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Original Article

Effects of cervical self-stretching on slow vital capacity

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Abstract. [Purpose] This study investigated the effects of self-stretching of cervical muscles, because the accessory inspiratory muscle is considered to improve pulmonary function. [Subjects] The subjects were 30 healthy university students 19–21 years old who did not have any lung disease, respiratory dysfunction, cervical injury, or any problems upon cervical stretching. [Methods] Spirometry was used as a pulmonary function test to measure the slow vital capacity before and after stretching. The slow vital capacity of the experimental group was measured before and after cervical self-stretching. Meanwhile, the slow vital capacity of the control group, which did not perform stretching, was also measured before and after the intervention. [Results] The expiratory vital capacity, inspiratory reserve volume, and expiratory reserve volume of the experimental group increased significantly after the cervical self-stretching. [Conclusion] Self-stretching of the cervical muscle (i.e., the inspiratory accessory muscle) improves slow vital capacity.
Key words: Self-stretching, Slow vital capacity

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INTRODUCTION

Respiration is the exchange of blood and oxygen via the lungs, which are the essential part of the ventilation system[1)]. The respiratory muscles can be divided into inspiration and expiration muscles. The major inspiratory muscles that engage during inspiration are the diaphragm and external intercostal muscles. Meanwhile, the accessory inspiratory muscles that engage spine movement are the sternocleidomastoid, scalene, trapezius, and serratus anterior muscles[2)]. Among the methods for improving respiratory function, inspiratory muscle training improves the strength and endurance of the diaphragm and accessory inspiratory muscles[3)]. Moreover, it improves ventilation function even when the inspiratory muscles are damaged by neurological or non-neurological lesions[4)].

Hence, self-stretching of the inspiratory muscles can improve respiratory function. Self-stretching of the inspiratory muscles not only improves pulmonary function, but can also increase joint mobility in the thoracic cage, further improving respiratory function[5)]. Although the self-stretching of accessory inspiratory muscles improves respiratory function, most previous studies involve interventions targeting respiratory muscles or exercises for thoracic cage mobility[6)]. Furthermore, few studies have investigated the effects of cervical muscle (i.e., accessory inspiratory muscle) stretching on the respiratory function. Therefore, this study examined the effects of cervical muscle self-stretching on pulmonary function, especially slow vital capacity.

SUBJECTS AND METHODS

The study sample consisted of 30 subjects (10 males and 20 females) who were studying at a university in Busan, Korea. All subjects were informed of the purpose and methods of the study beforehand and voluntarily agreed to participate. This study complied with the ethical standards of the Declaration of Helsinki, and written informed consent was obtained from all subjects. The inclusion criteria were as follows: no lung disease, history of respiratory dysfunction, or cervical injury; ability to perform cervical stretching without difficulty; no experience with any exercise program aiming to promote pulmonary function; and agreement to not take any drugs or perform other exercise during the study period.

The subjects were randomly divided into 2 groups of 15 each: the experimental group performed stretching, while the control group received no treatment. For the stretching program, the muscle was stretched slowly and gently without pain, and each posture was held for 30 seconds. The stretching was performed twice per day, 4 times per week for 4 weeks. Cervical flexion and rotation were performed as a warm-up. The main self-stretching exercise consisted of 4 types of muscle exercises targeting the sternocleidomastoid,

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Table 1. Pulmonary function changes in the experimental group

		Pre-exercise	Post-exercise	Mean rank	Rank sum
Slow vital capacity	EVC (L)*	2.71 ± 0.68	3.18 ± 0.55	10.00	10.00
				7.86	110.00
	ERV (L)*	0.98 ± 0.42	1.41 ± 0.46	1.00	1.00
				8.50	119.00
	IRV (L)*	1.31 ± 0.34	1.64 ± 0.67	2.67	8.00
				9.33	112.00
	VE (L/min)	8.25 ± 4.11	8.08 ± 3.88	7.88	63.00
				8.14	57.00
	IC (L)	1.74 ± 0.32	1.85 ± 0.36	9.33	28.00
				7.67	92.00

Data are mean ± SD, *p < 0.05

Table 2. Pulmonary function changes in the control group

		Pre-exercise	Post-exercise	Mean rank	Rank sum
Slow vital capacity	EVC (L)*	3.15 ± 0.81	2.99 ± 0.82	8.58	103.00
				5.67	17.00
	ERV (L)	1.15 ± 0.34	1.05 ± 0.28	8.80	88.00
				6.40	32.00
	IRV (L)*	1.50 ± 0.51	1.29 ± 0.48	8.69	113.00
				3.50	7.00
	VE (L/min)	9.12 ± 3.12	9.38 ± 2.56	8.00	56.00
				8.00	64.00
	IC (L)*	2.03 ± 0.60	1.88 ± 0.61	9.05	99.50
				5.13	20.50

Data are mean ± SD, *p < 0.05

Table 3. Comparison of pulmonary function between groups

		Group	Values	Mean rank	Rank sum
Slow vital capacity	EVC (L)*	Experimental	0.47 ± 0.48	21.67	325.00
		Control	−0.16 ± 0.21	9.33	140.00
	ERV (L)*	Experimental	0.43 ± 0.37	21.80	327.00
		Control	−0.10 ± 0.18	9.20	138.00
	IRV (L)*	Experimental	0.33 ± 0.65	22.20	333.00
		Control	−0.21 ± 0.18	8.80	132.00
	VE (L/min)	Experimental	−0.18 ± 1.96	14.97	224.50
		Control	0.26 ± 2.33	16.03	240.50
	IC (L)*	Experimental	0.12 ± 0.32	20.20	303.00
		Control	−0.15 ± 0.22	10.80	162.00

Data are mean ± SD, *p < 0.05

upper trapezius, scalene, and levator scapulae muscles were performed 3 times for 30 seconds each. Cervical flexion and rotation were performed again as a cool-down exercise. Meanwhile, the control group did not perform the stretching program and was merely revaluated after 4 weeks.

