Comparison of the effects of core stabilization and chest mobilization exercises on lung function and chest wall expansion in stroke patients

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Abstract. [Purpose] The main purpose of this study was to compare the effects of core stabilization and chest mobilization exercises on pulmonary function and chest expansion in chronic stroke patients. [Subjects and Methods] Thirty stroke patients were randomly divided into two groups: a core stabilization exercise group (n=15) and a chest mobilization exercise group (n=15). Each exercise was performed 3 times per week for 30 minutes for 4 weeks, and pulmonary function and chest expansion when breathing were measured for both groups. [Results] There were significant increases in both forced vital capacity and forced expiratory volume in 1 second before and after intervention. Core stabilization exercise resulted in a significant increase in peak expiratory flow, and significant increases in upper and lower chest expansion were detected with chest mobilization exercise. However, no significant difference was revealed between the two groups. [Conclusion] This study suggested that both exercises were effective in some aspects of pulmonary function while core stabilization can help increase peak expiratory flow and chest mobilization can assist with chest expansion.

Key words: Core stabilization exercise, Chest mobilization exercise, Pulmonary function

INTRODUCTION

After stroke, damage to the upper motor neurons can cause a deconditioned state. This results in physical inactivity and eventually a reduction in cardiorespiratory fitness1). An increase in physical activity through the movement of the thoracic cage2), and stabilization exercise improves respiratory function3). Therefore, therapeutic exercise is important in improvement of pulmonary function in stroke patients. In addition, because the inspiratory limitations in stroke patients are manifested by thoracic cage contracture and the expiratory decrease is caused by weakness of the hemi-abdominal muscle4), it is necessary to choose a proper exercise method depending on physical condition.

Currently, stabilization exercises and chest mobilization exercises that have been utilized in stroke patients have been objectively confirmed to increase their respiratory function3, 5). Stabilization exercises activate one’s trunk muscles, providing stability to the spine and abdominal wall9). The contraction of the diaphragm and transverse abdominis helps abdominal breathing, as it increases abdominal pressure5). Chest mobilization exercise is a combination of deep breathing and active movements of the limbs and body. It improves ventilation by increasing movement in the shoulder girdle, trunk, and chest wall, thereby improving chest breathing2, 8).
However, a previous study involved comparing the control group with chest mobilization exercises\(^9\), and comparing the control group with stabilization exercises\(^3\), both of which are the same as the majority of other studies compares the exercises to the control group. Although there are studies investigating the pulmonary function and stability of the trunk after comparing chest expansion exercise and chest resistance exercise, it was not able to confirm the PEF and chest-wall expansion\(^5\).

The chest mobilization exercise in this study was designed to enhance the pulmonary function while increasing the fascia of the neck and chest and the movement of the trunk on the affected side\(^8, 10\). The purpose of this study is to compare core stabilization exercise for the improvement of respiration, and chest mobilization exercise through deep muscle strengthening. Afterwards, its purpose is to suggest an effective exercise method for pulmonary function and chest-wall expansion.

### SUBJECTS AND METHODS

Thirty patients who had been admitted to the P Convalescent Hospital in Gyeonggi Province and had been diagnosed with a stroke for more than 6 months by a specialist in the Department of Rehabilitation Medicine were selected for the study. They included patients without respiratory diseases or injuries, patients who were not receiving any special treatment to improve their pulmonary function, patients who had scored more than 24 points in a Korean version of mini-mental state exam, and patients who had a score of 2 or less in the Modified Ashworth Scale (MAS). Patients who had orthopedic disorders or rib fractures were excluded from the study. The study was performed from June 6, 2016 to September 30, 2016. This study was approved by the Local Ethics Committee of Yong-In University. Informed consent was obtained and all subjects who agreed to participate were given sufficient explanation of the study’s purpose. The general characteristics of the participants in this study are shown in Table 1.

Using a computer’s random number table (Excel, Microsoft, USA), 30 patients with chronic stroke were randomly divided into two groups—15 people were placed in the core stabilization exercise group and the other 15 were placed in the chest mobilization exercise group. This intervention was conducted 3 times a week, for a total of 4 weeks.

The core stabilization exercise was utilized with patients after appropriate modification using a study conducted by Oh and Park\(^3\) as a reference. For the exercise, a total of 5 movements were set including: contraction of transverse abdominis, maintaining the bridge position, lifting one leg while maintaining the bridge position, lifting both legs while lying in supine, and lifting both arms and legs while lying in supine.

