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Original Article

Effect of bilateral upper extremity exercise on trunk performance in patients with stroke

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Abstract. [Purpose] The aim of this study was to investigate the effect of bilateral upper extremity exercises on trunk performance in patients with stroke. [Subjects and Methods] Twenty in-patients with chronic stroke of at least 6 month's duration participated in this study. Patients in the experimental and control groups received neurological rehabilitation treatment for stroke. In addition to the neurological rehabilitation treatment, patients in the experimental group received 30 minutes of bilateral upper extremity exercises 3 times weekly for 4 weeks. Outcomes were measured using the Trunk Impairment Scale before and after the 4-week training period. [Results] Significant intragroup differences in all items of Trunk Impairment Scale were observed after intervention. In particular, significant intergroup differences were observed for dynamic sitting balance, trunk coordination, and between total scores of the Trunk Impairment Scale. [Conclusion] The results of this study suggest bilateral upper extremity exercises could be used in addition to trunk exercises to improve trunk performance in patients with stroke.

Key words: Stroke, Bilateral upper extremity exercise, Trunk performance

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INTRODUCTION

A stroke is a neurological disease caused by a disturbance in blood supply to the brain[1)]. Stroke results in weakness and paresis in contralateral limbs and axial musculature[2)]. In addition, sitting balance and selective trunk movements remain impaired after stroke[3)]. It has also been reported stroke patients exhibit a significant decrease in trunk performance as compared with matched healthy individuals[4)]. Although trunk performance is considered to be less affected than those of the upper and lower extremities[5)], poor recovery of trunk performance results in severe disability and reduces the activities of daily living[2)].

In the context of stroke rehabilitation, trunk control is an indispensable basic motor ability for the execution of many functional tasks[6)], and convincing evidence indicates trunk performance is an important predictor of functional outcome after stroke[7)]. Some authors have defined trunk performance as the ability to control trunk movement and balance while sitting and standing[8–11)], and a recent study showed clear relations between trunk performance and measures of balance, gait, and functional ability in patients with stroke[12)].

Despite evidence of the importance of trunk performance in stroke rehabilitation, relatively few studies have attempted to evaluate therapies aimed at improving trunk function. Therefore, this study was undertaken to investigate the effect of additional upper extremity exercises on trunk performance in patients with stroke.

SUBJECTS AND METHODS

Twenty in-patients at a hospital in the city of Busan participated in the study. Subjects with chronic stroke of at least 6 month's duration were included in the study if they met the following criteria: 1) had unilateral hemiparesis as a result of

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Table 1. Baseline characteristics of the subjects

	Experimental group (n=10)	Control group (n=10)
Age (years)	56.0 ± 7.2†	59.0 ± 8.4†
Gender (male/female)	6/4	5/5
Paretic side (left/right)	3/7	6/4
Post-stroke duration (months)	11.6 ± 3.4†	15.0 ± 4.7†

†Values are means ± standard deviation

Table 2. Outcome measures

	Experimental group (n=10)		Control group (n=10)	
	Pre-training	Post-training	Pre-training	Post-training
Trunk Impairment Scale (0–23)	11.3 ± 3.4	15.9 ± 3.3*†	12.4 ± 3.9	14.8 ± 3.7*
Static sitting balance (0–7)	4.9 ± 1.0	6.5 ± 0.3*	5.9 ± 0.6	6.4 ± 0.7*
Dynamic sitting balance (0–10)	4.1 ± 1.3	5.7 ± 1.9*†	4.3 ± 1.6	5.0 ± 1.9*
Trunk coordination (0–6)	2.7 ± 1.1	4.9 ± 1.4*†	2.8 ± 1.4	3.1 ± 1.4*

†Values are means ± standard deviation.
*p significant vs. post-training (p<0.05)

stroke, 2) had a K-MMSE (Korean mini-mental state examination) score exceeding 24 points, 3) were able to remain in a sitting position without support, and 4) reported no cardiac, respiratory, or neuromuscular condition that would interfere with performing the testing protocol. All participants meeting the inclusion criteria were given verbal and written information on the purpose of this study, and provided written informed consent. In addition, the human rights of the subjects were protected.

