J. Phys. Ther. Sci.
23: 119–121, 2011

The Effect of Cervical Muscle Exercise on Respiratory Gas in Allergic Rhinitis

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Abstract. [Purpose] This study assessed the effect of stretching and strengthening exercises for the cervical muscles on the respiratory gas transport system in allergic rhinitis patients. [Subjects] The research subjects were those who had been diagnosed with allergic rhinitis by an otorhinolaryngologist and had at least one distinctive symptom such as sneezing, rhinorrhea, nasal obstruction, or pruritus whose severity level was higher than mild according to the diagnostic criteria test of ARIA (allergic rhinitis and its impact on asthma). [Methods] After sufficiently explaining about the research to the subjects before the experiment, the experimental group carried out three sets of stretching exercises for the sternocleidomastoid and scalene and strengthening exercises for the upper trapezius and suboccipitals ten times a day for five days a week with the aim of rectifying muscle imbalances. Respiratory gas was analyzed after eight weeks of exercises using a wireless metabolic measurement system (K4b2, Cosmed, Italy). The independent t-test and paired t-test were used to compare respiratory gas results. [Results] Tidal volume (Vt), oxygen uptake (VO2), carbon dioxide emission (VCO2), minute ventilation (VE), breathing frequency (BF), and heart rate (HR) significantly increased after the experiment in experimental group, while respiratory parameters did not significantly change in the control group except for VE. [Conclusion] A combination of postural and breathing exercises were effectively rectified muscle imbalances and posture in the experimental group as measured by changes in cardiopulmonary function.
Key words: Allergic rhinitis, Cervical muscle exercise, Respiratory gas

(This article was submitted Jul. 23, 2010, and was accepted Aug. 19, 2010)

INTRODUCTION

Rhinitis is an inflammation of the mucosa by definition and allergic rhinitis refers to cases in which inflammation of the nasal mucosa is caused by a hypersensitivite reaction to allergic antigens[1]. The symptoms of allergic rhinitis include paroxysmal sneezing, rhinorrhea, nasal pruritus, and nasal obstruction, the main causes of which are exposure to outdoor pollution or pollen. Among them, nasal obstruction is most common accounting for almost half of all cases. Persistent nasal obstruction can cause sleep disturbance, attention deficit, and depression, significantly lowering subjects' quality of life[2].

Nasal obstruction naturally results in respiration through the mouth, and most patients who have allergic rhinitis breathe through the oral cavity instead of the nasal cavity due to chronic obstruction of the airways[3]. When this mouth breathing continues, functional and anatomical problems appears in body posture as the resistance in the nasal cavity increases. As a result, the muscles assisting respiration in the neck keeps contracting, which in turn pushes the head forward raising abduction of the scapula. As such, breathing through the oral cavity with limited respiration through the nasal cavity causes insufficient ventilation and increases the respiratory work, causing respiratory imbalances[4].

When dysfunctional habits that limit lung ventilation in daily routine become ingrained, an exercise to restore normal function is necessary. Recovery can only be obtained by exercises that individuals can actively participate in[5]. Especially, the postures commonly observed among rhinitis patients, such as excessive protrusion of the head or slouchy shoulders, emerge as a result of continued abnormal physical stress due to the mechanical factor of muscle imbalances[6]. Carrying out active stretching exercise and strengthening exercise to control asymmetric posture and muscle contraction can reduce the abnormal stress arising from incorrect posture, eventually restoring effective ventilation through the nasal cavity[7].

Hence, maintaining and enhancing ventilation function among subjects with allergic rhinitis is a very important rehabilitation intervention. The purpose of this study was to achieve careful respiratory management by evaluating the effects of stretching and strengthening exercises for the

cervical muscle on the respiratory gas transport system.

