J. Phys. Ther. Sci.
24: 519–522, 2012

The Effect of a Task-oriented Training on Trunk Control Ability, Balance and Gait of Stroke Patients

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Abstract. [Purpose] This study examined the effect on stroke patients of a task-oriented training program for trunk control ability, balance and gait. [Methods] The subjects were 20 inpatients who were randomly divided into two groups; Ten patients in the experimental group performed the task-oriented training (3 times/wk) and received general physical therapy (5 times/wk) for 4 weeks, and 10 patients in the control group received only general physical therapy (5 times/wk) for 4 weeks. The Trunk Impairment Scale, Berg Balance Scale, Timed Up & Go test (TUG), and 10 m walking time, were measured before and after the 4 weeks of therapy. [Results] The experimental group showed significant improvements in trunk control ability, balance and gait after 4 weeks of task-oriented training. Except for TUG, significant differences in trunk control ability, balance and gait were observed between the experimental and control groups. [Conclusion] This study demonstrated that task-oriented training after a stoke can improve the trunk control ability, balance and gait, which be effective in stroke rehabilitation.
Key words: Stroke, Task-oriented training, Trunk control

(This article was submitted Nov. 30, 2011, and was accepted Feb. 12, 2012)

INTRODUCTION

Stroke is a major cause of disability and handicap in adults[1)] and it usually results in some degree of muscle weakness. In addition, muscle paresis and decreases in balance and mobility are also observed[2)]. Following a decrease in balance, stroke patients show postural sway, asymmetrical production of force, and migration of the center of mass to the unaffected lower extremity[3)]. The strong relationships among the measures of balance, gait and functional ability highlight the importance of trunk rehabilitation. Trunk control has been identified as an important early predictor of activities of daily living after stroke[4)]. The activation of the trunk muscles has a relationship with gait speed and the Functional Independence Measure[5)]. Most prior studies of performance after stroke concerned with the lower or upper extremity[6, 7)]. In comparison with limb rehabilitation, trunk recovery is a rather neglected area of stroke rehabilitation research. However, Davies clearly associated a loss of selective trunk control with limitations of breathing, speech, balance, gait, and arm and hand function[8)].

In one rehabilitative approach, task-oriented training, the practice of goal-directed, functional movement is carried out in a natural environment. Task-oriented training involves a variety of practices to help patients derive optimal control strategies for solving motor problems[9)]. During task-oriented training, many types of movement are practiced, to limit compensatory movements and increase adaptive movements are increased[10)]. Task-oriented training is a method which focuses on specific functional tasks associated with the musculoskeletal and neuromuscular systems[11)]. In task-oriented training, gait and gait-related tasks are practiced using a functional approach. Moreover, there is growing evidence that intensive, task-oriented practice results in greater improvement than conventional therapy in walking competency of people with stroke[12)]. After stroke, task-oriented circuit training improves the balance, mobility[13)] and performance of locomotor tasks more than other training interventions[1)].

The present study examined the effects of task-oriented training on the trunk control ability, balance and gait of stroke patients to suggest effective training methods for the functional improvement of stroke patients.

SUBJECTS AND METHODS

The subjects were twenty patients with stroke who had been admitted to hospital and agreed with the study's aim and methods. The eligibility criteria included the following: ability to walk 10 m independently using an aid or orthotic with or without supervision or aid[14)]; and a minimum score of 20 in the Korean Mini-Mental State Examination (K-MMSE)[15)]. The exclusion criteria were joint contraction, pain or fracture of the musculoskeletal system, and hemianopsia[15)]. All the subjects signed an informed consent form (Table 1).

The twenty participants were randomly assigned to two groups: the experimental (n=10) and control groups

Table 1. General characteristics of the subjects

Variables	Experimental (n=10)	Control (n=10)
Age (year)	52.50 ± 11.72	53.40 ± 12.11
Height (cm)	168.10 ± 5.49	161.60 ± 8.37
Weight (kg)	65.50 ± 5.87	62.40 ± 10.27
Years post-stroke	7.70 ± 6.11	13.10 ± 10.62
K-MMSE	26.90 ± 3.11	26.00 ± 3.83

ns: not significant, Values: mean ± SD, K-MMSE: Korean mini-mental state evaluation

(n=10). Subjects in both groups underwent conservative physical therapy for 1 hour per day, 5 days a week, for 4 weeks. Conservative physical therapy consisted of joint mobilization, muscle strengthening, and balance training. The experimental group also participated in task-oriented training for 1 hour per day, 3 days a week, for 4 weeks.

