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Original Article

The effects of upper extremity task training with symmetric abdominal muscle contraction on trunk stability and balance in chronic stroke patients

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Abstract. [Purpose] The purpose of this study is to examine the effects of upper extremity task training employing the bracing method on the trunk control and balance of stroke patients. [Subjects and Methods] The subjects were 46 stroke patients whose strokes had occurred six months or more prior to the study. The subjects were divided into two groups. One group underwent upper extremity task training with symmetric abdominal muscle contraction (bracing) applied. The other group simply underwent upper extremity task training, without bracing. [Results] The experimental group's Trunk Impairment Scale (TIS) significantly increased after the intervention, whereas the control group did not see any significant difference. There was significant improvement in balance after the intervention in both the experimental group and the control group. According to the between-group comparisons, the improvements in the experimental group were significantly greater in the control group, except in the Postural Assessment Scale (PASS). [Conclusion] Based on the results of this study, upper extremity task exercises with symmetric abdominal muscle contraction, conducted as part of adult hemiplegic patients' trunk stabilization exercises, can be applied to a diverse range of hemiplegic patients and implemented as an exercise program after discharge from hospital.

Key words: Abdominal muscle, Trunk stability, Balance

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INTRODUCTION

A stroke is a central nervous system disease that has a serious impact on individuals' lives[1)]. Depending on the lesion area, strokes cause diverse and complex functional disabilities, including decreased motor function, sensory loss, and impaired balance ability[2, 3)]. Stroke patients also experience restricted performance of the functional motions necessary for ordinary life, and reduced gait ability[4, 5)].

To support the many body postures needed in everyday life, maintenance of appropriate trunk muscle strength and endurance are very important[6)]. The abdominal and trunk muscles maintain the stability of the lower trunk, and they are important for trunk movement and motor control[7)]. Dickstein et al.[8)] demonstrated the significance of trunk muscles by verifying a decrease in anticipatory postural adjustments in hemiplegic patients compared to healthy subjects, based on a comparison of left and right trunk muscle onset time through movement of the upper and lower extremities. Therefore, to improve the abilities of chronic stroke patients, it is important to ensure functioning postural stability during movement training. This requires activation of the trunk muscles. A representative technique for achieving this is the bracing method. Bracing involves stabilizing the trunk by increasing internal abdominal pressure through the action activation of 29 pairs of deep and superficial muscles[9)]. Accordingly, this study examined the effects of upper extremity task training with the bracing method applied on trunk adjustment ability and balance in stroke patients.

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Table 1. General characteristics of the subjects

		Experimental group (n=23)	Control group (n=23)
Age (yrs)		60.4 ± 10.5[a]	58.1 ± 10.7
Height (cm)		164.0 ± 8.6	164.4 ± 8.2
Weight (kg)		65.8 ± 10.5	63.5 ± 9.8
Gender	Male	13 (56.5)[b]	14 (60.9)
	Female	10 (43.5)	9 (39.1)
Affected side	Left	7 (30.0)	10 (43.5)
	Right	16 (69.6)	13 (56.5)
Time since stroke (months)		17.7 ± 10.4	16.5 ± 11.2

[a]Mean ± standard deviation; [b]n (%)

SUBJECTS AND METHODS

As subjects, this study selected 46 non-traumatic hemiplegic stroke patients in at R, H, and B hospitals whose onset of stroke had occurred at least six months earlier. All demonstrated an understanding of the experimental process before they agreed to participate in the experiment. (All scored at least 24 on the Korean version of the mini-mental state examination.) They were able to sit unassisted for five minutes or longer without special equipment. The subjects were able to understand and follow the therapist's directions and had no other neurological problems (vision, hearing, other senses) or orthopedic damage (Table 1). All protocols were approved by the University of Daejeon. Before participation, the procedures, risks, and benefits were explained to the participants, who gave informed consent. Participant rights were protected according to the guidelines of the University of Daejeon.

