



Original Article

## Effect of diaphragm breathing exercise applied on the basis of overload principle

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**Abstract.** [Purpose] The purpose of this study was to examine effects of diaphragm breathing exercise applied on the basis overload principle on respiratory function. [Subjects and Methods] The subjects of this study were 35 normal adults. They were randomly assigned to two group; the maneuver-diaphragm exercise group and self-diaphragm exercise group. The respiratory function was evaluated using the CardioTouch 3000S (BIONET, Korea) as a pulmometry device. [Results] The maneuver-diaphragm exercise was more effective on functional vital capacity and forced expiratory volume at one second when compared to the self-diaphragm exercise. [Conclusion] According to the results of this study, although the self-diaphragm exercise did not show effects as much as the maneuver one, but the self-diaphragm exercise had a similar effects as the maneuver-diaphragm exercise. The self-diaphragmatic respiration applied on the basis of overload principle may be used as an effective respiratory exercise as a part of home respiration program.

**Key words:** Diaphragm, Breathing exercise, Respiratory function

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### INTRODUCTION

When the diaphragm is contracted and descended to be flat, several organs within the abdominal cavity are pressed anteriorly and inferiorly and the abdomen is swelled anteriorly<sup>1)</sup>. During breathing out, the diaphragm is recovered and the abdominal swelling is reduced<sup>2, 3)</sup>. The diaphragm as an important factor of diaphragmatic respiration plays a key role in the respiratory pump, respiratory function of controlling breathing, and human posture. Also, the diaphragm is known to contribute to stability of the trunk by enhancing intra-abdominal pressure to reinforce the lumbar vertebra<sup>4, 5)</sup>.

In particular, there have been many studies related to diaphragmatic respiration; the diaphragmatic respiration has been used partially in yoga, pilates, and exercises focusing on core stability and emphasized in the field of alternative medicine<sup>6)</sup>.

The basic principle of reinforcing skeletal muscles is based on the overload principle. The inspiratory muscles including the diaphragm are known to show morphologic, functional reactions consistent with those of the skeletal muscles of other regions when proper physiological loads are applied<sup>7, 8)</sup>. The skeletal muscles only show enhancement when at least 60% of resistance is applied on the basis of overload principle, which should be applied for enhancement of the diaphragm. But, previous the diaphragm breathing exercises are difficult to define the exact amount of resistance. Also it can cause errors in the accuracy when performing each time. For this reason, the effect of self-breathing exercise can be reduced. If the patient learns the correct breathing exercise from therapists, the self-breathing exercise will also be able to effect similar to the effect of diaphragm breathing by the therapist. The present study investigated effects of diaphragm breathing exercise applied overload principle on respiratory function.

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## SUBJECTS AND METHODS

Thirty-five subjects without any of neuromuscular disorder, orthopedic disorders and cardiopulmonary disorder were recruited, for this study. They were randomly assigned to two group; the maneuver-diaphragm exercise (MDE) group (thirteen females, four males; age,  $21.18 \pm 0.23$  years; height,  $161.88 \pm 1.94$  cm; weight,  $56.19 \pm 1.92$  kg) and self-diaphragm exercise (SDE) group (seven females, eleven males; age,  $22.17 \pm 0.43$  years; height,  $169.89 \pm 1.71$  cm; weight,  $65.56 \pm 2.08$  kg). All the patients understood the purpose of this study and provided their written informed consent prior to their participation, in accordance with the ethical principles of the Declaration of Helsinki.

The maneuver-diaphragmatic respiration was an up and down motion of the diaphragm, performed by a therapist, who demonstrated an accurate method of the respiration. A subject in a hooklying position was asked to put his/her hands on the rectus abdominis muscle immediately below the anterior costal cartilage, and to inhale slowly and deeply only by swelling his/her abdomen without moving his/her upper chest while relaxing his/her shoulders. Then, the subject exhaled all the air slowly. During inhalation, the air was breathed in through his/her nose, and his/her abdomen was swollen. After the breathe was suspended at the last moment, the subject exhaled the air according to the pursed lip breathing, with which the subject breathed out the air through his/her mouth with his/her lips half-opened and his/her abdomen made hollow. One breathing consisted of three seconds of inhalation, three seconds of suspension, and six seconds of exhalation. A subject was asked to put one hand on the chest and the other one on the abdomen, not to show movement of the upper chest.

The maneuver-diaphragmatic respiration was applied in a way that a subject could perform respiration with 11 to 13 of the Borg rating of perceived exertion scale (RPE) and that the investigator set the tolerable resistance as 11 to 13 of the RPE on the upper abdomen while the subject inhaled and suspended during the exercise.

The investigator observed the facial expression and breathing of the subject during the exercise, and encouraged him/her to maintain 11 to 13 of the RPE by showing him/her the RPE. A subject was asked to swell his/her abdomen sufficiently while inhaling. The 30-minute exercise was performed four time per week for four weeks. The self-diaphragm exercise method was consistent with the method of maneuver-diaphragmatic respiration. The investigator observed the initial week of performance in order to provide accurate method of respiration and resistance of 11 to 13 of the RPE. In order to confirm that the subjects underwent the respiratory exercise as a home program, the exercise was filmed and identified.

