J. Phys. Ther. Sci.
26: 977–980, 2014

Original Article

# Effect of Gross Motor Group Exercise on Functional Status in Chronic Stroke: A Randomized Controlled Trial

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**Abstract.** [Purpose] The aim of this study was to understand the effects of task-oriented gross motor group exercise based on motor development on chronic stroke patients' joint, bone, muscle, and motor functions and activities of daily living. [Subjects] Twenty-eight stroke patients hospitalized at P municipal nursing facility for the severely handicapped were randomly assigned to the gross motor group exercise group (experimental group, n=14) or the control group (n=14). [Methods] The two groups performed morning exercise led by a trainer for 30 minutes a day, 5 times a week for 6 weeks in total. The experimental group performed a gross motor group exercise in addition to this exercise for 50 minutes a day, 3 times a week for 6 weeks in total. Before the experiment, all subjects were measured with the Modified Barthel Index (MBI) and for their neuromuscular skeletal and motor-related functions according to the International Classification of Functioning, Disability and Health. [Results] Significant improvements were found in the experimental group's neuromusculoskeletal and motor-related functions and MBI test, except for the stability of joint functions. The control group showed no significant difference from the initial evaluation. [Conclusion] The gross motor group exercise based on motor development is recommended for chronic stroke patients with severe handicaps.

**Key words:** Chronic stroke, Group exercise, ICF

*(This article was submitted Nov. 21, 2013, and was accepted Jan. 8, 2014)*

## INTRODUCTION

Functional damage in stroke patients varies with regard to kind and level of seriousness, requiring a more systematic and consistent functional evaluation. The World Health Organization presented the International Classification of Functioning, Disability and Health (ICF) as a systematic tool and unified standard classification to express the status of health and related matters[1)]. The ICF is closely correlated with other existing other evaluation tools but is capable of further explaining the kind and seriousness of a stroke patient's damage. Thus, it can be utilized as an evaluation tool for functionality status[2, 3)].

Many studies for improving joint and bone function, muscle function, and motor function in stroke patients have been carried out. Previous studies on gross motor exercise using object grasping[4)] and task-oriented training focused on specific functional task performance by associating the musculoskeletal system with the nervous system[5)] and Bobath's techniques, which are well known as neurodevelopmental treatments, have proved the effectiveness of these treatment methods. However, the effects of combined therapy composed of gross motor exercise, task-oriented training, and neurodevelopmental treatment have not been studied. Our hypothesis is that task-oriented gross motor group exercise that matches the neurodevelopment stage is more effective.

Given the above, the present study sought to suggest an effective exercise method to improve the joint, bone, muscle, and motor functions and performance of activities of daily living (ADL) in stroke by assessment with the ICF tool.

## SUBJECTS AND METHODS

This study examined 28 stroke patients hospitalized in P municipal nursing center for the severely handicapped located in Seoul, Republic of Korea. The subjects were randomly grouped into a gross motor group exercise group (n=14) and a control group (n=14). Randomization was performed with a computer using a basic random number generator. A summary of the general characteristics of the subjects is shown in Table 1.

The subjects were selected based on the following criteria: 1) chronic stroke patients who were at least 5 years after their stroke diagnosis, 2) those whose brain lesions degree was 1 or 2, 3) those whose Mini-Mental State Examination-Korean (MMSE-K) score was 20 or more, and 4) those who understood the research experiment and were capable of

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**Table 1.** General characteristics of the subjects

| Parameters | GMGEG (n=14) | CG (n=14) |
|---|---|---|
| Gender (male/female) | 14/0 (100/0) | 14/0 (100/0) |
| Affected side (Rt/Lt) | 10/4 (71.4/28.6) | 8/6 (57.1/42.9) |
| Age (years) | 58.2 ±10.3 | 55.9±10.1 |
| Height (cm) | 163.1±7.1 | 168.3±6.3 |
| Duration (years) | 11.4±2.7 | 9.4±3.1 |
| MMSE-K (score) | 22.0±0.7 | 21.6±0.5 |

Values are numbers (%) or means±SD
GMGEG, gross motor group exercise group. CG, control group

**Table 2.** Change in MBI within groups and between groups

| Group | Pre-training | Post-training | Change value (post-pre) |
|---|---|---|---|
| GMGEG (n=14) | 62.1±18.3 | 64.2±17.2* | 2.1±1.1* |
| CG (n=14) | 52.1±19.4 | 52.1±19.4 | 0±0 |

Values are means±SD. *p<0.05
GMGEG, gross motor group exercise group. CG, control group

communication.