The subjects of the experimental group (upper extremity task-training group with symmetric abdominal muscle contraction) received upper extremity task training while maintaining symmetric abdominal muscle contraction (referred to here as "bracing"). They made brief "ch" sounds while they concurrently contracted left and right and forward and backward trunk muscles isometrically for five seconds as if force was given to the abdomen reflexively, and while maintaining hallow respiration. The subjects also engaged in upper extremity task training.

The control group (general upper extremity task-training group) received upper extremity task training. During the training, each subject sat on a chair with the back. They flexed the hip, knee, and ankle joints of both lower extremities by 90 degrees and placed both feet on the floor. They were instructed to utilize only the paretic upper extremity and were assisted in the movement so that they did not exert compensatory strategies. Six numbered tasks were performed in sequence for five to six minutes. The order and duration of the tasks were adjusted according to the subject's function. For example, subjects who showed good function in one task were asked to stop and move on to the next task. If they were not able to perform the next task due to poor function, they performed the previous task for an extended amount of time.

The Postural Assessment Scale for Stroke (PASS) and Trunk Impairment Scale (TIS) were utilized to evaluate subjects' postures and assess balance. The Balance Performance Monitor (BPM) was employed and BioRescue software (AP 1153 RM Ingenierie, Rodez, France) was utilized to evaluate static balance ability and limit of stability (LOS).

PASW Statistics 18.0 for Windows (IBM/SPSS Inc, Chicago, IL, USA) was used for all statistical analyses performed in this study. The general characteristics of each group were analyzed using a χ^2 test and an independent t-test. To compare differences in pre- and post-training results between the two groups over time, an independent samples t-test was utilized. To determine the statistical significance of data over time within each group, a paired t-test was employed. A statistical significance level was set at α=0.05 for all data.

RESULTS

Table 2 shows the results of posture comparisons between the experimental group and the control group before and after intervention. The experimental group's TIS scores significantly increased after the intervention ($p<0.05$), whereas the control group did not see any significant difference. Table 3 displays the results of a comparison of pre- and post-intervention balance evaluations between the groups. There was significant improvement in balance after the intervention in both the experimental group and the control group. According to the between-group comparisons, the improvements in the experimental group were significantly greater in the control group ($p<0.05$), except in the Postural Assessment Scale (PASS) ($p>0.05$).

DISCUSSION

This study applied upper extremity task training with symmetric abdominal muscle contraction as a method of improving postural adjustment in adult hemiplegic patients and examined its effect on postural adjustment. The pre- and post-exercise values of TIS scores were significantly different in both groups, and a significant difference was seen between the two groups.

Table 2. A comparison of postural assessment scale for stroke, trunk impairment scale scores

		Experimental group (n=23)	Control group (n=23)
PASS (score)	Pre-test	21.7 ± 7.4[a]	21.0 ± 7.0
	Post-test	22.4 ± 7.0	21.5 ± 6.7
TIS (score)	Pre-test	13.0 ± 4.3	12.5 ± 4.6
	Post-test	14.4 ± 4.3*+	13.1 ± 4.4

[a]Mean ± standard deviation
*Significant difference within group (pre-test vs. post-test)
+Significant difference between groups (experimental group vs. control group)

Table 3. A comparison of center of pressure and limit of stability

		Experimental group (n=23)	Control group (n=23)
COP (cm)	Pre-test	5.39 ± 2.82[a]	5.65 ± 3.13
	Post-test	3.98 ± 2.31*+	4.80 ± 2.93*
LOS (mm^2)	Pre-test	8,443.4 ± 1,545.7	8,440.4 ± 1,573.3
	Post-test	8,866.0 ± 1,611.0*+	8,651.0 ± 1,610.7*

[a]Mean ± standard deviation
*Significant difference within group (pre-test vs. post-test)
+Significant difference between groups (experimental group vs. control group)

