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Original Article

The effect of smartphone usage time on posture and respiratory function

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Abstract. [Purpose] The aim of this study was to evaluate the changes in posture and respiratory functions depending on the duration of smartphone usage. [Subjects and Methods] Participants were randomly allocated to 2 groups: group 1 (subjects who used smartphones for <4 hours/day, n=25) and group 2 (subjects who used smartphones for >4 hours/day, n=25). The craniovertebral angles of all participants were measured and scapular indices were calculated to assess the change in posture and forced vital capacity, forced expiratory volume in 1 second, the ratio of forced expiratory volume in 1 second to forced vital capacity, and peak expiratory flow were measured to assess changes in respiratory function. [Results] There were significant differences in the craniovertebral angle, scapular index, and peak expiratory flow depending on the duration of smartphone usage. [Conclusion] The result of this study showed that prolonged use of smartphones could negatively affect both, posture and respiratory function.
Key words: Smartphone, Posture, Respiratory function

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INTRODUCTION

In the past few years, the number of smartphone users have progressively increased worldwide[1)]. With the growing use of smartphones, concerns have also increased about musculoskeletal problems associated with the prolonged use of smartphones. Recent investigations have shown that smartphone users tend to report pain in the neck, shoulder, and thumb, and the severity of the symptoms as the total time spent using the smartphone increases[2)]. Prolonged smart phone usage causes faulty posture such as forward neck posture, slouched posture, or rounded shoulders[3)]. Sustained forward neck posture can cause injury to the structure of the cervical and lumbar spine, as well as ligaments[4, 5)]. These structural problems caused by faulty posture can also lead to respiratory dysfunction[6)]. Perry et al. investigated the possibility correlation between dysfunctional breathing and musculoskeletal pain patterns. Their result showed that 83% of patients with neck pain (caused by faulty posture) experienced a changed breathing pattern. This study indicated that there was a relationship between neck pain and respiration[7)]. The adverse effects of prolonged sitting and a sedentary lifestyle on our health are well known, and similarly, we should understand the effect of prolonged smartphone usage on our posture and respiratory function. Therefore, our study focused on the change in the subjects body posture and respiratory function caused by using smartphones for prolonged durations. The aim of this study was to evaluate the changes in the posture and respiratory functions depending on the duration of smartphone usage.

SUBJECTS AND METHODS

Fifty healthy volunteers were recruited from Daegu University, South Korea. The subject characteristics (mean ± SD) were: 21 ± 2.41 years old; 168 ± 8.15 cm in height; 65 ± 14.41 kg in body weight. The subjects were divided in to 2 groups

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according to the duration of smartphone usage reported by each individual: group 1 for those that used smartphones less than 4 hours per day (3.0 ± 1.0 hours), and group 2 for those that used smartphones for more than 4 hours each day (5.5 ± 1.0 hours).

Subjects were excluded if they met any of the following conditions: had experienced cervical fracture or trauma, bone cancer, neurological motion disorders, restrictions in lung function, or other neurologic, orthopedic, or unstable cardiac conditions; were smokers or smoke-free within 5 years; or had undergone thoracic or abdominal surgery. Informed consent was voluntarily obtained from all the subjects prior to participation in the study, and this study was approved by the Institutional Review Board of Daegu University.

To determine the subjects' posture and lung function, we examined craniovertebral angle (CVA), scapular index and respiratory function. Forward head posture (FHP) was assessed by using CVA. A lower CVA indicates greater FHP. CVA showed good retest reliability in previous studies (intra-class correlation coefficients ranged from 0.88 to 0.98)[8].

CVA was assessed by using a digital, lateral-view photograph of the subjects in their usual standing posture. A photograph was taken laterally by using a digital camera (AlpaNEX-6; Sonny, China). The CVA was calculated by using Adobe Photoshop CS6. To minimize image distortion, the assessor placed a circular spirit level at the base of the camera to ensure that the camera was positioned perpendiculary to the horizontal. The tragus of the subject's ear was marked, and the seventh cervical vertebra was found and marked by finding its bony landmark. This was done by asking the subject to flex and extend her head 3 times, and then finding the seventh spinous process of the vertebra. The angle of FHP was calculated between the line connecting the tragus of ear to seventh cervical vertebra and the horizontal plane[9].

