J. Phys. Ther. Sci. 28: 257–260, 2016

The Journal of Physical Therapy Science

Original Article

Effect of thoracic and cervical joint mobilization on pulmonary function in stroke patients

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Abstract. [Purpose] This study aimed to conduct thoracic and cervical mobilization in stroke patients and determine its effects on respiratory function. [Subjects and Methods] Twenty-one stroke patients were studied. Subjects were divided into a control group (control group, n=11) who did not undergo thoracic and cervical joint mobilization, and an experimental group (thoracic and cervical mobilization group, n=10) who underwent thoracic and cervical joint mobilization. Forced vital capacity and forced expiratory volume in the first second, well-known indicators of respiratory capabilities, were measured. Peak cough flow was measured as an indicator of cough capability. [Results] After the exercise, respiratory function in the thoracic and cervical mobilization group showed statistically significant improvements demonstrated by increases in forced vital capacity, forced expiratory volume in the first second, and peak cough flow. [Conclusion] The findings indicate that thoracic and cervical mobilization can improve the thoracic movements of stroke patients resulting in improved pulmonary function.
Key words: Thoracic and cervical mobilization, Stroke, Pulmonary function

(This article was submitted Sep. 29, 2015, and was accepted Oct. 16, 2015)

INTRODUCTION

Addressing pulmonary function disorders is the most important measure in maintaining quality of life in stroke patients, especially in those who experience asymmetrical breathing due to impairment of respiratory muscles (such as the diaphragm) on the affected side[1)] and abnormal thoracic extension[2)]. Impaired pulmonary function limits physical activities[3)], and compromises pulmonary hygiene due to the inappropriate removal of mucus inside the airway, inducing complications such as pneumonia[4)]. Abnormal respiratory function reduces forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), and peak cough flow (PCF)[4)]. Methods used to increase respiratory ability include stretching the pectoralis major[5)], pursed-lip breathing[6)], and inspiratory muscular training[7)].

Among stroke patients undergoing rehabilitation, trunk mobility is essential to balance recovery[8)]. Reduced trunk mobility and thoracic space can lead to reduced respiratory function. Consequently, thoracic mobilization may increase trunk mobility[9)].Thoracic movements are related to cervical movements[10)]. Therefore, thoracic and cervical mobilization may increase trunk mobility, improving respiratory function. However, few studies have examined the relationship between thoracic and cervical mobilization and respiratory function in stroke patients.

This study aimed to conduct thoracic and cervical mobilization in stroke patients and to determine its effect on respiratory function.

SUBJECTS AND METHODS

The subjects were 21 stroke patients admitted to M Rehabilitation Hospital in Daegu Metropolitan City, South Korea. The purpose and scope of the study was explained, and informed consent was obtained according to the ethical standards of the

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Declaration of Helsinki. The study was conducted from June to August 2015. Subject selection was based on the following: no previous respiratory disease, no diagnosis of lung disease based on radiography and physical examination, and no cognitive dysfunction (i.e., MMSE-K scores exceeding 24) that could lead to impaired cooperation (i.e., due to severe aphasia or dementia). A physiotherapist blinded to the assessment results entered all demographic data into a computer program designed to perform stratified randomization. Pre-randomization stratification was based on gender and hemiplegic side. Subjects were randomly divided into a control group (CG, n = 11), whose members did not undergo thoracic and cervical joint mobilization, and an experimental group (TCMG, n = 10), whose members underwent thoracic and cervical joint mobilization.

Subjects underwent one intervention per week for 4 weeks. Both groups were simultaneously given physiotherapy treatments consisting of 30 min of exercise, 15 min of rehabilitation ergometer training, and 15 min of functional electrical stimulation. Additionally, members of the TCMG had 30 min of thoracic and cervical joint mobilization.

During thoracic mobilization, subjects were seated on a height-adjustable therapeutic table and asked to cross their arms. The therapist conducted flexion, extension, lateral flexion, and thoracic rotation while wrapping the patient's crossed arms with the therapist's left hand, and the therapist's right hand on the patient's thoracic vertebrae. Movement of the vertebrae was checked using the right hand[9)].

Cervical joint mobilization followed. Subjects remained on the same table and in the same posture. The therapist wrapped the right arm around the patient's face, up to the back of the patient's neck, and put the hand on the segment to be mobilized. The segmental spinous process just below the segment to be mobilized was fixed with the left hand using the index finger and thumb. Mobilization was conducted using the right hand[11)].

Respiratory function was measured using a pulmonary function calculator in a micro spirometer (Micro Medical Ltd., UK). The FVC and FEV_1 were measured while sitting on the table. We defined FVC as the amount of air that can be forcibly exhaled from the lungs after taking the deepest breath possible; additionally, we defined FEV_1 as the volume of air that can be forced out in one second after taking the deepest breath possible. A mean value was recorded after three measurements for each test.

PCF was measured using a peak flow meter (Cardinal Health 232 Ltd., UK) to measure cough capability. The subjects assumed the same posture as previously described, taking breaths as deep as possible followed by forcibly coughing as strongly as possible. A mean value was recorded after three measurements for each test.

A paired t-test was conducted to compare changes in the values of respiratory and cough function according to the length of time the groups had undergone mobilization. To test statistical significance, the significance level was set to 0.05. The results, which were statistically processed using PASW 18.0 for Windows, are expressed as mean and standard deviations.

