

Effects of Respiratory Muscle Activity in Stroke Patients after Feedback Breathing Exercise

The purpose of this study is to examine the effects of feedback breathing exercise on respiratory muscle activity. Thirty stroke patients were randomly and equally assigned to an experimental group and a control group. The experimental group received rehabilitation exercise treatment for 30 minutes and feedback respiratory exercise for 30 minutes and the control group received rehabilitation exercise treatment for 30 minutes and conducted motomed exercise for 30 minutes. All of them conducted exercises five times per week for four weeks. Respiratory muscles including the upper trapezius(UT), longissimus dorsi(LD), rectus abdominis(RA), external abdominal oblique(EAO) and, internal abdominal oblique(IAO) were measured using MP 150WSW prior to and after the experiment. Regarding pulmonary functions prior to and after the experiment, the experimental group showed significant differences in all sections but the control group did not show significant differences in any sections. As for in-between group differences after the experiment, there were significant differences in the UT, LD, RA, and IAO but no significant differences in the EAO. In conclusion, respiratory muscle activity was more effective for the experimental group than the control group. It is considered that feedback respiratory exercise may induce improvement in respiratory muscles in stroke patients through feedback breathing exercise.

Key words: *Feedback Breathing Exercise; Electromyography; SpiroTiger*

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INTRODUCTION

Asymmetric respiration is triggered in stroke patients because of increased sensitivity of the paretic side to CO₂ and decrease involuntary respiration, triggering changes in respiratory adjustment(1) and decrease in movement of the thoracic wall and in electric activity directly or indirectly affects pulmonary function. Therefore, respiratory efficiency and changes in respiratory mechanism of patients reflect damage and asymmetry of thoracic wall movement and muscular paralysis. In order to resolve these problems, chest wall expansion and ventilation and pulmonary volume and capacity should be appropriately maintained(2) and evaluation of functional ability of the lungs through precise measurement of pulmonary functions, and diagnosis, prognosis, and degree of a disease may be made to

obtain the ground for exercise prescription(3). There have been diverse previous studies of exercises to improve respiratory function: a study of respiratory function through a long term use of positive expiratory pressure mask and flutter treatment in cystic fibrosis patients(4), a study of respiratory muscle activity through diaphragmatic respiration exercise in chronic obstructive pulmonary disease(COPD) patients(5), a study of abdominal muscle activity through respiratory muscle exercise in quadriplegia patients(6), and a study of abdominal respiratory muscle activation in muscle dystrophy patients(7), and a study of expiratory muscle activation through expiratory muscle strengthening exercise in multiple sclerosis patients(8).

Thus far studies of respiratory exercise have concerned respiratory muscle activity, superficial respiratory movement largely in patients with respiratory

disease and neurological damage but research on respiratory muscle activation through respiratory exercise in stroke patients has been lacking. Based on previous theoretical grounds, accordingly, this study intends to look at the effects of feedback breathing exercise on stroke patients' respiratory muscle activity.

METHODS

Subjects

This study was conducted in K Hospital located in Daegu Metropolitan City from December 1 to December 30, 2012. The subjects of this study were 30 stroke patients who were diagnosed with a stroke 6 months or longer before through computed tomography or magnetic resonance, and they were randomly and equally assigned to an experimental group and a control group. All the subjects sufficiently listened to explanation on this study and consented to participate in the experiment. The criteria for inclusion were: those who did not have a history of pulmonary disease prior to the onset of a stroke, who did not have a damage accompanying orthopedic disease such as congenital thoracic deformation or rib fracture, who did not receive special treatment for pulmonary function improvement, who were able to walk independently, who did not receive drug therapy for the alleviation of stiffness, and whose mini mental state examination-Korean version score was 24 or higher so that they could understand and follow what the researcher instructed. This study was approved by the University institutional review board and was conducted in accordance with the ethical standards of the Declaration of Helsinki. The general characteristics of the both groups are schematized in Table 1.

