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Effects of Exercise on Cervical Angle and Respiratory Function in Smartphone Users

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Objectives: The aim of this study was to determine whether exercises can change the cervical angle and respiratory function in smartphone users.
Methods: Thirty healthy volunteers were recruited. The subjects were randomly divided into an exercise group and a control group. All participants used a smartphone for 1 hour while maintaining a sitting posture. Then, each group performed their assigned activity. The exercise group performed two types of exercises and the control group maintained routine activities for 20 minutes. To investigate the changes in cervical angle and respiratory function, we measured the craniovertebral angle by using a spirometer.
Results: Statistically significant differences were noted in the craniovertebral angle, forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, peak expiratory flow, maximal inspiratory pressure, and maximal expiratory pressure of the two groups ($p < 0.05$).
Conclusion: Our findings showed that proper exercise could be a good method of improving the cervical angle and respiratory function in smartphone users.

Key Words: smartphone, respiratory function test, cervical vertebrae

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INTRODUCTION

Recently, the number of smartphone users has been increasing worldwide. More than 20 million people were smartphone users, as of October 2011 in South Korea, which comprises approximately 40% of the whole South Korean population [1]. Accordingly, the negative aspects of smartphone overuse have been emerging as a major topic of interest in young adults. Those problems vary and include disruption of social interactions and poor mental health [2]. Moreover, smartphone overuse could lead to musculoskeletal problems and decreased activity in smartphone users may affect their respiratory function [3].

Recent studies have shown that users of mobile devices tend to complain of pain in the neck, shoulder, and thumb [4]. Such pain has often been referred to as the "text neck," which results from being in a position resembling the forward head posture frequently or for long durations. Smartphone users typically hold their device with one or two hands below their eye height, look down at the device, and type on or touch the touchscreen display mostly using the thumb [5]. Maintaining this abnormal posture may influence the respiratory function. Some studies have reported that the forward head posture causes nasal breathing or mouth breathing in school-aged children. Mouth breathing is a mechanically incorrect form of respiration. A previous study interpreted this result as being due to an alteration in the positioning of the mandible, resulting from the forward head posture [6].

Such symptoms from abnormal posture can be alleviated using exercise intervention [7]. There are a number of studies about the adverse effects of smartphone overuse. However, there is no study about the effect of exercise in solving the abnormalities (such as in posture or respiration) in smartphone users. Therefore, the aim of our study was to investigate how exercise could change the cervical angle and respiratory function in smartphone users.

MATERIALS AND METHODS

1. Study subjects

Thirty healthy volunteers were recruited from Daegu University, South Korea. The subjects were randomly divided into an exercise group and a control group. The characteristics (mean ± standard deviation) of the subjects in the exercise group (7 men and 13 women) were as follows: age, 22.12 ± 3.21 years; height, 166.04 ± 7.65 cm; and weight, 58.12 ± 13.05 kg. The age, height, and body weight (mean ± standard deviation) of the control group (8 men and 12 women) were 23.13 ± 1.43 years, 167.52 ± 7.21 cm, and 60.21 ±10.56 kg, respectively.

Subjects were excluded if they had a history of cervical fracture or trauma, bone cancer, neurological motion disorder, restrictions in lung function, and other neurologic, orthopedic, or unstable cardiac conditions; were smokers or became nonsmokers within 5 years; or had undergone a thoracic or abdominal surgery. Informed consent was voluntarily obtained from all subjects before participation in the study. The study was approved by the Institutional Review Board of Daegu University (No. 1040621-201405-HR-013-08).

2. Procedure

All participants used a smartphone while in a sitting position for 1 hour. Thereafter, each group performed the assigned activity. The subjects in the exercise group laid supine with their head upward and their chin tucked for strengthening the deep neck flexors. Both hands were placed on the abdomen. This exercise consisted of 10 repetitions of 10-second holds with a rest period of 15 seconds. In addition, the exercise group was positioned in a prone hip bridge with the forearms and toes supporting the body on the floor or table. They then performed push-ups of 1- to 2-cm height, protracting the scapula but actively attempting to prevent scapular winging. This exercise consisted of 10 repetitions. The subjects performed three sets of 10 repetitions of each exercise with a rest period of 3 minutes between each exercise. The total exercise time was 20 minutes. The subjects in the control group maintained routine activities while sitting on a stool during 20 minutes.

3. Craniovertebral angle measurement

To determine the subjects' posture and lung function, we measured their craniovertebral angle (CVA) and respiratory function. The cervical angle was assessed by using the CVA. Lesser CVA indicates greater forward head posture. The CVA showed good test-retest reliability in previous studies (intraclass correlation coefficients ranging from 0.88 to 0.98). CVA was assessed by using digital lateral-view photographs of the subjects in their usual standing posture. The photographs were taken laterally by using a digital camera (Alpha NEX-6; Sony, Beijing, China). The CVA was calculated with Adobe Photoshop CS6 (Adobe Systems, San Jose, CA, USA). To minimize image distortion, the experimenter placed a circular spirit level at the base of the camera to ensure that the camera was perpendicular to the horizontal plane. Then, the tragus of the subject's ear was marked. Moreover, the seventh cervical vertebra was located and marked by finding its bony landmark; this was done by asking the subject to flex and extend the head three times, to locate the seventh spinous process of the vertebra. Then, the angle was calculated between the line connecting the tragus of the ear and the seventh cervical vertebra to the horizontal plane.

