The Effects of Combination of Inspiratory Diaphragm Exercise and Expiratory Pursed-lip Breathing Exercise on Pulmonary Functions of Stroke Patients

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Abstract. [Purpose] The purpose of this study was to examine the effects of a combination of inspiratory diaphragm exercise and expiratory pursed-lip breathing exercise on pulmonary functions and respiratory muscle activation of stroke patients. [Methods] Thirty stroke patients were randomly and equally allocated to an experimental group and a control group, and the intervention was conducted five times per week for four weeks. In each session, both groups received rehabilitative exercise treatment for 30 minutes, and a feedback breathing device exercise for 15 minutes. In addition, the experimental group performed a combination of inspiratory diaphragm breathing exercise and the expiratory pursed-lip breathing exercise for 15 minutes. Prior to and after the intervention, patients’ pulmonary functions were measured using a spirometer. The pulmonary functions assessed were tests included FVC, FEV1, FVC/FEV1, PEF, VC, TV, IC, ERV, IRV. [Results] With respect to changes in the pulmonary functions of both groups after the intervention, the experimental group showed significant differences in FVC/FEV1, TV, and IC, but not in FVC, FEV1, PEF, VC, ERV, and IRV. The control group showed no significant differences. There were significant differences in FEV1, TV, and IC between the two groups, but no significant differences in FVC, PEF, FVC/FEV1, VC, ERV, and IRV after the experiment. [Conclusions] The experimental group, which conducted a combination of breathing machine exercise and the respiratory muscle strengthening exercise, saw their respiratory ability increase more significantly than the control group. The combination breathing exercise was found to improve pulmonary functions of stroke patients.

Key words: Inspiratory diaphragm exercise, Expiratory pursed-lip breathing exercise, Pulmonary function

INTRODUCTION

Stroke patients’ respiratory function is affected by the cardiopulmonary performance, both directly and indirectly, as they experience a decline in cardiovascular function and pulse rate, which affects oxygen delivery, and a deterioration in the movement of the chest wall on the paralyzed side and its electrical activities1). The respiratory efficiency and the changes in breathing mechanism reflect the extent of damage in the movement of the chest wall, its asymmetry and the degree of muscular paralysis of stroke patients. To resolve these problems, it is important to expand the chest wall, enhance lung ventilation, and keep an appropriate volume and capacity of the lung2). In order to prescribe an exercise therapy for stroke patients, basic data based on accurate assessment of the pulmonary function of the patients, diagnosis of the condition, and its symptoms and severity are needed3).

Studies have been conducted on the strengthening of respiratory function. A study of COPD (chronic obstructive pulmonary disease) patients examined the impact of diaphragmatic breathing, pursed-lip breathing (PLB), and a combination of the two exercises on respiratory rate and oxygen consumption4-6). In another study, a respiratory exercise machine was used to show breathing volume, oxygen saturation, volume of instant ventilation, respiration rate and the expiratory volume of myotomic muscular dystrophy patients was decreased7).

In research into equipment-assisted respiratory exercise, a long-term study was conducted for cystic fibrosis patients who used a CPAP (continuous positive airway pressure) mask to enhance pulmonary function8, 9). Koppers et al.10) conducted a study to examine how a feedback breathing device exercise affects patients’ endurance and quality of life. The feedback respiratory equipment, SPIROTIGER® (Idiag AG, Volketswil, Switzerland) is a training device which is useful for strengthening the inspiratory and expiratory at the same time. Kim and Seo11) conducted the same exercise to show that lung capacity patients could be increased. It was shown that direct functional training can strengthen
the muscular power of stroke patients as well as stability of their postures. Dietz conducted research to show that resistance training that stimulates proprioceptive nervous muscles increases muscular power and coordination.

Based on these findings, this study conducted a respiratory exercise that combined direct resistance training by a therapist with an equipment-assisted respiratory exercise to examine its impact on hemiplegia patients’ pulmonary function.

**SUBJECTS AND METHODS**

**Subjects**

This study was conducted in a hospital located in Daegu Metropolitan City, from March 1 to April 30, 2012. The subjects of this study were 30 chronic stroke patients who had been diagnosed with stroke by computed tomography or magnetic resonance imaging (MRI), with a duration of at least six months since the onset of their stroke. The subjects understood the purpose of this study and agreed to participate in it.

The subjects of this study were selected from among patients without any particular history of respiratory disease before the onset of stroke, or additional without combined injury such as congenital chest deformity, or rib fracture, or any history of treatment to increase pulmonary function. A further criterion for inclusion was that all subjects had to score 22 points or higher on the Mini-Mental State Examination/Korean version (MMSE-K) to ensure that they were able to understand and follow the researcher’s orders. The general characteristics of both groups are shown in Table 1.