SUBJECTS AND METHODS

The study sample consisted of 18 subjects who had been diagnosed with allergic rhinitis by an otorhinolaryngologist and had at least one distinctive symptom such as sneezing, rhinorrhea, nasal obstruction, or pruritus whose severity level was higher than mild according to the diagnostic criteria test of ARIA (allergic rhinitis and its impact on asthma). For posture evaluation, subjects were asked to stand upright at a certain position from a wall and the linear and horizontal distances from the target occipital peak to the wall were measured[8]. After sufficiently explaining about the research to the subjects before the experiment, the experimental group carried out three sets of stretching exercise for the sternocleidomastoid and scalene and strengthening exercises for the upper trapezius and suboccipitals ten times a day for five days a week with the aim of rectifying abnormal posture and muscle imbalances[7]. Respiratory gas was analyzed after eight weeks of exercises using a wireless metabolic measurement system (K4b2, Cosmed, Italy). An adjustable tape was attached to the body a little bit below the nipples in order to measure the heartbeat. A mask that covers the nose and mouth was also used. The wireless metabolic measurement system was used front and back. The slope of a treadmill was fixed at 0%. For the first two minutes, subjects stood still on the treadmill. Then, the speed was increased to a regular walking speed of 5 km/hr and maintained until 5 min; it took 30–40 seconds to arrive at the determined walking speed. The average heart rate before performing the gas analysis ranged from 65 to 70. Tidal volume (Vt), oxygen uptake (VO2), carbon dioxide emission (VCO2), minute ventilation (VE), breathing frequency (BF), and heart rate (HR) were measured when the resistance reached 0.8–0.9. For data analysis the, means and standard deviations of all the measurements were computed and the independent t-test and paired t-test were conducted. The statistics program, SPSS/WIN (ver 17.0), was used with a significance level of α=0.05.

RESULTS

Eighteen subjects participated in this study. The control group comprised 3 males (33.3%) and 6 females (66.7%) with an age of 20.22 ± 1.39 years, height of 166.88 ± 8.78 cm, weight of 61.44 ± 9.81 kg, and hospital stay of 38.18 ± 7.65 month, and the experimental group comprised 4 males (44.4%) and 5 females (55.6%) with an age of 21.00 ± 1.65 years, height of 165.44 ± 8.64 cm, weight of 59.77 ± 10.91 kg, and hospital stay of 41.26 ± 8.33 month. The rhinitis subjects who participated in this experiment were chosen by evaluation of their posture in the sagittal plane from among those who had imbalance in the cervical muscle because of forward head. The occipital peak value of the forward head of the subjects in the sagittal plane referring to the center line of the body mass was changed from 14.66 ± 0.72 cm to the 13.97 ± 0.42 cm (t=5.996, p=0.000) after the intervention in the experimental group, while it was changed from 14.67 ± 0.60 cm to 14.61 ± 0.59 cm in the control group (t=1.271, p=0.215).

Table 1. The comparison of cardiorespiratory function (Mean ± SD)

		Control group	Experimental group
Vt(*l*)	Pre-test	1.32 ± 0.23	1.30 ± 0.21a
	Post-test	1.45 ± 0.27*	1.63 ± 0.29*a
VO2(*l*/min)	Pre-test	290.20 ± 44.22	292.05 ± 42.54 a
	Post-test	307.70 ± 62.86*	433.62 ± 60.29* a
VCO2(*l*/min)	Pre-test	270.47 ± 44.27	268.98 ± 42.33 a
	Post-test	285.83 ± 39.26*	1157.53 ± 902.31* a
VE(*l*/min)	Pre-test	9.98 ± 0.88 a	9.71 ± 0.93 a
	Post-test	10.75 ± 0.90* a	11.72 ± 1.47* a
BF(f/min)	Pre-test	21.50 ± 1.30	21.94 ± 1.70 a
	Post-test	22.12 ± 1.60*	23.71 ± 2.23* a
HR(beats/min)	Pre-test	70.11 ± 4.04	70.77 ± 4.92 a
	Post-test	72.44 ± 3.98	73.40 ± 3.68 a

*: significant difference between control group and experimental group ($p<0.05$). a: significant difference between pre and post intervention ($p<0.05$). Vt: Tidal volume, VO2 : Oxygen uptake, VCO2 : Carbon dioxide emission, VE: Minute ventilation, BF : Breathing frequency, HR : Heart rate.