Prior to initial evaluation, participants were equally allocated by simple randomization to an experimental or a control group. Patients in the experimental and control groups received neurological rehabilitation treatment for stroke, which consisted mainly of physical therapy, by the rehabilitation center at our hospital. In addition to neurological rehabilitation treatment, patients in the experimental group received 30 minutes of extra training 3 times weekly for 4 weeks. The additional exercise consisted of movements of the upper extremities and trunk in a sitting position. The exercise was performed in a specific order[13)] and supervised by a therapist to prevent the patients from falling during all sessions.

The Trunk Impairment Scale (TIS) was used to assess outcomes. The TIS contains 17 sub-items in three categories: static sitting balance, dynamic sitting balance, and coordination. This tool can be used to evaluate degree of trunk motor impairment after stroke. The highest possible TIS score is 23 points, with 0–7 possible points for static sitting balance, 0–10 points for dynamic sitting balance, and 0–6 points for coordination, whereas a higher score indicates better trunk performance[14)].

Statistical analyses were performed using PASW for Windows 18.0. The Wilcoxon signed-rank test was used to determine whether TIS scores changed within each group before and after intervention, and the Mann-Whitney test was used to determine the significances of intergroup differences. Level of significance was set at 5% ($p<0.05$), and results are expressed as mean values ± standard deviations (SDs).

RESULTS

Baseline subject characteristics are summarized in Table 1. Measured characteristics were no different in the two groups. The results for all outcome measures are provided in Table 2. Significant intragroup differences in all items of the TIS were observed in both groups after intervention ($p<0.05$), and significant intergroup differences were observed between dynamic sitting balance, and trunk coordination, and between total TIS scores ($p<0.05$) (Table 3).

DISCUSSION

The purpose of this study was to determine the effect of additional exercises on trunk performance in patients with stroke. Patients in both groups received neurological rehabilitation treatment for stroke, but patients in the experimental group also received 6 hours of bilateral upper extremity activities as additional exercise over a 4-week period.

Bilateral upper extremity activities require that unaffected upper extremities guide affected upper limbs in order to improve mobility and trunk control in affected sides[15)]. Researchers have also reported that bilateral upper extremity activities reduced stiffening of damaged arms and associated reactions during passive movements, and induced symmetrical movements to activate trunk activity[16)]. Hodges et al. observed that trunk muscles are activated before movement of upper extremities[17)], and Lehman et al. reported that movement of upper extremities are associated with trunk muscle activity[18)]. It has also been

Table 3. Between-group comparison

	Experimental group (n=10)	Control group (n=10)
Trunk Impairment Scale (0–23)	4.6 ± 0.3	2.4 ± 0.4*
Static sitting balance (0–7)	1.6 ± 0.1	0.5 ± 0.1
Dynamic sitting balance (0–10)	1.6 ± 0.2	0.7 ± 0.2*
Trunk coordination (0–6)	2.2 ± 0.1	0.3 ± 0.1*

Values are mean ± standard deviation.
*p significant between groups after training (p<0.05)

reported controlled movements of upper extremities activate trunk muscles[19].

Significant intragroup differences were found for total TIS scores and all three TIS subscales in the experimental and control groups after intervention, which indicates neurological rehabilitation treatment and bilateral upper extremity activities can effectively improve trunk performance in stroke patients. It was also found that bilateral upper extremity activities aimed at improving trunk performance resulted in short-term improvements above those achieved by neurological rehabilitation treatment alone, in dynamic sitting balance, trunk coordination, and total TIS scores. These findings are consistent with previously published results that trunk control in stroke patients affects TIS subscales associated with dynamic balance and coordination[20]. Michaelsen et al. indicated that limitation of compensatory trunk movement may be an essential element during task-related training of upper extremities particularly for chronic patients with hemiparesis[21], and bilateral upper extremity exercise was suggested to decrease the need of trunk involvement[22]. It was also demonstrated that bilateral upper extremity training had beneficial effect on reducing trunk compensation[23].

The results of this study are subject to several limitations. First, the small sample size prevents the generalization of results to all stroke patients, and thus, we suggest further larger scale studies be undertaken to confirm our results. Second, neither the patients nor the physiotherapist that administered the interventions were blinded, which may have introduced bias. Third, we only analyzed the data obtained at pre- and 4-week post-treatment assessments. Future studies are required to evaluate the long-term effects of additional bilateral upper extremity activities. Finally, our control group did not receive placebo therapy, and therefore, received less therapy than the experimental group. Nonetheless, our findings suggest bilateral upper extremity activities, in addition to trunk exercises, have a significant beneficial effect on trunk performance in stroke patients.

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