This research was approved by the Sahmyook University's Institutional Review Board, and informed consent was received from the subjects after providing them with a sufficient explanation of the study.

This study was a single-blind study. The two groups underwent evaluation of joint and bone function, muscle function, and motor function both before and after the experiment by referring to the neuromusculoskeletal and movement-related functions in Chapter 7 of the ICF and evaluation of their self-reliance in ADL by using the Modified Barthel Index (MBI). Both of the groups performed morning exercise led by a trainer. For the morning exercise, the subjects performed a video-based exercise program with the assistance of a trainer. They performed the exercise program on their own bed in the morning for 30 minutes in total; the program comprised an introduction, warm-up, flexibility and muscle exercise, and cool-down segments, respectively, and included repetition. The actions performed included hand clapping, clapping the back of the hands, trunk twists, back/leg stretches, shoulder movements, and breathing.

The experimental group additionally performed the gross muscle group exercise for 50 minutes a day, 3 times a week for 6 weeks in total. The gross muscle exercise program comprised the 1st phase of the sensorimotor stage (ages from 0 to 2), 2nd phase of pre-operational stage (ages from 2 to 7), 3rd phase of the concrete operational stage (ages from 7 to 11), and 4th phase of the formal operational stage (ages from 11 and over) based on Piaget's cognitive development theory. Each phase consisted of elements such as power, balance maintenance, transfer ability, and coordination. Thresholds for the study were built for 6 areas: personal daily activity self-reliance, social sentiment, language development, cognitive ability, gross motor ability, and fine motor ability development.

The results of this study were processed by SPSS ver. 12.0 to produce means and standard deviations. Wilcoxon's signed-ranks test and the paired t-test were conducted to compare the groups' pre- and post-experimental differences. To analyze the difference between the groups, the independent t-test and Mann-Whitney test were run as well. The level of significance was chosen as 5% for all statistical analyses.

The MBI was employed to assess ADL of the subjects. Items from Chapter 7 of the ICF for neuromusculoskeletal and movement-related functions were used. Their subitems included joint, bone, muscle, and motor function. This assessment tool has a high correlation with other tools along with higher validity and has proved to be a useful evaluation device for a stroke patient's functional status[6, 7].

## RESULTS

The gross motor group exercise group was found to have significantly increased MBI results, increasing from 62.07 before training to 64.21 after training for a total of 2.14 points ($p<0.05$). The changes between the pre-/post-training measurements of the two groups were proven to be significant ($p<0.05$) (Table 2).

A significant change was found in the mobility of joint function test in the gross motor group exercise group (p=0.016). No change was found in the control group. The change between the pre- and post-training measurements was significantly different between the two groups (p=0.003) (Table 3).

No significant change was found in the stability of joint function test between the pre- and post-training measurements within the experimental and control groups (p=0.066). The changes between the pre- and post-training measurements were significantly different between the two groups (p=0.034).

A significant change was found in the mobility of bone function test but only in the experiment group (p=0.016). The changes between the pre- and post-training measurements were significantly different between the two groups (p=0.016)

A significant decrease was found in the muscle power function test but only in the experiment group (p=0.017). The changes between the pre- and post-training measurements indicated a significant change between the two groups (p=0.003).

A significant difference was found in the muscle tone function test but only in the experiment group (p=0.026). The changes between the pre- and post-training measurements indicated a significant change between the two groups (p=0.007).

A significant difference was found in the muscle endurance function test but only in the experiment group (p=0.011). The changes between the pre- and post-training measurements indicated a significant change between the two groups (p=0.003).

The gross motor group exercise group displayed a significant difference in movement function (p=0.041). The changes between the pre- and post-training measurements