A study by Allison et al.[10] featuring bracing-assisted trunk stabilization exercises showed heightened activity of the trunk muscles and improved trunk function, which is consistent with the results of the present study. The stroke postural evaluation scores of both groups increased, but no significant difference was seen between them. This is consistent with a study of sub-acute state patients by Benaim et al.[11], which showed that a short intervention period of six weeks resulted in no significant difference. In the static balance test, significant differences were seen within both groups in pre- and post-exercise results, as well as in the scores between the two groups. This is consistent with the results of research by Brown et al.[12], which show that short muscle contraction initiation times enabled anticipatory postural adjustments, and that postural adjustment affected balance. In the LOS test, both groups saw significant differences in pre- and post-exercise results; a significant difference was also seen between the results of the two groups after the exercise. Hodge and Richardson[13] report that intervention in the deep abdominal muscles through trunk stabilization exercises was more effective than other forms of exercise in achieving improved movement of the four limbs and postural adjustment ability; this is consistent with the present study's results. The limitations of this study were the short intervention period of six weeks and the small number of experimental participants satisfying selection criteria. Based on the results of this study, upper limb task training with symmetric abdominal muscle contraction, applied as part of trunk stabilization exercises in adult hemiplegic patients, may be applied to diverse hemiplegic patients in the clinical field and be implemented as an exercise program for them after discharge from hospital.

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REFERENCES

1) Warlow CP, van Gijn J, Dennis MS: Stroke: practical management, 3rd ed. New Jersey: Blackwell Publishing, 2008.
2) Glen G: Cerebrovascular accident stroke. Occupational therapy—practice skills for physical dysfunction, 6th ed. Missouri: Mosby Elsevier, 2006.
3) Carr J, Shepherd R: Stroke rehabilitation. Guidelines for exercise and training to optimize motor skills, 1st ed. Philadelphia: Elsevier, 2003.
4) Geurts AC, de Haart M, van Nes IJ, et al.: A review of standing balance recovery from stroke. Gait Posture, 2005, 22: 267–281. [Medline] [CrossRef]
5) Johansson BB: Current trends in stroke rehabilitation. A review with focus on brain plasticity. Acta Neurol Scand, 2011, 123: 147–159. [Medline] [CrossRef]
6) Handa N, Yamamoto H, Tani T, et al.: The effect of trunk muscle exercises in patients over 40 years of age with chronic low back pain. J Orthop Sci, 2000, 5: 210–216. [Medline] [CrossRef]
7) Hodges PW, Gurfinkel VS, Brumagne S, et al.: Coexistence of stability and mobility in postural control: evidence from postural compensation for respiration. Exp Brain Res, 2002, 144: 293–302. [Medline] [CrossRef]
8) Dickstein R, Shefi S, Marcovitz E, et al.: Anticipatory postural adjustment in selected trunk muscles in post stroke hemiparetic patients. Arch Phys Med Rehabil, 2004, 85: 261–267. [Medline] [CrossRef]
9) McGill SM: Low back stability: from formal description to issues for performance and rehabilitation. Exerc Sport Sci Rev, 2001, 29: 26–31. [Medline] [CrossRef]
10) Allison GT, Godfrey P, Robinson G: EMG signal amplitude assessment during abdominal bracing and hollowing. J Electromyogr Kinesiol, 1998, 8: 51–57. [Medline] [CrossRef]
11) Benaim C, Pérennou DA, Villy J, et al.: Validation of a standardized assessment of postural control in stroke patients: the Postural Assessment Scale for Stroke Patients (PASS). Stroke, 1999, 30: 1862–1868. [Medline] [CrossRef]
12) Brown JE, Frank JS: Influence of event anticipation on postural actions accompanying voluntary movement. Exp Brain Res, 1987, 67: 645–650. [Medline] [CrossRef]
13) Hodges PW, Richardson CA: Contraction of the abdominal muscles associated with movement of the lower limb. Phys Ther, 1997*a*, 77: 132–142, discussion 142–144. [Medline]