Subjects were assessed using pre-value and post-value measurement pulmonary function (forced vital capacity; FVC, forced expiratory volume at one second; FEV<sub>1</sub>, forced expiratory volume at one second / functional vital capacity; FEV<sub>1</sub>/FVC, peak expiratory flow; PEF, slow vital capacity; SVC, tidal volume; TV, expiratory reserve volume; ERV, inspiratory reserve volume; IRV). The respiratory function was evaluated using the CardioTouch 3000S (BIONET, Korea) as a pulmonary device when a subject sat on a chair comfortably. We gave sufficient explanation and demonstration for enhancing accuracy before measuring. Wilcoxon signed ranks test was used to examine the effects of diaphragm breathing exercises on the respiratory function and in each group. Statistical analyses were performed using SPSS 21.0 for Windows (SPSS Inc., Chicago, IL, USA) with a significance level of  $\alpha=0.05$

## RESULTS

There was a significant difference in the FVC, FEV<sub>1</sub>, PEF, SVC and IRV those of before and after the all breathing exercise. In addition, there was also a significant difference in FVC and FEV<sub>1</sub> according to the breathing exercise methods (Table 1).

**Table 1.** Effects of breathing exercise on the respiratory function

	SDB		MDB	
	Pre	Post	Pre	Post
FVC (l)	$3.15 \pm 0.93$	$3.49 \pm 0.84^*$	$2.21 \pm 0.99$	$2.85 \pm 0.90^*, \ddagger$
FEV <sub>1</sub> (l)	$2.91 \pm 0.90$	$3.21 \pm 0.73^*$	$1.97 \pm 0.95$	$2.70 \pm 0.83^*, \ddagger$
FEV <sub>1</sub> /FVC (%)	$96.56 \pm 4.91$	$93.94 \pm 5.95$	$98.47 \pm 2.00$	$97.19 \pm 3.19$
PEF (l/s)	$6.08 \pm 2.09$	$7.18 \pm 2.16^*$	$4.33 \pm 2.00$	$5.64 \pm 1.88^*$
SVC (l)	$5.43 \pm 1.51$	$6.13 \pm 1.35^*$	$4.51 \pm 1.63$	$5.17 \pm 1.31^*$
TV (l)	$0.67 \pm 0.31$	$0.61 \pm 0.22$	$0.54 \pm 0.31$	$0.62 \pm 0.30$
ERV (l)	$1.55 \pm 0.71$	$1.67 \pm 0.79$	$1.46 \pm 0.69$	$1.61 \pm 0.48$
IRV (l)	$3.21 \pm 1.17$	$3.85 \pm 0.80^*$	$2.38 \pm 0.95$	$2.95 \pm 0.78^*$

Values are reported as the Mean  $\pm$  SD.

\* $p < 0.05$ , within group,  $\ddagger p < 0.05$ , between groups

## DISCUSSION

The diaphragm breathing exercise is being performed in a variety of ways. However the exact methods is not fixed and the amount of resistance. In any case, the purpose of diaphragm breathing exercises was strengthening of diaphragm function. So, the purpose of this study was to examine the effects of diaphragm breathing exercise applied overload principle. The maneuver-diaphragmatic respiration by the therapists was more effective on FVC and FEV1 when compared to the SDE group. However, the SDE had a similar effects as the MDE. Indicating that difficulty in diaphragmatic respiration due to the characteristics of diaphragm breathing exercise made the maneuver one more effective. The MDE could receive feedback during the diaphragm breathing exercise, but not the SDE. Also, the SDE may be performed unwittingly by lowering the intensity of the breathing exercise. In this way, if the SDE is set to the minimum intensity, it can be as effective as MDE. Also, the disadvantage of SDE is that it can be supplemented if the patient takes a video and received feedback from the therapist, or visits a therapist.

The respiratory muscles can be expected to improve respiratory functions by increasing muscular strength and endurance through various types of exercise. By enhancing ventilation through reinforcing strength and endurance of the respiratory muscles, respiratory imbalance is improved and tissue oxygenation is promoted to enhance daily life activities and quality of life<sup>9)</sup>. When compared to outpatient respiratory rehabilitation, home respiratory rehabilitation maintained longer positive effects of rehabilitation. Efficiency and availability of home respiratory rehabilitation can be seen in that the home exercise is easily mixed within daily life and its effects can be maintained for a long term<sup>10)</sup>. However, to go into or visit a hospital for respiratory recovery is practically difficult, requires much time, and give the subjects burden of expense and difficulty in adjusting to daily life, and it is needed to develop a program that is easier and cost-efficient for them to perform by themselves under familiar environment<sup>11)</sup>. The self-diaphragm exercise applied on the basis of overload principle may be used as an effective respiratory exercise as a part of home respiration program, and can be provided as a new method of respiration exercise when the overload principle is applied.

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