Table 1. General characteristics of the subjects

	EG(n=10)	CG(n=10)
Sex(M/F)	10/5	8/7
Age(years)	65.8±4.8	61.6±7.1
Height(cm)	168.9±5.1	165.8±4.3
Weight(kg)	64.1±3.2	65.8±6.2
Paretic side(R/L)	5/10	7/8
Onset duration(months)	5.1±4.8	6.1±4.3

Mean±SD, EG: Experimental Group; CG: Control Group

Procedures

The experiment was conducted five times per week for four weeks. Both groups received ordinary physical therapy for 30 minutes consisting of joint mobilization exercise, muscular strengthening exercise, and extension exercise. Then the experimental group conducted feedback breathing exercise for 30 minutes. For feedback breathing exercise, SpiroTiger (Idiag AG, Volketswil, Switzerland) was utilized: a patient in a sitting position held the mouthpiece in the mouth and stared at the main body of the Spiro Tiger. When the experimenter operated the main body and pressed the starting button, the patient inhaled when the scarlet scale was directed toward the mark "in" and exhaled when it was directed toward the mark "out". At this point what is important is that when the scarlet pilot lamp indicates "in" or "out", the green light turns on and the sound of "pee" is made, normal feedback breathing exercise is enabled(9). When a patient complained about fatigue or dizziness during breathing exercise, the patient took a rest and conducted breathing exercise again. The control group after receiving ordinary physical therapy comprised of joint mobilization exercise, muscle strengthening exercise, and extension exercise for 30 minutes performed motomed exercise (RECK-Technik GmbH & Co, Betzenweiler, Germany) that did not affect breathing exercise at an intensity of no more than 20% of heart rate reserve for 30 minutes(10).

As measurement equipment for the experiment, MP 150WSW(Biopac System Inc. CA, U.S.A.) was used. For electromyographic measurement, while a patient in a sitting position was breathing deeply, data filtering and other signal processing were made using ACqknowledge 3.8.1 software on a personal computer. Surface electrodes were attached to the lateral middle area of the acromion from the seventh cervical vertebra on the upper trapezius(UT), the inferior angle of the scapula from the tenth thoracic vertebra on the latissimus dorsi(LD), 1cm area upward from the 2cm side from the center of the navel on the rectus abdominis(RA), the lowest area of the thorax on the external abdominal oblique(EAO), and 1cm medial area in the central part from the anterior superior iliac spine on the internal abdominal oblique(IAO). The reference electrode was attached to the spinous process of the seventh cervical vertebra(11). An EMG surface electrode Ag/AgCl(Biopac, diameter 2cm) was attached on the muscle belly where muscles developed most after measurement errors were eliminated and medical alcohol was used to clean the area(12).

For electrode analysis of respiratory muscles, muscle contraction of specific motions was assumed as reference voluntary contraction(RVC) and based on this, standardization was made(%RVC method)(13) and electrode values on the effect of respiratory training were observe dusing integrated EMG. In order to minimize differences between individuals and areas with in each individual and observe overall trends, normalization process(%) is needed(14). Therefore, the subjects' muscle activity during deep respiration prior to and after the experiment was measured and the entire area of each muscle was calculated and the average value was set at 100% and then muscle activity in accordance with the experimental period was normalized(%). As for measurement time, motions for 5 seconds were conducted three times in order to obtain average values among 5-second measured time and in order to measure average activity, average values of the middle three seconds excluding the first second and the last second were obtained(15). Sampling rates of electrode signals were set at 1024Hz. In order to remove noise from the measured EMG signals, raw data were band pass filtered at 10Hz-200Hz and smoothing filtered at RMS 20ms through rectification(16). EMG signals were analyzed using MyoReserch program after measuring changes in muscle activity and collecting EMG signals.

Data Analysis

Data of this study were analyzed using SPSS win 12.0 program. A paired t-test was performed in order to comparatively analyze activity of the respiratory muscles before and after the experiment in the experimental group and the control group through feedback breathing exercise and an independent t-test was employed to comparatively analyze differences between the experimental group and

the control group after the experiment. A statistical significance level was set at $\alpha = .05$.

RESULTS

According to comparison of activity of respiratory muscles of the paretic side in the experimental group and the control group, there were significant differences in all sections in the experimental group($p < .05$) and no significant differences in any sections in the control group. As for differences between the experimental group and the control group after the experiment, there were significant differences in the UT, LD, RA, and IAO($p < .05$) but no significant differences in the EAO(Table 2).

