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The Effect of Thoracic Cage Mobilization and Breathing Exercise of Respiratory Function, Spinal Curve and Spinal Mobility in Elderly with Restrictive Lung Disease

The purpose of this study was to examine the effects of combined respiratory physical therapy on respiratory function, spinal curve and spinal mobility for community-dwelling elderlies with restrictive lung diseases. In total, 10 patients participated in an 8-week intervention program of thoracic cage mobilization and breathing exercise in combination.

The results of the study are as follows: for respiratory function, the forced expiratory volume in 1 second (FEV1), forced vital capacity(FVC), and FEV1/FVC were significantly improved to .30±0.31ℓ, .46±.42ℓ, and 18.10±11.39%, respectively ($p<.05$). For spinal curve, the thoracic curve and the lumbar curve were improved significantly to −2.20±1.40˚ and −1.20±1.14˚, respectively ($p<.01$). For spinal mobility, the thoracic flexion (3.40±2.99˚), thoracic extension (3.50±1.43˚), lumbar flexion (4.50±4.74˚), and lumbar extension(−1.50±1.84˚) were all significantly improved ($p<.05$).

These findings indicate that thoracic cage mobilization and breathing exercise in combination improve the respiratory function, spinal alignment, and spinal mobility in elderly people with restrictive lung diseases,

Key words: *Breathing Exercise; Elderly with Restrictive Lung Disease; Spinal Curve; Spinal Mobility; Thoracic Cage Mobilization*

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INTRODUCTION

Patients with restrictive lung disease generally have limited dyspneic and breathing patterns [1]. There is also a strong association between the prevalence of ischemic heart disease and heart disease [2]. To prevent respiratory dysfunction [1] and heart failure [2] in patients with restrictive lung disease, appropriate treatment management should be accompanied by usual care.

Aging-related physical changes are characterized by a decrease in respiratory function [3], a hump back [4], and a decrease in spinal mobility [5]. It is important to maintain proper mobility because the movements of the thoracic cage joints are involved in breathing [6]. Therefore, respiratory physical therapy for the elderly requires an efficient treatment method to improve their respiratory function, spinal curve and spinal mobility simultaneously.

Inspiratory muscle training is an effective respiratory exercise to increase the thickness of the diaphragm, vital capacity, and total lung capacity [7]. Thoracic spine mobilization, used in this study, has been widely applied as an intervention method for patients with thoracic spine pain [8] and scoliosis [9]. In recent years, thoracic cage mobilization has been widely used in respiratory physical therapies to improve the respiratory function of patients with respiratory disease and central nervous system injuries [10,11].

Therefore, a combined application of thoracic spine mobilization and breathing exercise in patients with restrictive lung disease is expected to offer synergistic benefits.

Based on the above research background, this study aimed to investigate the effects of respiratory physical therapy combined with joint mobility exercise and breathing exercise on the improvement of respiratory function, spinal curve, and spinal mobility in elderly patients with restrictive lung disease residing in the community and to propose a new intervention method of respiratory physical therapy.

SUBJECTS AND METHODS

Subjects

This study was conducted on 10 elderly patients with restrictive lung disease living in the community for 8 weeks. Patients with restrictive lung disease with a forced expiratory volume in 1 second (FEV1)/forced vital capacity(FVC)≤65% and FVC〈80% [12], who were identified by a respiration measuring device (spirom-eter), who were able to walk independently, and who had normal cognitive function (scored at least 24 points on the Korean version of the Mini-Mental State Examination) [13] were included in this study. Patients who were under medical treatment for res-piratory disease, who have a history of spinal sur-gery, and who have central nervous system injuries were excluded from the study. All of the subjects were fully informed of the purpose of the study, and they gave a voluntary consent to participate.

Regarding the general characteristics of the study subjects, one male and nine females participated in this study, and they were 63.17±3.87 years old, 155.83±7.31cm in height, and 61.50±6.72kg in weight.

Measurement Methods

Respiratory function

In this study, FEV1, FVC, and FEV1/FVC were measured to determine the respiratory function. A spirometer (Fitmate MED, Cosmed, Italy) was used for the measurement. For the measurement, the subject put on a mouthpiece and nose plugs in an upright sitting position. Then, the subject's respira-tory function was measured according to the investi-gator's instructions. The Ahemss measurement was repeated three times in total to use the mean value as data.