**Table 3.** Changes of ICF function within groups and between groups (N=28)

| Group | Test | MJF | SJF | MBF | MPF | MTF | MEF | MF |
|---|---|---|---|---|---|---|---|---|
| GMGEG | Pretest | 1.2 (0.1–1.6) | 0.8 (0.0–1.4) | 1.0 (0.3–1.3) | 1.2 (0.8–1.9) | 1.1 (0.8–1.9) | 1.1 (0.6–1.6) | 1.3 (0.7–2.0) |
| (n=14) | Posttest | 0.9 (0.4–1.4)$^{a,b}$ | 0.7 (0.0–1.4)$^{b}$ | 0.8 (0.3–1.2)$^{a,b}$ | 1.1 (0.8–1.9)$^{a,b}$ | 1.1 (0.8–1.4) $^{a,b}$ | 1.0 (0.6–1.6) $^{a,b}$ | 1.2 (0.7–2.0) $^{a,b}$ |
| CG | Pretest | 1.2 (0.6–1.8) | 1.2 (0.6–1.4) | 1.1 (0.7–1.7) | 1.4 (0.9–1.9) | 1.2 (0.6–1.9) | 1.0 (0.6–1.6) | 1.3 (1.3–2.2) |
| (n=14) | Posttest | 1.2 (0.6–1.8) | 1.2 (0.6–1.4) | 1.1 (0.7–1.7) | 1.4 (0.9–1.9) | 1.2 (0.6–1.9) | 1.0 (0.6–1.6) | 1.3 (1.3–2.2) |

Values are expressed as medians (minimum value-maximum value)
$^{a}$Significant differences between the pretest and posttest. $p<0.05$
$^{b}$Significant differences between the GMGEG and CG. $p<0.05$
MJF, mobility of joint function; SJF, stability of joint function; MBF, mobility of bone function; MPF, muscle power function; MTF, muscle tone function; MEF, muscle endurance function; MF, movement function

indicated a significant change between the two groups (p=0.016).

## DISCUSSION

As a result of the experiment in the present study, we found significant improvement in post-training mobility of joint function, mobility of bone function, muscle power function, muscle tone function, muscle endurance function, control of voluntary movement, and MBI test ($p<0.05$). But no significant change was observed in stability of joint function.

The cause of movement disorder in stroke patients was considered to be spasticity until recently, and thus spasticity treatment has been dominant. But more recently, the focus has been placed on improving muscle strength, joint mobility, etc., to reach a normal level[8]. The effect of elevated muscle strength was larger on early-stage stroke patients and then decreased with stroke period[9]. However, there have been reports of a strength improvement effect in chronic stroke cases[5, 10]. In this study, the subjects had been chronic stroke cases for 9 years on average after stroke occurrence, and their muscular function (b730–b749) was improved significantly through the 6-week motor development-based task-oriented gross motor group exercise. Similar to previous studies, the task in this study was composed of power (strength of power) elements and muscular function. For this reason, it is considered to have influenced muscular function.

The task-oriented program is a kind of treatment designed based on motor learning theory and has been reported to trigger a sufficient amount of cortical sense stimulation in an undamaged cortical circuit together with the damaged part and its adjacent areas to facilitate terminal sprouting or functional connection reorganization[11]. Intentional and complicated multi-joint movements such as object grasping require many components contributing to performance such as object gazing, stretching hands out to the object, posture stabilization, and balance maintenance. Such complicated components need to be controlled and coordinated by central regulation to be aligned for the same movement goal[12]. As a way for task-oriented training, a previous study used a chair with an adjustable height to let the subjects step on and grasp food stuff on a shelf[4]. Their results were measured 4 and 12 weeks later, respectively, and the group that received stretch training showed improvement in symmetric weight distribution. This indicates that diverse components such as stretching a hand out to an object, posture stabilization, and balance maintenance were coordinated for the same single movement goal.

In this study, we found significant changes in the control of simple voluntary movement (b7600), control of complex voluntary movement (b7601), coordination of voluntary movement (b7602), and supportive function of the arm or leg (b7603). Such results, as shown in previous studies, were possible because the present study's tasks were constructed with coordination activities and because the efforts of the patients to pass the acceptance criteria of these task affected the coordination function.

The stability of joint function test in this study, means the function to support the structural frame of joints. This study found no significant change in joint stability function from before and after the training intervention. This was possibly because 9.42 years had passed on average since stroke occurrence. Suffering from power imbalance for a long time caused them to experience structural changes or soft tissue property changes.

When a stroke patient was trained with a task-oriented program, they showed significant improvements in ADL, independent activities, bowel control, and transfer[13]. Also, a significant change was observed in MBI score, and this was due to the task structure in this study, which was comprised of sitting by placing an arm on the floor, standing up for a while alone, holding an object and moving it to the other hand, standing up by using a support, standing up on one leg, throwing away an object, and kicking a ball standing still, which is helpful for ADL performance.

As this study looked into patients with first- and second-grade brain lesions only, it would be difficult to generalize the study findings to all handicapped patients with brain lesions.

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