RESULTS

Ten of the subjects were in the TCMG and 11 were in the CG. The general characteristics of the subjects are listed in Table 1. A paired t-test was conducted to compare respiratory function of the subjects before and after the exercise. These results are shown in Table 2. The CG showed no significant changes in FVC. However, the TCMG had a statistically significant increase in FVC, from 1,589.0±323.2 mL to 1,692.0±336.1 mL. The CG showed no significant changes in FEV_1. However, the TCMG saw a statistically significant increase in FEV_1, from 1,275.0±340.7 mL to 1,365.0±324.7 mL. Changes in PCF between the groups are shown in Table 3. The CG showed no significant changes. However, the TCMG showed a statistically significant increase in PCF, from 149.0 ± 65.7 l/min to 157.5±69.8 l/min.

DISCUSSION

Stroke patients generally have reduced respiratory function due to reduced thoracic space caused by reduced trunk mobility. This study sought to determine the effects of thoracic and cervical joint mobilization on respiratory capabilities of stroke patients.

FVC and FEV_1, are well-known indicators of respiratory capabilities; stroke patients are known to have low FVC and FEV_1 values due to damage sustained by the central nervous system's respiratory system regulators[4, 12)]. In a previous study, the FVC values of healthy male and female subjects were 3,600 mL and 2,500 mL, respectively, while their FEV_1 values were 2,500 mL and 1,800 mL, respectively[13)]. Comparatively, our study subjects had lower FVC and FEV_1 values. This suggests that stroke patients needed appropriate intervention to improve their respiratory functions.

The TCMG showed improved FVC and FEV_1following the exercise, indicating that thoracic and cervical mobilization can improve the respiratory function of stroke patients. Thoracic mobilization increases facet joint sliding in the thoracic vertebrae and normalizes the joint capsule, thereby improving thoracic flexibility while expanding the thorax[9)]. Stroke patients have reduced thoracic mobility[14)]. Mobilization exercises help facilitate thoracic movement during inhalation, increasing thoracic expansion and improving pulmonary function.

Biomechanically, cervical and thoracic movements are related. Abnormal thoracic movements can induce cervical dysfunction[15)], and thoracic mobilization can increase cervical range of motion and reduce cervical pain[16)]. Therefore, not only has the cervical or thoracic spine been treated to correct deformation or relieve pain, but concurrent mobilization of the cervical and thoracic spine has also been attempted in recent years[11)]. A recent report states that abnormal cervical and thoracic

Table 1. General characteristics of the subjects (number or mean±SD)

Variables	Control group (n=11)	Experimental group (n=10)
Gender (male/female)	3/8	3/7
Paretic side (left/right)	7/4	4/6
Age (years)	76.5±8.7	76.5±10.2
Time since stroke (months)	29.6±17.8	30.9±12.9
Height (cm)	162.1±7.6	160.0±6.5
Weight (kg)	51.5±9.4	56.7±8.0

Table 2. Comparison of pre and post pulmonary function (mean±SD)

Group	Variables	Pre	Post
TCMG*	FVC (mL)	1,589.0±323.2	1,692.0±336.1
	FEV_1 (mL)	1,275.0±340.7	1,365.0±324.7
CG	FVC (mL)	1,531.8±674.9	1,557.3±608.6
	FEV_1 (mL)	1,240.9±545.2	1,280.0±541.3

TCMG: thoracic and cervical mobilization group, CG: control group, FVC: forced vital capacity, FEV_1: forced expiratory volume at 1 second, *$p<0.05$

Table 3. Comparison of pre and post coughing function (mean±SD)

Group	Variables	Pre	Post
TCMG*	PCF (mL)	149.0±65.7	157.5±69.8
CG	PCF (mL)	137.7±94.7	141.4±94.8

TCMG: thoracic and cervical mobilization group, CG: control group, PCF: peak cough flow, *$p<0.05$

posture—such as a forward-leaning head and kyphosis—are related in stroke patients[10]. This study treated the cervical and thoracic spine concurrently, inducing thoracic expansion and increased pulmonary capability through an effective increase in movement.

Impaired cough capability following a stroke can trigger a higher incidence of aspiration and reduced cleaning ability in the cilia of the mucosa, increasing chest infection susceptibility[4]. A PCF of 300 l/min or higher is typical among healthy persons. At 160–270 l/min, patients are vulnerable to viral infections. At less than 160 l/min, the self-cleaning action of the muco-ciliary pathways may be significantly impeded[17]. The subjects had PCF lower than 160 l/min., thus indicating low cough capability. Thus, appropriate intervention is required to improve their cough capabilities. To improve cough capability, patients need to strengthen expiratory muscles, have an appropriate inhalation ability prior to cough, and have the ability to maintain a small airway to increase intrathoracic pressure[18]. The exercises used in this study can increase thoracic movement, helping patients inhale appropriately prior to coughing. These exercises can also facilitate expiratory muscle (e.g., the abdominal muscles) lengthening prior to contraction, increasing cough capability.

The finding sindicate that these exercises improve thoracic movement, resulting in improved pulmonary and cough function. Pulmonary function is crucial to stroke patients. Future research on improvements in the pulmonary function of stroke patients is needed. A multifaceted study on trunk movements, posture, and respiratory functions should be undertaken.

ACKNOWLEDGEMENT

This work was supported by the 2015 Gimcheon University Research Grant.

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