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Original Article

Effects of proprioceptive neuromuscular facilitation neck pattern exercise on the ability to control the trunk and maintain balance in chronic stroke patients

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Abstract. [Purpose] The aim of this study was to investigate the effects of proprioceptive neuromuscular facilitation neck pattern exercise on the ability to control the trunk and balance in chronic stroke patients. [Subjects and Methods] A total of 30 study subjects were selected and randomly divided into an experimental group of 15 subjects, who received the proprioceptive neuromuscular facilitation neck pattern exercise, and a control group of 15 subjects, who received a traditional rehabilitation treatment. [Results] Statistically significant changes in all the items of the Trunk Impairment Scale, the Trunk Impairment Scale total score, and the Berg Balance Scale were observed in both the experimental group and the control group. significant between-group differences were found in all items among the subitems of the Trunk Impairment Scale except the static sitting balance. [Conclusion] Proprioceptive neuromuscular facilitation neck pattern exercise was shown to have a positive effect on increasing the ability to control the trunk and maintain balance in chronic stroke patients.

Key words: PNF neck pattern, Balance, Stroke

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INTRODUCTION

Control of the trunk of the body is a necessary condition for humans to maintain their balance against gravity[1)]. However, patients with stroke caused by brain damage experience a diminished ability to balance because of the weakened muscle strength of the trunk[2)]. Training to control the trunk and maintain balance is essential for functional improvement in chronic stroke patients[3)]. Improved trunk control enhances the ability to balance, which is a necessary condition for the prevention of falling. Hence, the probability of falling is decreased because the ability to maintain balance is enhanced[4)].

Proprioceptive neuromuscular facilitation (PNF) improves the functions of the muscles and tendons by stimulating the proprioceptive sense, which enhances muscle strength, flexibility, and balance[5)]. Neck pattern exercises are known to increase the stability of the head and neck[6)]. The resistance against the neck exercise causes irradiation in the body-trunk muscle exercise[7)]. However, few studies have investigated the improvement in trunk control in chronic stroke patients as a result of using the PNF neck pattern.

Hence, the purpose of this study was to examine the effects of the PNF neck pattern exercise on the ability to control the trunk and balance in chronic stroke patients.

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SUBJECTS AND METHODS

The subjects of this study were patients who were diagnosed with stroke through CT or MRI at Hospital F located in Daegu, Korea, between January and July 2015 (Table 1). The subjects had a duration of illness of six months or longer, a MMSE-K score over 24, manual muscle testing results for neck flexion and extension graded as better than fair, and the ability to sit and stand independently. Those who were incapable of training, including patients with high-risk heart disease or musculoskeletal disease, were excluded from the sample. Prior to the experiment, the Institutional Review Board (IRB) at Daegu Fatima Hospital approved the study. This research was conducted after signed agreements to participate in the study were received from the patients and their guardians.

After 30 research subjects were selected, they were divided randomly and evenly into an experimental group in which the PNF neck pattern was applied and a control group in which traditional rehabilitation therapy was applied. Traditional rehabilitation therapy was applied daily for 30 minutes to both groups five times a week for six weeks. The experimental group received additional application of the PNF neck pattern, while the control group received additional application of 30 minutes more traditional rehabilitation therapy per day, three times a week for six weeks. One physiotherapist conducted all the exercises, which are described below.

First, the patients were instructed to assume the preparation position. The patients sat on a mat that was knee height with their feet placed shoulder width apart and their hands on their knees. For the neck pattern, both the flexion pattern and extension pattern were performed. The neck-flexion pattern exercise was performed as follows. The experimenter stood behind the patient on the right side and put the tip of his right finger below the chin of the patient. The experimenter then put his left hand slightly left of the top of the patient's head in a diagonal direction. The experimenter pulled the patient's chin so that it was lifted and the neck was extended. Hence, in the preparation position, the patient's head was tilted and rotated towards the right side. The preliminary exercise was performed with sufficient explanation so that the patient could accurately recognize the exercise direction. The experimenter then issued the following instructions to the patient: "pull your chin in" and "look at your left hip." Hence, the patient's head, neck, and upper thoracic spine had sufficient extension, left rotation, and left lateral flexion. The experimenter provided resistance against left rotation, flexion, and lateral flexion by providing traction to the patient's chin. The identical method was applied on the opposite side.

For the neck extension pattern, the preparation position was the same as described above. The experimenter stood behind the patient on the right side. He put his right thumb on the right side of the patient's chin and placed his left hand slightly right of the top of the patient's head in a diagonal direction. The patient assumed the preparation position in which the chin was pulled, the neck was flexed, and the head was rotated and tilted to the left. The experimenter issued the following instructions to the patient: "lift your chin" and then "lift your head to look above." Hence, the patient's head, neck, and upper thoracic spine had complete extension, right rotation, and right lateral flexion. Resistance against right rotation, extension, and lateral flexion was provided during the exercise in order to induce strong muscle contractions.