The experimental group participated in task oriented training inspired by Dean et al.[1], which is a standardized program supervised by a physical or occupational therapist. The training consists of 10 walking-related tasks designed to strengthen the lower extremities, and enhance the walking balance, speed and distance in a progressive manner. The 10 tasks were (1) step-ups, (2) balance beam, (3) kicking a ball, (4) stand up and walk, (5) obstacle course, (6) treadmill, (7) walk and carry, (8) speed walk, (9) walk backwards, and (10) stairs. Before commencing training, the subjects warmed up for 5 minutes to improve their range of motion and flexibility. Each item was practiced for 5 minutes, and 1 minute of rest time was allowed between each item.

Outcome measurements were made of trunk control ability, gait and balance. The Trunk Impairment Scale (TIS) is a clinical test which measures the motor impairment of the trunk after stroke, and consists of three subscales: static sitting balance, dynamic sitting balance and co-ordination[16]. The Berg Balance Scale (BBS) is an objective test which measures the static and dynamic balance, and consists of 14 routine functional tasks used in activities of daily living; the score ranges from 0 to 4 for each item[17]. The Timed Up & Go test (TUG) is a measure of balance and functional mobility that predicts the risk of falls. Recently, it has been used not only to assess weak elderly people but also stroke, Parkinson's disease and arthritis patients[18]. The time taken to stand up from an armchair, walk forward 3 m, turn and return to the seated position is recorded. The 10 m walking time (10mWT) is used to measure the gait speed of patients with neurological damage. The subjects are instructed to walk 14 m at a comfortable speed and are timed using a stopwatch over the middle 10 m.

Data analysis was performed using SPSS version 12.0. The Kolmogorov-Smirnov test was used to test the normality of the subjects' characteristics and variables. The paired t test was used to compare the trunk control ability, balance and gait between pre- and post-intervention. The independent t test was used to test the differences between the experimental and control groups. A p value < 0.05 was considered significant.

RESULTS

After the completion of 4 weeks of the intervention, the TIS was significantly higher than before the intervention in both groups ($p<0.05$), and it showed a significant difference between the experimental and control groups ($p<0.05$). A comparison of the subscales of the TIS revealed the experimental group showed increases in dynamic balance (from 6.20 to 7.90) and coordination (from 2.50 to 3.90), whereas the control group showed only an increased in dynamic balance ($p<0.05$). Post-intervention, BBS was significantly higher than before intervention in both groups ($p<0.05$). BBS showed a significant difference between the experimental (50.10) and control group (44.60) after the intervention ($p<0.05$). The TUG was significantly higher than before the intervention in both groups ($p<0.05$). After the intervention, the experimental group showed a greater improvement than the control group, but the difference between the two groups was not significant. Post-intervention, 10mWT was significantly higher than that before the intervention in both groups ($p<0.05$), and it showed a significant difference between the experimental (20.22s) and control groups (26.19) after the intervention ($p<0.05$) (Tables 2 and 3).

DISCUSSION

This study examined the effects of task-oriented training for stroke patients on gait, balance and ability of trunk control to suggest a proper approach for improving functional movements after stroke.

In this study, TIS was used to evaluate the ability of trunk control. After the experiment, there was a significant difference in the ability of trunk control between the two groups. The increase in TIS was significantly larger in the experimental group than in the control group. Therefore, task-oriented training was effective at improving the ability of trunk control. The present study examined the relationships between task-oriented training and static and dynamic control, and coordination. In static control, there was some difference between the two groups but it was not significant. This is because all subjects in this study were able to walk independently, so they had no difficulties in maintaining static sitting balance. The two groups showed significant post-intervention improvements in dynamic control but there was no significant difference between the two groups. Only the experimental group showed a significant improvement in coordination between pre- and post-intervention. The coordination assessment of TIS consists of upper and lower trunk rotation. In the task-oriented training of this study, several items for balance and lower extremity strength were done by changing position in the frontal, sagittal, and horizontal planes. To enable efficient walking, trunk rotation between the shoulder and pelvic girdle is needed. Trunk function implies more than just sitting balance stability and selective movements of the trunk in flexion, extension, lateral flexion, and rotation are important aspects as well. The TIS is measured in the sitting position, so it has a limitation in that lying or standing are not evaluated. Another limitation is that the TIS contains items for the compensatory movement of