DISCUSSION

This study intended to examine changes in activity of the respiratory muscles through four week feedback breathing exercise in the experimental group and the control group.

According to comparison of respiratory muscle activity between prior to and after the experiment, there were relatively more increase in all sections in the experimental group than in the control group and such increases were significant in all sections. By moving respiratory muscles in a certain time and with a certain intensity according to signals of equipment through feedback breathing exercise, mobility of the upper trapezius(UT) muscle and the latissimus dorsi(LD) muscle where coordinated action of the extensor of the abdominal region during inspiration occurs is improved, the diaphragm is pushed more easily upward by strongly contracting

Table 2. Comparison of RVC(%) of experiental group and control group

	EG			CG			D-Value		
	Pre-test	Post-test	P	Pre-test	Post-test	P	EG	CG	P
UT	100.0±0.0	143.1±3.6	.00*	100.0±0.0	104.2±13.1	.50	43.1±3.6	4.2±13.1	.00*
LD	100.0±0.0	135.1±4.4	.00*	100.0±0.0	101.3±3.8	.51	35.1±4.4	1.3±3.8	.00*
RA	100.0±0.0	139.8±9.5	.00*	100.0±0.0	107.5±9.1	.11	39.8±9.5	7.5±9.1	.00*
EAO	100.0±0.0	122.4±5.1	.24	100.0±0.0	100.9±7.5	.55	22.4±5.1	0.9±7.5	.00*
IAO	100.0±0.0	128.1±7.4	.00*	100.0±0.0	102.4±9.2	.23	28.1±7.4	2.4±9.2	.05

Mean±SE, * $p < .05$. D-Value: Difference between Pre-Post value of each groups

the abdominal muscles during expiration, and improvement in muscle activity is made because the contraction of the internal intercostals muscle pushes the rib downward and makes respiration more smooth.

As studies to look at the effects of muscle activity through breathing exercise, Hoit et al. looked at the effects of vocalization and breathing exercise on activity of the abdominal muscles in cerebral palsy children and aided them inspiration by weakening activity of the abdominal muscles during inspiration(17). Gosseiink et al. measured the movement of chest wall, mechanical efficiency, and breathing difficulty during normal breathing, load breathing, and diaphragm breathing and obtained a result that abdominal amplitude increased in the diaphragm breathing group and mechanical efficiency of breathing increased in the normal breathing group(18). DeAndrade et al. measured muscle activity of COPD patients through breathing exercise and observed that activity of the trapezius muscle significantly increased(5). Zupan reported that respiratory muscle exercise in quadriplegia patients activated abdominal muscles(6). In a study by Ugalde et al. of abdominal muscle activity during respiration in muscle dystrophy patients, they noted that the external oblique abdominal muscle was activated by 8% and the rectus abdominis muscle was activated by 5%(7). In a study where respiratory muscle strengthening exercise was applied to multiple sclerosis patients for 3 months, Smeltzer et al. observed that respiratory muscle strength significantly increased(8) and Brannon et al. noted that respiratory muscle strength increased by 55% through a 5-week respiratory muscle strength training plan for patients whose respiratory muscle strength had been weakened(19). Beith et al. applied abdominal communicated movement to low back pain patients and observed that the activity of their internal oblique abdominal muscle and external oblique abdominal muscle increased(8). McCool and Tzelepis reported that inspiratory muscle strengthening exercise applied to muscle dystrophy patients significantly increased their inspiratory muscle strength(21). Study results through diverse breathing exercises were consistent with that of the present study, although they did not conduct complex breathing exercises on stroke patients like the present study.

If breathing exercise is continuously applied using feedback breathing exercise equipment in rehabilitation centers, a lot of contributions will be made to increase efficiency and efficacy of respiration in those with other neurological diseases such as multi-

ple sclerosis patients and Parkinson's disease.

CONCLUSION

The purpose of this study is to examine the effects of feedback breathing exercise on respiratory muscle activity. The experimental group showed significant differences in all sections but the control group did not show significant differences in any sections. It is considered that feedback respiratory exercise may induce improvement in respiratory muscles in stroke patients through feedback breathing exercise.

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