**Methods**

The experimental group and the control group received ordinary physical therapy, comprising a joint mobilization exercise, a muscle strengthening exercise, and an extension exercise, for 30 minutes, and an exercise a feedback breathing device for 15 minutes.

For the feedback breathing device exercise, a therapist manipulated the device and pressed the start button. When the red notch was set to “in,” the patient breathed in, and when the notch was set to “out,” the patient breathed out; when the red pilot lamp indicated “in” or “out,” a green light was displayed, and a “buzzing” sound was heard. Thereafter, the normal feedback breathing exercise was initiated. If a patient complained of fatigue or dizziness during the breathing exercise, he or she took a rest before restarting the exercise.

The experimental group performed a combination of inspiratory diaphragm breathing exercise and the expiratory pursed-lip breathing exercise for 15 minutes. For the inspiratory diaphragm breathing exercise, the therapist placed his or her hands on the rectus abdominis muscle, just below the anterior costal cartilage, and induced inspiratory diaphragm breathing so that the patient breathed in slowly and deeply through his or her nose. The therapist then provided the appropriate resistance when the rectus abdominis muscle went up so that the patient could breathe in deeply. When the patient breathed in deeply, he or she maintained his or her shoulders in a relaxed state and did not move the upper chest, thus allowing only an abdominal rise. When the inspiratory diaphragm breathing ended, the patient conducted the expiratory pursed-lip breathing exercise. The patient pursed his or her lips with adjusted deep inspiration and breathed out for a specified time.

A spirometer (A CardioTouch 3000S, Bionet, USA) was used as the measuring equipment for the pulmonary function test. Before measuring pulmonary function, the patient was asked to wear a nose clip to prevent nose breathing. The patient was then instructed to use the mouthpiece to breathe three to five times in the usual manner. Upon hearing the starting signal from the respiratory equipment, the patient was directed to slowly exhale and inhale as much air as possible. The measurement was completed after another two or three regular and complete breaths. For accuracy, the measurements of the two groups were taken after the researcher had given the patient a thorough explanation and demonstrated the method of measuring pulmonary function. In each group, forced vital capacity (FVC), forced expiratory volume at one second (FEV1), forced expiratory volume at one second/forced vital capacity (FEV1/FVC), peak expiratory flow (PEF), tidal volume (TV), vital capacity (VC), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), and inspiratory capacity (IC) were measured.

The data obtained from the A CardioTouch 3000S was statistically analyzed using SPSS 12.0 for Microsoft Windows. The change in each group’s pulmonary function between before and after the interventions, and the difference between the groups before and after the experiment, were analyzed using the paired t-test and the independent sample t-test, respectively. A p-value of less than 0.05 was considered statistically significant.

**RESULTS**

The experimental group showed significant differences in FVC/FEV1, TV, and IC (p<0.05), but showed no differences not in FVC, FEV1, PEF, VC, ERV, or IRV after the intervention (p>0.05). The control group did not differ in any of the items (p>0.05). There were significant differences in FEV1, TV, and IC between the two groups after the interventions (p<0.05), but no differences in FVC, PEF, FVC/FEV1, VC, or ERV (p>0.05) (Table 2).
**DISCUSSION**

This study examined the effects of a combination of inspiratory diaphragm exercise and expiratory pursed-lip breathing exercise on hemiplegic patients’ pulmonary functions after four weeks of training with a therapist’s resistance and feedback equipment.

Pulmonary functions improved more in all items in the experimental group than in the control group, and in particular, FVC/FEV1, TV, and IC significantly increased in the experimental group.

Our results can be explained as follows: a labored breathing exercise was performed for a specified time and intensity using breathing device signals to strengthen the respiratory exercise was performed for a specified time and intensity. Jones et al.4) saw their expiratory reserve volume increase by 47% after a spirometric measurement. Estenne et al.17) noted that quadriplegia patients of spinal cord injury patients increased their vital capacity.

In the present study, the control group, performed a combined breathing exercise and feedback breathing exercise, saw their respiratory ability increase more significantly than the control group, and this result is consistent with the results of several previous studies. Therefore, this study provides objective data supporting the use of a combination of inspiratory diaphragm exercise and expiratory pursed-lip breathing exercise for the strengthening of weakened pulmonary functions in the rehabilitation of neurological disease patients.

**REFERENCES**

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