).
Table 1. General characteristics of subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>General characteristics (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>56.44±8.87</td>
</tr>
<tr>
<td>Years post-stroke</td>
<td>4.69±2.85</td>
</tr>
<tr>
<td>Gender (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>87.50</td>
</tr>
<tr>
<td>Female</td>
<td>12.50</td>
</tr>
<tr>
<td>Affected side (%)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>68.80</td>
</tr>
<tr>
<td>Left</td>
<td>25.00</td>
</tr>
<tr>
<td>Others</td>
<td>6.30</td>
</tr>
</tbody>
</table>

Values are mean±SD (range) or frequency (percentage)

2. Berg’s Balance Scale Test

The average score on Berg’s Balance Scale was 43.2 before starting the program. The increase in scores for the group ranged from 43.2 to 49.7, and there was a significant difference between pre- and post-training scores (p<0.05)(Table 2).

Table 2. Comparison of pre-training and post-training measures within group

<table>
<thead>
<tr>
<th>Measures</th>
<th>Pre-training</th>
<th>Values</th>
<th>Post-training</th>
<th>p</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBS (score)</td>
<td>43.20 ± 10.50</td>
<td>49.70 ± 4.40</td>
<td>0.02</td>
<td>-2.72</td>
<td></td>
</tr>
<tr>
<td>TUG (sec)</td>
<td>23.70 ± 12.70</td>
<td>19.50 ± 9.50</td>
<td>0.01</td>
<td>3.50</td>
<td></td>
</tr>
<tr>
<td>FRT (cm)</td>
<td>27.70 ± 9.08</td>
<td>47.00 ± 5.70</td>
<td>0.08</td>
<td>-1.89</td>
<td></td>
</tr>
</tbody>
</table>

Values: mean ± SD

BBS: Berg’s balance scale
TUG: Time up and go test

3. Functional Reach Test

The pre-training reach distance on the FRT was 27.7cm. After the circuit training program, the distance increased to 47.0cm. The increase in distance ranged from 27.7cm to 47.0cm. Although all participants increased their FRT distance, the difference between pre- and post-training scores was not significant (p>0.05)(Table 2).

4. Time Up & Go Test

The pre-training average on the TUG test was 23.7sec. After the circuit training program, the time decreased to 19.5 sec. The reduction in time ranged from 23.7sec to 19.5sec. There was a significant difference between the pre- and post-training times on the TUG test (p<0.05)(Table 2).

IV. Discussion

Our study findings support the efficacy of a task-related circuit training program intervention in enhancing balance ability in chronic stroke patients. Recently, studies have shown that motor recovery may still occur at more than three months poststroke.1,3,4,8,9,13,19

After discharge from the hospital, stroke patients still need care, but often do not get sufficient care due to cost concerns. Community physiotherapy treatment for patients with mobility problems one year after the stroke is important, but it has been shown that clinically minor improvements in mobility and gait speed are not sustained after the treatment ends.14 Therefore, community-based rehabilitation (CBR) focuses on patients who need care after being discharged from the hospital. At present, some universities have begun participating in the CBR programs at public health care centers. Therefore, we tested a task-related circuit training program for stroke patients as a CBR program. Most patients want a training program to improve their function. We focused on improving patients’ ability to balance, since patients need balance to walk safely and reduce their risk of a second attack.

Won3,5 found that stroke patients improved their balance and occupational performance after community-based functional group training. This result is similar to the result obtained in our study. Yang9 et al reported that a dual-task-based exercise program is feasible and beneficial for improving walking ability (walking speed, cadence, stride time et al) in patients with chronic stroke.