In this study, the Trunk Impairment Scale (TIS) was used to evaluate the ability to control the trunk. The TIS consists of 17 subitems in three categories: static sitting balance, dynamic sitting balance, and coordination. Because the TIS has high reliability and validity, it is used to evaluate the degree of motor damage to the trunk in stroke patients[8]. In the TIS, static sitting balance has a minimum score of zero and a maximum score of seven, dynamic sitting balance has a minimum score of zero and a maximum score of 10, and coordination has a minimum score of zero and a maximum score of 6; the maximum TIS score is 23. The Berg Balance Scale (BBS), which has proven reliability and validity, was used to examine the ability of patients to balance before and after the exercise[9]. The BBS consists of 14 items, each of which has a minimum score of zero and a maximum score of four; the maximum score is 56.

PASW Statistics for Windows 18.0 was used to analyze results of the experiments. The nonparametric Wilcoxon signed-rank test was performed to compare the TIS and BBS scores before and after the intervention. The nonparametric Mann-Whitney test was performed for comparisons between groups. The statistical significance level α was set at 0.05.

RESULTS

Statistically significant changes in all items of the TIS, TIS total score, and BBS were observed in both the experimental group and the control group ($p<0.05$) (Table 2). Table 3 shows the comparison results according to the therapy method. A significant between-group difference was found in all items among the subitems of the TIS except the static sitting balance ($p<0.05$).

DISCUSSION

Selective control of the trunk affects breathing, speaking, balancing, walking, and the functions of the hands and the upper limbs[10]. Improvement in the ability to control the trunk is necessary to enhance the ability to balance in chronic stroke patients[11]. Hence, this study applied the PNF neck pattern to chronic stroke patients in order to investigate the effects on their ability to control the trunk and to maintain balance.

Table 1. General characteristics of the subjects (Mean±SD)

	Experiment group (n=15)	Control group (n=15)
Age (years)	59.4±9.1	55.9±9.8
After onset (months)	11.2±3.6	10.9±3.5
Gender (M/F)	5 /10	7 /8
Side (R/L)	7 /8	9 /6

Table 2. Comparison between before and after the intervention

	Experiment group (n=15)		Control group (n=15)	
	Before	After	Before	After
BBS	41.8±4.2	47.6±3.3*	42.0±4.3	44.6±4.3*
TIS				
Static sitting	6.2±1.0	6.8±0.3*	6.3±0.7	6.6±0.6*
Dynamic sitting	4.3±1.8	6.5±1.9*	6.4±1.7	5.3±1.8*
Coordination	3.5±1.3	5.1±1.6*	3.2±1.2	3.8±1.4*
Total	14.0±3.4	18.5±3.3*	14.0±3.0	15.7±3.1*

*p<0.05. BBS: Berg Balance Scale; TIS: Trunk Impairment Scale

Table 3. Comparison of effects between the groups

	Experiment group (n=15)	Control group (n=15)
BBS	−5.8±2.3	−2.6±1.6*
TIS		
Static sitting	−0.6±0.9	−0.2±0.4
Dynamic sitting	−2.2±1.4	−0.9±0.8*
Coordination	−1.6±0.7	−0.5±0.5*
Total	−4.4±1.8	−1.7±1.0*

*p<0.05. BBS: Berg Balance Scale; TIS: Trunk Impairment Scale

Mobility and ability of the trunk to maintain balance are important factors in the functional independence of stroke patients[12]. Moreover, improved motor control of the trunk is known to assist independent performance of daily tasks in stroke patients[13]. Both the experimental group and the control group showed a significant difference in the BBS and TIS after the intervention. This implies that both traditional rehabilitation therapy and PNF neck pattern exercises are effective in enhancing the ability of chronic stroke patients to control the trunk and to maintain balance.

Using the TIS, Park predicted falling among patients with subacute stroke, reporting that a TIS score between 14.5 and 15.5 corresponded to the range of risk for falling[14]. In the present study, both groups showed average TIS scores of 14.0 before the intervention, which was within the range of risk for falling. After the intervention, the average improved to 18.5 in the experimental group and 15.7 in the control group. The improvement in both groups exceeded the range of risk for falling. The experimental group showed greater improvement than the control group did. It is possible that the PNF neck pattern exercise contributed to the ability to control the trunk and maintain balance more than the traditional rehabilitation therapy did, eventually decreasing the risk of falling. Moreover, Park observed that better TIS dynamic sitting balance was connected to a lower risk of falling. In the present study, significant results were found for all items except TIS static sitting in the between-group comparison. This indicates that the PNF neck pattern exercise resulted in stronger improvement in TIS dynamic sitting balance, TIS coordination, and BBS scores compared with the traditional rehabilitation therapy. In particular, the improvement in dynamic sitting balancing was expected to contribute to the prevention of falling[14]

Overall, the PNF neck pattern exercise was shown to have a positive effect on increasing the ability to control the trunk and maintain balance in the chronic stroke patients in this study. However, because of the small number of subjects, the results of the study cannot be generalized. Thus, in future research, studies should be conducted to apply the PNF neck pattern exercise to a large sample of chronic stroke patients.

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