For the chest mobilization exercise, 5 kinds of movements were included using the chest and neck mobilization technique described by Lima et al.\(^10\) and Colby and Kisner’s\(^9\) chest mobilization exercise as references. Fascia globalmobilization: The patient was supine, with the therapist at the bedside with 2 hands on the patient’s sternum. At the end of the expiration, the therapist amplified the decline in the chest being supported by the manubrium. At the end of inspiration, the therapist amplified the chest elevation through a little traction on the xiphoid process. Scalene muscle mobilization: the patient was supine, with the therapist at the bedside with the hand performed an occipital grip, and the opposite hand on the upper trapezius. Tension was obtained by occipital hand pull. Sternocleido-occipital-mastoid muscle mobilization: The patient was supine, head opposite rotated to the treated muscle. The therapist at the bedside with the hand on the muscle to be treated held the skull base, and the opposite hand applied mobilization to the sternocleidomastoid muscle. Tension was obtained by a downward pressure of sternal hand, accompanying the patient’s expiration. To mobilize paretic side of the chest: while sitting, have the patient bend away from the tight side and expand that side of the chest during inspiration. Then, have the patient bend toward the tight side during expiration. To mobilize the upper chest and stretch the pectoralis muscles: While the patient is sitting in a chair with hands clasped behind the head, have him or her horizontally abduct the arms during a deep inspiration. Then instruct the patient to bring the elbows together and bend forward during expiration. Each exercise was done for 6 minutes, for a total of 30 minutes.

Pulmonary function was assessed using a spirometer (MicroLab spirometer ML3500 MK6, UK) to measure FEV1, FVC, FEV1/FVC, and PEF before and after the intervention. Subjects were asked to sit on a chair with a seat back, put on a nose plug, and place a disposable mouthpiece into their mouths. After the intervention they were asked to breathe normally 3

| Classification                  | CSEG (n=15) | CMEG (n=15) |
|--------------------------------|-------------|-------------|
| Gender (male/female)           | 12/3        | 11/4        |
| Etiology (infarction/hemorrhage) | 11/4        | 9/6         |
| Paretic side (right/left)      | 7/8         | 5/10        |
| Disease duration (month)       | 16 ± 6.8    | 12 ± 8.1    |
| Korean-mini mental state examination (point) | 26.9 ± 2.2  | 26.5 ± 2.2  |
| Age (years)                    | 54.9 ± 11.0 | 60.8 ± 10.3 |
| Height (cm)                    | 165.8 ± 5.4 | 168.3 ± 6.5 |
| Weight (kg)                    | 68.3 ± 9.2  | 61.6 ± 6.6  |

Values are means ± standard deviation. CSEG: Core stabilization exercise group; CMEG: Chest mobilization exercise group

### Table 1. Subject characteristics
times, and then to carry out their maximum inspiration and expiration for 6 seconds, as prompted by the researcher’s foot signal.

The chest-wall expansion measurement was performed using a tape measure (Hoechstmass-Rollfix, Germany) to determine the range of motion of the thoracic cage. The upper chest expansion measure was made by placing the tape measure parallel to the space between the 3rd rib and then measuring the area where it made contact with the 5th spinous process. For the lower chest expansion measure, it was made by measuring the area that was horizontal to the inferior aspect of the xiphoid process and 10th spinous process, and the measurement value was the difference between the measured value at maximum inspiration and maximum expiration. The inter-rater reliability of this measurement method is 0.99, which is close to 1. All the interventions and evaluations were carried out by one researcher who has more than 5 year experience, and no information about the exercises was given to the subjects to exclude items that seem to affect parameters.

This study’s statistical analysis was performed using the SPSS 20.0 program. The general characteristics of stroke subjects were analyzed using descriptive statistics. In order to analyze the effect of intervention methods on pulmonary function and chest-wall expansion, a paired t-test was used. To evaluate the effect of intervention on pulmonary and thoracic cage expansion, an independent t-test was used for analysis. All statistical significance levels were set to $\alpha=0.05$.

### RESULTS

Analysis of the changes in pulmonary function of the core stabilization exercise group before and after intervention showed a significant increase in FEV1, FVC, and PEF. Analysis of the changes in pulmonary function of the chest expansion exercise group showed a significant increase in FEV1 and FVC, as well as in upper and lower chest expansion. There was no significant difference in the pulmonary function and chest-wall expansion between the two groups (Table 2).