Kim and Oh7 was used a weekly circuit-group exercise program on functional performance flexibility of the trunk and lower extremity and balance in individuals with thirteen chronic stroke and found that the mean time on the TUG test decreased after chronic stroke patients participated in a circuit group program. The finding suggested that a weekly circuit group exercise program has some benefit for individual with mobility problems after stroke. Wavers et al investigated the use of task-oriented circuit class training on walking competency after stroke was improved gait and gait-related activities (TUG and walking distance) but No significant summary effect was found for balance control. Catherine et al have suggested
that task-related circuit class improved walking speed and endurance that indicate locomotor function in chronic stroke. Our study found that the average time on the TUG test decreased to 19.5 sec, which is similar to that obtained in the studies conducted by Yang et al\textsuperscript{9}, Kim and Oh\textsuperscript{7}, Van de port et al.\textsuperscript{22} On the whole, we can conclude that the task-oriented circuit training improved the ability of walking. However, our study had a limitation in that we not measure improvement in velocity for getting up from a chair.

After eight weeks of balance training for elderly, Jung and An\textsuperscript{7} reported that distance on the FRT test increased up to 5.56cm (LT side) and 6.73cm (RT side). In our study, the distance increased 19.3cm (non-hemi side), but there were no significant differences between the pre- and post-training scores. Lack of a significant improvement in FRT distance for our study participants could be the result of the number of years poststroke. The mean years poststroke in our study was 4.69. It is possible that participants of our study could not use proper hip strategy, because they were habituated to an incorrect hip strategy, which prevented their FRT distance from improving significantly.

Dean and Shepherd suggested task-related motor training in improving the ability to balance during seated reaching activities after stroke.\textsuperscript{23} but Van de port et al.\textsuperscript{22} supported that no significant summary effect was found for balance control. Hyndman et al.\textsuperscript{19} found the sway of people with stroke decrease under the dual task condition and changed as the difficulty of the balance task changed. So, we included the dual task condition and changed the difficulty the balance task weekly. In our study, the score of BBS was increased. The BBS is a psychometrically sound measure of balance impairment for use in post-stroke assessment.\textsuperscript{24} Therefore, after task related circuit program was benefit the improving of balance.

The improvement in BBS, TUG, FRT suggests that experimental subjects at the end of training had learned how they got the balance. There is increasing interest in the potential benefits of circuit class training after stroke, but its effectiveness is uncertain.\textsuperscript{22}

Our finding support the balance task-oriented circuit program is benefits for people with stroke. So, the clinician can select the task-oriented circuit program, which focus on improving balance, when they design the program.

A limitation of our study is that we did not screen patients according to their functional ability; instead, we recruited patients who wanted to participate in a group program. Therefore, in the future, before starting a program, patients should be screened for their ability, and a program should be administered based on their abilities.

It is possible to provide community therapy support for patients not admitted to a hospital, but to determine whether it is economically or clinically effective would require trials of adequate size. We found that task-related circuit training was effective for patients with chronic stroke, and community-based programs like ours do appear to benefit chronic patients. Such patients can participate in these types of programs without incurring economic burden or loss of time. Moreover, task-related programs attract and raise the spirits of patients, because the program consists of interesting tasks and patients encourage each other during the program.

Our community based rehabilitation program had a positive effect on motion, besides its physical effect. Therefore, we recommend a task-related program for chronic patients in a community-based program format. We hope to develop various such programs for chronic patients in the future.

V. Conclusion

We investigated the effect of a task-related circuit program on 12 stroke patients. The intervention resulted in improvements in balance ability and mobility. Significant changes in scores were observed at 12 weeks for BBS and TUG, although the change in the FRT score was small. We believe that all participants benefited from a positive group synergy effect. This study identified that task-related circuit training program on focusing balance improved balance and mobility of chronic stroke patients. Even if the patients took a program a week, they got a little improvement. This result might be due to education effect. So, task-related circuit training program on focusing balance is useful for chronic stroke patients.
Further research is needed to evaluate whether functional improvements result from group exercise, to develop promising programs such as dual task and to compare the results according to frequency of program. This will result in cost-effective options for chronic patients who may not have other treatment options due to financial difficulties. The community-based environment is an ideal setting given the nature and structure of the activities, making such programs easily adaptable to the home or community.

Author Contributions
Research design: Lee HS
Acquisition of data: Lee HS, Kim MC
Analysis and interpretation of data: Kim MC
Drafting of the manuscript: Lee HS, Kim MC
Research supervision: Kim MC

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