4. Respiratory function assessment

Respiratory function testing was performed with a spirometer (Cardiotouch 3000; BIONET, Seoul, Korea), which calculated and recorded the forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), ratio of FEV1 to FVC (FEV1/FVC), and peak expiratory flow (PEF). Each subject was seated and asked to look straight ahead with the mouthpiece of the spirometer inserted in the mouth and a nose clip fixed on the nose. The maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) were measured to determine the PImax values by using a respiratory pressure meter (MicroRPM; CareFusion, Basingstoke, Ireland). Maximum inhalation and exhalations were performed in a comfortable sitting position. Measurements were performed before and after the experiment.

5. Data analysis

Statistical analysis was performed by using PASW Statistics software version 18.0 (IBM Co., Armonk, NY, USA). Data were analyzed by using analysis of covariance to examine differences in the results between the two groups. Statistical significance was set at $p < 0.05$.

RESULTS

The general characteristics of the subjects were not significantly different between the two groups ($p > 0.05$). Observational data concerning the CVA and respiratory function in both groups are summarized in Table 1. Significant differences were noted in CVA, FVC, FEV1, FEV1/FVC, PEF, MIP, and MEP between the two groups ($p < 0.05$).

DISCUSSION

In this study, we investigated whether exercise could improve the status of the cervical angle and respiratory function in smartphone users. The exercise group showed significant increases in all variables compared with the control group. These results suggest that exercise can be a method of improving the cervical angle and respiratory function in smartphone users.

CVA measurement is an objective assessment of changes in the cervical angle. Previous studies found that subjects with head, neck, and shoulder discomfort are more likely to have a smaller cervical angle [8]. Lau et al. [9] showed that the average cervical angle of subjects with neck pain was 40.8° ± 5.4°. In this study, most subjects did not have any severe discomfort; thus, their cervical angle was generally > 50°. The results from the exercise group showed that exercise may be an effective method of decreasing the cervical angle.

In this study, all variables of respiratory function showed significant improvements in the exercise group. This result could be explained in two respects. First, it may be correlated with the effect of facilitated respiratory muscles. The two exercises in this study involved various muscles (e.g., sternocleidomastoid, scalene, serratus anterior, and trapezius) [7,10]. Moreover, these muscles are also known as accessory muscles of respiration [11]. Although the exercises were short and simple, the facilitated muscles would influence the improvement of respiratory function.

Second, the slight change in posture induced by the exercises may improve respiratory function. According to a previous study, exercise intervention could successfully reduce forward head posture [7]. In addition, there have been many studies about the correlation between posture and respiration [12–14]. Lee et al. [13] reported that cervical lordosis due to forward head posture affects vital lung capacity. Another study revealed that cervical sustained natural apophyseal glide is effective for improving neck posture and respiratory function in patients with forward head posture [12].

The findings of this study showed that proper exercise could be a good method of improving decreased cervical angle and respiratory function in smartphone users. Despite the limitation of this study, we could confirm the potential effect of exercise on posture and respiratory function in smartphone users. Further studies are required to investigate the various problems experienced by smartphone users and also to determine how the intervention works.

Many modern people are using smartphones for long durations worldwide. This leads to abnormal posture, which then causes health problems. Our findings showed that proper exercise could be a good method of improving decreased cervical angle and respiratory function in smartphone users.

Table 1. Forward head posture and respiratory function of each group

		Exercise group (n = 15)	Control group (n = 15)	*p*-value
Forward head posture				
CVA (°)	Pre	52.6 ± 6.1	53.8 ± 5.62	0.00*
	Post	54.4 ± 5.9	53.8 ± 5.5	
Respiratory function test				
FVC (L)	Pre	3.3 ± 0.9	3.1 ± 0.8	0.00*
	Post	3.4 ± 0.9	3.1 ± 0.7	
FEV1 (L)	Pre	2.8 ± 0.8	2.9 ± 0.8	0.00*
	Post	3.1 ± 0.7	3.0 ± 0.7	
FEV1/FVC (%)	Pre	85.7 ± 10.7	94.1 ± 7.2	0.02*
	Post	93.2 ± 5.2	94.9 ± 4.4	
PEF (L/s)	Pre	5.2 ± 2.2	5.9 ± 2.1	0.00*
	Post	5.5 ± 1.6	5.8 ± 1.8	
MIP (cm H_2O)	Pre	68.4 ± 36.4	82.3 ± 27.1	0.00*
	Post	79.0 ± 41.5	76.9 ± 25.4	
MEP (cm H_2O)	Pre	71.9 ± 28.1	74.0 ± 30.0	0.00*
	Post	85.3 ± 35.0	75.5 ± 24.7	

Values are presented as mean ± standard deviation.
CVA, craniovertebral angle; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; FEV1/FVC, ratio of FEV1 to FVC; PEF, peak expiratory flow; MIP, maximal inspiratory pressure; MEP, maximal expiratory pressure.
*Significant difference ($p < 0.05$) between the two groups.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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