Table 2. Comparison of the variables between the two groups

Measures	Training	Values Experimental (n=10)	Control (n=10)
TIS	Pre-	15.10 ± 3.25	14.70 ± 4.30
	Post-	18.50 ± 2.37*	16.40 ± 4.67*,**
BBS	Pre-	43.20 ± 5.05	42.10 ± 10.89
	Post-	50.10 ± 4.12*	44.60 ± 10.17*,**
TUG	Pre-	29.84 ± 13.32	39.10 ± 14.97
	Post-	24.15 ± 12.11*	33.96 ± 13.91*
10mWT	Pre-	25.76 ± 12.56	28.12 ± 10.96
	Post-	20.22 ± 10.69*	26.19 ± 11.09*,**

Values: mean ± SD, TIS: Trunk impairment scale, BBS: Berg balance scale, TUG: Timed Up & Go test, 10mWT: 10m walking time, *p<0.05, between pre- and post-training, **p<0.05, between the experimental and control groups

Table 3. Comparison of the subscales of TIS between the two groups

Measures	Training	Values Experimental (n=10)	Control (n=10)
Static sitting	Pre-	6.40 ± 0.70	6.20 ± 0.79
Balance (A)	Post-	6.70 ± 0.48	6.40 ± 0.70
Dynamic sitting	Pre-	6.20 ± 1.69	6.10 ± 2.56
Balance (B)	Post-	7.90 ± 1.29*	7.00 ± 2.58*
Coordination (C)	Pre-	2.50 ± 1.43	2.40 ± 1.78
	Post-	3.90 ± 1.20*	3.00 ± 1.70
Total (A+B+C)	Pre-	15.10 ± 3.25	14.70 ± 4.30
	Post-	18.50 ± 2.37*	16.40 ± 4.67*,**

Values: mean ± SD, *p<0.05, between pre- and post-training, **p<0.05, between the experimental and control group after test

the trunk but it does not assess subjective factors. Therefore, another study will be needed to obtain subjective measurements that evaluate the musculoskeletal activities and compensatory movements of the trunk.

In the BBS, the general functional balance scale, there were significant improvements in both groups, and the change in the experimental group was significantly larger than that in the control group. Kim et al. reported that task-oriented training on a mobile surface for stroke patients increased their dynamic balance[15]. Alain et al. reported that task-oriented training for stroke chronic stroke patients increased BBS scores significantly from 48.3 ± 5.9 to 51.1 ± 5.1[19]. These results are in agreement with those of to the present study and show that task-oriented training can improve balance. These results also suggest that dynamic task-oriented training effects the equilibrium and weight-shifting of stroke patients, which should assist in the recovery of balance. Future studies will be needed to determine the factors that affect balance such as vestibular function, proprioception, the musculoskeletal system and cognition[20].

Both groups showed significant improvements in TUG and 10mWT after the intervention but the experimental group showed greater improvements than the control group. Cho et al. reported that after task-oriented training, the walking speed of stroke patients was increased significantly from 2.88 m/s to 3.74 m/s[21], and Alain et al. reported that the 10mWT decreased significantly from 25.2 ± 14.4 s to 20.8 ± 10.5 s[19]. Yang et al. stated that the gait speed of stroke patients was increased significantly from 0.84 ± 12.7 m/s to 0.92 ± 13.5 m/s by task-oriented progressive resistance strength training[13]. These results are similar to those of the present study and show that task-oriented training can be an effective intervention for the gait of stroke patients. Previous studies have reported stroke patients showed improved gait ability after being given the proper loading and resistance in TUG, but the present study did not consider the resistance. Both groups showed significant improvements an after the intervention but there was no significant difference between the two groups. Yang et al. reported that experimental group showed a significant decrease in the TUG time[11], while Dean et al. and Nancy et al. reported no significant differences between their experimental and control groups[1]. In the present study, task-oriented training was effective at reducing the 10mWT but it is unclear if the task-oriented training was significantly more effective than the conservative physical therapy. Nancy et al. and Dean et al. suggested that the sit-to-stand task was reinforced by task-oriented training[1]. In the present study, the stand up and walk task was performed but a suitable training time and repetition for each subject were needed. Therefore, when starting task-oriented training, the training duration and repetition number for each item should be considered, and subjective and standardized criteria for the time and number of repetitions for each item will be needed in future studies.

This study examined the effect of task-oriented training on trunk control ability, balance and gait of stroke patients. Task-oriented training was effective at enhancing trunk control ability, and gait and balance also improved significantly. Therefore, we consider that task-oriented training with general physical therapy is an effective intervention for stroke patients. Future studies need to determine when a specific intensity task or standard loading task in a task-oriented training program should be performed. In addition, more study will be needed to examine the factors of trunk stability that affect the correlation of trunk control ability and gait.

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