### DISCUSSION

Both the core stabilization exercise group and the chest mobilization exercise group showed significant improvement in FEV1 and FVC after intervention. However, in the PEF of the two groups, a significant increase in the chest-wall expansion was only shown in the chest mobility exercise group.

With the purpose of stimulating the core muscles in stroke patients, Oh and Park3) conducted lumbar stabilization exercise on patients 3 times a week for 30 minutes each, over a span of 8 weeks. The results showed that there was an increase in FEV1, FVC, and PEF, which is consistent with our findings. Core stabilization exercises activate one’s core muscles to increase the intra-abdominal pressure and to reduce intrathoracic pressure through the contraction of abdominal walls. This helps increase airflow7).

In pulmonary function, the PEF is dependent on the force-velocity relationship and length-tension relationship of the exhalation muscles. Because it is a measurement method that is affected by abdominal muscles12), it seems that improvement of pulmonary function including the PEF is possible.

Song and Park5) reported that the FVC and FEV1 of stroke patients increased after performing chest-expansion exercises 5 times a week for 30 minutes each, for 8 weeks total. Park3) reported that there was an increase in the upper and lower chest expansion through rib cage joint mobilization among stroke patients. In addition, Minoguchi et al.13) showed that chest expansion significantly increased after carrying out respiratory muscle stretch exercises in patients with chronic obstructive pulmonary disease, but there were no significant differences in PEF, which is consistent with our study’s results.

This study showed no significant difference between the two groups. Similarly Kim et al.14) revealed that there was no significant difference in pulmonary function and chest expansion when comparing the abdominal muscle exercise and thoracic mobility exercise. Unlike Kim’s, study, the current study showed a significant increase in PEF in the core stabilization exercise group, and there was a significant increase in chest expansion in the chest mobilization exercise group. It is assumed that the chest mobilization exercise improves chest-wall expansion as it is an intervention aimed at reducing stiffness of the

### Table 2. Comparison within and between groups

| Classification | Core stabilization exercise group (n=15) | Chest mobilization exercise group (n=15) |
|----------------|----------------------------------------|----------------------------------------|
|                | pre-test      | post-test     | pre-test      | post-test     |
| FEV1 (l)       | 2.2 ± 0.4    | 2.3 ± 0.4*    | 2.0 ± 0.3    | 2.3 ± 0.4*    |
| FVC (l)        | 2.7 ± 0.5    | 3.0 ± 0.5*    | 2.6 ± 0.3    | 2.8 ± 0.4*    |
| PEF (l/min)    | 282.9 ± 79.6 | 362.8 ± 92.2* | 241.8 ± 129.7| 278.2 ± 117.8|
| Upper (cm)     | 1.0 ± 1.0    | 1.1 ± 1.2     | 1.1 ± 0.8    | 1.5 ± 0.7*    |
| Lower (cm)     | 2.0 ± 1.0    | 2.2 ± 0.9     | 1.7 ± 0.8    | 2.1 ± 1.0*    |

Values are means ± standard deviation. FEV1: forced expiratory volume at one second; FVC: forced vital capacity; PEF, peak expiratory flow; Upper: upper chest expansion; Lower: lower chest expansion

*Significant difference between before and after exercise in each group (p<0.05)
chest wall\textsuperscript{13}, not at improving respiratory muscle strength. In addition, an increase in the chest-wall motion can increase one’s lung volume during inspiration, so the FEV\textsubscript{1} is also increased when the FVC increases.

Therefore, if the decreased respiratory function is due to a weakening of the abdomen and reduced exhalation caused by muscle coordination disorders\textsuperscript{4}, then core stabilization exercises should be carried out rather than chest expansion exercises. However, if the reduced exhalation is due to the thoracic cage contracture\textsuperscript{4}, then we recommend doing chest expansion exercises rather than core stabilization exercises.

This study was conducted in a specific medical institute and because of the small sample size, it is difficult to generalize the results of the study. In addition, the comparative analysis only involved pulmonary function and chest function, so it is difficult to say that the measured results reflect the overall respiratory function of stroke patients. Therefore, in the future, a larger study with a greater sample size could reveal more substantial differences among the patient groups.

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