Spinal curve

To determine the spinal curves of the subjects, the thoracic curve and lumbar curve were measured using the Spinal Mouse system (Idag, Swiss). The investigator palpated the spinous process of C7 and the top of the anal crease of the subject in usual standing posture and landmarked the positions on the skin surface. By dragging down the two marks along the spine using a Spinal Mouse, the angles of the thoracic curve and the lumbar curve were measured [14].

Spinal mobility

To determine the spinal mobility of the subjects, the Spinal Mouse system (Idag, Swiss) was used. After the measurement of spinal curve, the subject main-tained the trunk flexion and extension postures in a standing position in accordance with the investiga-tor's instructions. At this time, the investigator determined the angles of the thoracic curve and the lumbar curve by measuring each posture in the same manner as the spinal curve measurement method [14]. The Spinal Mouse system is a validated spinal mobili-ty-measuring device with an excellent reliability [15].

Exercise Methods

All subjects underwent thoracic cage mobilization to the thoracic cage and breathing exercise for 30 min-utes a day, three times a week for 8 weeks.

Joint mobilization

For thoracic cage joint mobilization, posterior-ante-rior rib mobilization and thoracic vertebrae traction with thoracic segmental mobilization (extension) were applied [16]. For this exercise, Grade III treatment [17] was applied for 25-30 seconds, followed by a resting time of 3 seconds between the joint mobilization exercises, and each session lasted 15 minutes in total.

Breathing exercise

For breathing exercise, the subject performed diaphragm breathing exercise and lateral costal expansion [18,19] for 15 minutes in a sitting position. The bare hand resistance method was applied for 7 sec-onds by the investigator in each breathing exercise. At the end of the breathing exercise, the subject was instructed to exhale to the end [18]. If a subject com-plained of dizziness or fatigue during the breathing exercise, the exercise was resumed once he/she returned to a stable state after a rest.

Data analysis

The data of this study were analyzed using the SPSS statistical processing program for Windows (ver. 19.0). Descriptive statistics were used for the analysis of general characteristics. Changes in FVC, FEV1, FEV1/FVC, spinal curve, and spinal mobility after the intervention were analyzed using the independent t-test with the significance level at a = .05.

RESULTS

Comparison of respiratory function

The FVC, FEV1, and FEV1/FVC of the subjects increased significantly to .30±.31ℓ, .46±.42ℓ, and 18.10±11.39ℓ, respectively ($p<.05$), an indicator of improved respiratory function 〈Table 1〉.

Comparison of spinal curve

Both the thoracic curve and the lumbar curve of the subjects were significantly improved to −2.20±1.40° and −1.20±1.14°, respectively ($p<.01$) 〈Table 2〉.

Comparison of spinal mobility

The thoracic flexion, thoracic extension, lumbar flexion, and lumbar extension were all significantly improved to 3.40±2.99°, 3.50±1.43°, 4.50±4.74°, and −1.50±1.84°, respectively ($p<.05$) 〈Table 3〉.

Table 1. Comparison of respiratory function

Variable	Pre-test	Post-test	Rate of change	t	p
FVC(ℓ)	1.89±0.24	2.19±0.13	.30±0.31	3.056	.14*
FEV1(ℓ)	1.44±0.36	1.90±0.27	.46±0.42	3.477	.07**
FEV1/FVC(%)	68.40±6.69	86.50±11.52	18.10±11.39	5.027	.01**

Mean±SD, *p<.05, **p<.01
FVC : forced vital capaity, FEV1 : forced expiratory volume at 1 second

Table 2. Comparison of spinal curve

Variable	Pre-test	Post-test	Rate of change	t	p
Thoracic curve(°)	48.30±3.95	46.10±4.01	−2.20±1.40	−4.975	.001**
Lumbar curve(°)	−14.00±5.12	−15.20±5.63	−1.20±1.14	−3.343	.009**

Mean±SD.