Pulmonary function was measured by spirometry (Pony FX, Cosmed Inc., Italy). Before measuring slow vital capacity, the subject breathed normally 4 times; the machine subsequently beeped, and the subject inhaled slowly as much as possible. The subject subsequently exhaled as much as possible and then recovered normal breathing. The items of slow vital capacity include expiratory vital capacity (EVC), expiratory reserve volume (ERV), inspiratory reserve volume (IRV), expiratory minute ventilation (VE), and inspiratory capacity (IC).

The Wilcoxon signed-rank test was used to examine the effects of cervical muscle self-stretching on pulmonary function. The changes of pulmonary function were determined by subtracting the data after self-stretching from those before self-stretching. Furthermore, the Mann-Whitney *U*-test was used to analyze differences between groups. SPSS version 21.0 for Windows was used for all analyses. The level of significance was set at $p < 0.05$.

RESULTS

In the experimental group, EVC increased significantly from 2.71 to 3.18 after self-stretching ($p < 0.05$). ERV increased significantly from 0.98 to 1.14 ($p < 0.05$). IRV increased significantly from 1.31 to 1.64 ($p < 0.05$). VE decreased from 8.25 to 8.08 after self-stretching, but the difference was not significant ($p > 0.05$). Although IC increased from 1.74 to 1.85, the difference was not significant ($p > 0.05$) (Table 1).

Meanwhile, in the control group VC decreased significantly from 3.15 to 2.99 ($p < 0.05$). ERV decreased from 1.15 to 1.05, although the difference was not significant ($p > 0.05$). IRV decreased significantly from 1.50 to 1.29 ($p < 0.05$). VE increased from 9.12 to 9.38, but the difference was not significant ($p > 0.05$). IC decreased significantly from 2.03 to 1.88 ($p < 0.05$) (Table 2).

Comparison of the changes in pulmonary function between groups showed EVC, ERV, IRV, and IC were significantly higher in the experimental group ($p < 0.05$). VE was lower in the experimental group than the control group, although the difference was not significant ($p > 0.05$) (Table 3).

DISCUSSION

Limited thoracic cage movement and respiratory muscle dysfunction cause pulmonary dysfunction. Thus, improving thoracic cage movement and respiratory muscle strengthening can improve pulmonary function. Kim[7] found that lumbar stabilization movement and trunk muscle stretching significantly increase VC, FVC, and MVV. Meanwhile, Choi and Oh[8] report that chest mobilization exercise improves the pulmonary functions of stroke patients. These studies demonstrate that it is vital to promote thoracic cage mobility in order to improve pulmonary function. Joint mobilization and stretching are effective interventions for this purpose. However, previous studies only investigated the effects of interventions targeting the respiratory muscles (e.g., intercostal muscles and diaphragm) on pulmonary function.

On the other hand, although thoracic cage movement is known to be affected by cervical muscles, studies about the effects of interventions targeting the cervical muscles on pulmonary function are insufficient. Hence, the present study determined if self-stretching of the accessory inspiratory muscles can improve pulmonary function. The self-stretching program targeted the sternocleidomastoid, upper trapezius, scalene, and levator scapulae muscles. The origins of the sternocleidomastoid are the clavicle and sternum, and its insertion is the mastoid process of the temporal bone and superior nuchal line[9]. The upper trapezius originates from the occipital bone and inserts at the clavicle, acromion, and scapular spine[10]. The scalenes originate from the second to seventh transverse process and the costal process of the cervical vertebra and insert at the first and second ribs[11]. The levator scapulae originate from the first to fourth transverse process of the cervical vertebra and insert at the scapular superior angle[12].

As these 4 muscles are not only involved in cervical movements, but also thoracic cage movement, we hypothesized thoracic cage movement would increase after self-stretching, thus improving pulmonary function. Indeed, self-stretching improved EVC, ERV, and IRV. These findings are very similar to those of Han et al.[13], who found that stretching and strengthening exercises targeting the cervical muscles improved pulmonary function in 18 patients with allergic rhinitis patients. Han et al.[13] also report that the cervical muscle intervention improved thoracic cage movement, which consequently improved pulmonary function. This phenomenon also explains the results of the present study. In other words, self-stretching of the accessory inspiratory muscles improved chest muscle length and thus improved pulmonary function. In conclusion, self-stretching of the accessory inspiratory muscles improves pulmonary function. Therefore, self-stretching of the accessory inspiratory muscles should be included in intervention programs aiming to strengthen pulmonary function.

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