We also examined the effect of exercise on cardiopulmonary function by asking the rhinitis patients, who were in their twenties, to do regular exercise five times a week for eight weeks. According to the results, the control group showed a significant difference in their VE before and after the experiment ($p<0.05$), while the other respiratory parameters did not significantly change ($p>0.05$). However, in the experimental group, Vt, VO2, VCO2, VE, BF, and HR significantly increased after the intervention ($p<0.05$). Moreover, the respiratory parameters after performance of both stretching and strengthening exercises by the two groups, showed statistically significant change ($p<0.05$), while no difference in HR was found ($p>0.05$).

Tidal volume (Vt), oxygen uptake (VO2), carbon dioxide emission (VCO2), minute ventilation (VE), breathing frequency (BF), and heart rate (HR) significantly increased after the experiment in the experimental group ($p<0.05$), while respiratory parameters did not significantly change in the control group ($p>0.05$) except for VE ($p<0.05$). The respiratory parameters after the cervical muscle exercise were significantly different between the two groups: Vt, VO2, VCO2, VE and BF ($p<0.05$) (Table 1).

DISCUSSION

Respiration is the first vital function to develop after birth, establishing itself as the organism's primary function. The nasal cavity has a fundamental role in respiratory physiology, filtering, heating and humidifying inspired air, ensuring that it arrives in the lungs at the ideal temperature favoring correct oxygenation of the organism. The oral cavity only participates in this process when inspired air is

not sufficient, which is generally caused by nasal obstruction[9]. There are many factors which may result in mouth breathing and allergic rhinitis is possibly the most common cause of chronic airway obstruction, affecting from 15 to 20% of the population[10].

Mouth breathers observed among the rhinitis patients project their heads forwards to facilitate and accelerate airflow. The postural equilibrium of the head is the most important factor in achieving good posture[11].

In our present study, it was observed that the head and the position of the shoulders behaved differently in the control group from the experimental group. Our findings support those of Ribeiro et al.[4] who evaluated the electrical activity of the upper fibers of the trapezius and sternocleidomastoid muscles in mouth breathing. They reported that the muscles showed increased muscular activity in order to maintain the head and neck in an position appropriate for thereby reducing airway constriction.

In the present study, we examined how exercises could improve the limited airways and ventilation of allergic rhinitis subjects. Specifically, stretching exercise for the sternocleidomastoid and scalene and strengthening exercises for the upper trapezius and suboccipitals were carried out five times a week for eight weeks with the aim of restoring the correct position of head. After the intervention, we tested cardiopulmonary function using a wireless metabolic measurement system. For cardiopulmonary function HR was examined, which is most fundamental and sensitive reaction of the body, together with BF, VO2, VCO2, Vt, and VE.

VO2 and VCO2 measure oxygen uptake and removal of the metabolite, carbon dioxide. In this study, VO2 and VCO2 increased after exercise in the experimental group, while the control group showed no change in the transport of oxygen or carbon dioxide. Moreover, Vt increased from 1.30 ± 0.21 *l* to 1.63 ± 0.29 *l* and VE increased from 9.71 ± 0.93 *l*/min to 11.72 ± 1.47 *l*/min after the intervention in the experimental group. The control group showed change in only VE which was negligible. The significant increase in the ventilation rate was probably observed because the stretching and strengthening exercises had the effect of correcting the head forward posture, displacing it to the normal. The results showed that there was no significant change in the posture of the control group before and after the intervention, indicating that the forward head posture was maintained as the cervical muscles continually contracted. In contrast, the forward head posture of the experimental group was significantly improved after the intervention showing that the cervical muscle exercises effectively improved the abnormal posture that was limiting ventilation. The positive change in the posture, due to recovery of the cervical muscle function, may have reduced the airway resistance.

BF and HR did not show any change in control group, whereas both showed significant increase in the experimental group. The increase in BF can be attributed to the breathing exercises that became active following the increased ventilation rate. Increase in HR is a desirable effect that can lessen the burden on the heart. A combination of postural and breathing exercises was effective in restoring muscle imbalances and posture in an experimental group as measured by changes in cardiopulmonary function.

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