Table 3. Comparison of spinal mobility

Variable	Pre-test	Post-test	Rate of change	t	p
Thoracic Flexion(°)	10.80±4.94	14.20±7.04	3.40±2.99	3.597	.006**
Thoracic Extension(°)	−7.80±3.94	−11.30±4.30	3.50±1.43	7.720	.000**
Lumbar Flexion(°)	36.50±2.27	41.00±5.94	4.50±4.74	3.000	.015*
Lumbar Extension(°)	−5.50±1.35	−7.00±2.21	−1.50±1.84	−2.577	.030*

Mean±SD, *p<.05, **p<.01

DISCUSSION

The purpose of this study was to investigate the effects of thoracic cage mobilization exercise and breathing exercise in elderly patients with restrictive lung disease living in the community. The FVC, FEV1, and FEV1/FVC of the subjects, the indicators of respiratory function, increased significantly after the intervention, demonstrating improved respiratory function. Considering that rib movements should accompany inhalation [6], the increases in FVC, FEV1, and FEV1/FV were likely to result from the enhanced thoracic cage joint mobilization, which was reduced with aging, by the joint mobilization exercise, which led to the increase in thoracic cage mobilization during breathing and ultimately to the enhanced respiratory capacity of the subjects. Many previous studies have reported breathing exercise, in general, to be a highly effective intervention method for improving respiratory function [7,18]. In the present study, the combined application of thoracic cage mobilization and breathing exercise was confirmed an effective method for improving respiratory function in elderly people with restrictive lung disease.

In a related study, it was reported that FVC and FEV1 increased significantly and FEV1/FVC increased on average after thoracic cage joint mobilization exercise was performed in hemiplegic patients [20], which is consistent with the result of the present study.

Thoracic cage mobilization in elderly people with restrictive lung disease has the effect of decreasing thoracic kyphosis and increasing thoracic and lumbar mobility [10]. The intervention method applied in this study, where breathing exercise was combined with thoracic cage mobilization to produce the above therapeutic effects, is believed to have a positive effect on the improvement of overall respiratory function by decreasing thoracic kyphosis and increasing lumbar lordosis and spinal mobility.

In the present study, both the thoracic curve and lumbar curve related to the spinal alignment of the subject were improved significantly after the intervention. The slouching spinal alignment due to aging [4] can be regarded as a natural change, but with the consideration that spinal alignment was improved in this study through intervention, leading to a better posture, this finding suggests the intervention method used in this study may have a variety of physical benefits to elderly patients with restrictive lung disease.

Moreover, the significantly improved spinal mobility is also an indication of improved physical function. The intervention method used in this study, where thoracic cage mobilization exercise an effective method for improving joint mobility was applied to the thoracic cage along with breathing exercise, seems to increase the flexion and extension motions of the thoracic curve and the lumber curve, thereby imposing a positive effect on the improvement of the overall flexibility of the spine. Trunk posture affects spinal stability [21] and upper extremity function [22]. Thus, the improved thoracic and lumbar curves shown in this study are expected to have a positive impact on spinal stability and upper extremity function.

However, it is worth noting there is also a study reporting that spinal joint mobilization exercise and breathing exercise, an intervention method similar to that used in the present study, did not change the respiratory function of the elderly [23]. Therefore, it is necessary to consider that the effect may vary depending on disease type and severity.

This study has limitations in that the sample size was small and the results cannot be generalized to patients of all ages and with various respiratory diseases. Nonetheless, as this study verified the intervention effect of respiratory physical therapy newly combined with a physical therapy intervention method in elderly patients with restrictive lung disease, the findings obtained from this study are expected to offer a positive impact on follow up research related to the development of new intervention methods for respiratory physical therapy. Based on the up to date research on respiratory function, it is recommended that, in addition to breathing exercise based therapy, joint mobilization exercise and breathing exercise be performed together as an intervention method of respiratory physical therapy to improve the spinal curve and spinal mobility in elderly patients with restrictive lung disease.

CONCLUSION

In this study, thoracic cage mobilization exercise and breathing exercise were applied to the elderly with restrictive lung disease living in the community. This study confirmed that this intervention method combining thoracic cage mobilization exercise and breathing exercise is effective in improving the respiratory function, thoracic curve, lumbar curve, thoracic mobility, and lumbar mobility of the elderly with restrictive lung disease. Based on these findings, it is necessary to activate door to door physical therapy programs in local communities and to apply joint mobilization exercise and breathing exercise to elderly people with respiratory diseases living in the community.

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