To assess for rounded shoulders, subjects were asked to stand normally with their hands hanging beside the body. The coracoid process, sternal notch, posterior edge of the acromion process and the adjacent thoracic vertebral spine were then palpated and marked. The distance between the coracoid process and sternal notch, and the distance between the posterior edge of acromion process and the adjacent thoracic vertebral spine were measured by using tape. The scapular index was calculated by using the following formula[10, 11] (Fig. 1).

Test of respiratory function were performed by using a spirometer (Cardiotouch 3000. BIONET). The spirometer calculated and recorded the following measurements: forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), ratio of forced expiratory volume in 1 second to forced vital capacity (FEV1/FVC), and peak expiratory flow (PEF). Each subject was seated and asked to look straight ahead, while the mouthpiece of the spirometer was inserted into their mouth and a nose clip was fixed on their nose. The same assessor performed measurements throughout the entire experiment and the most physiological respiratory function test results of three trials was recorded.

Statistical analysis was performed by using Statistical Package for Social Sciences (SPSS) version 18.0 (SPSS Inc., Chicago, USA). Data were analyzed by using the independent t-test to examine for differences in results between the 2 groups. Statistical significance was defined as $p < 0.05$.

RESULTS

A total of 50 subjects participated in the study, with 25 subjects in each group. The general characteristics of the subjects were not significantly different between the groups ($p > 0.05$). The observational data regarding CVA, scapular index, and respiratory function tests of both groups is summarized in Table 1. Significant differences were noted for CVA, scapular index, and PEF of the 2 groups ($p < 0.05$).

DISCUSSION

Our study measured CVA and scapular index as parameters to demonstrate the effect of prolonged smartphone use on change in posture. We also measured FVC, FEV1, FEV1/FVC and PEF as parameters to demonstrate the change in respiratory function cause by prolonged smartphone use. The results of this study show significant differences in CVA, scapular index and PEF. As shown in Table 1, subjects who used smartphones for prolonged durations tended to have poorer FHP and rounded shoulders compared with the subjects who spent less time on smartphones. It also shows that people who used smartphones for prolonged durations had partly impaired respiratory function.

FHP is one of the most common cervical abnormalities that predisposes individuals to pathological conditions, such as headache, neck pain, temporomandibular disorders, vertebral body disorders, alterations in the length and strength of soft-tissue, and scapula and shoulder dyskinesia[12]. Many studies proved that prolonged computer users tended to have a higher ratio of FHP[13–15]. If people concentrate on watching the relatively small screen, they tend to bend their neck more to look at the screen. This may be the reason for the development of more severe problems[16].

As stated earlier, a lower CVA indicates greater FHP. In our study, subjects who use smartphone more than 4 hours per day had lower CVAs. This result is consistent with the results from a recent study conducted by Kim et al. who showed that the increase in both flexion angles of the cervical and lumbar spine were significantly higher in the group of prolonged smartphone users (300 s) compared with the group of smartphone users that used the device for a short time (3 s)[16]. Another study showed that many smartphone users had neck pain due to increased cervical angles[17].

A lower scapular index indicates a higher degree of rounded shoulders. In our study, subjects who used smartphones more

$$\text{Scapular index} = \frac{SN\ to\ CP}{PLA\ to\ TS} \times 100$$

Fig. 1. The resting position of the scapula was determined by measuring the distance from the midpoint of the sternal notch (SN) to the medial aspect of the coracoid process (CP) (the length of the chest side) and the horizontal distance from the posterolateral angle of the acromion (PLA) to the thoracic spine (TS) (the length of the back side).

Table 1. Forward head posture (FHP), round shoulder, and respiratory function of the 2 groups

		Group 1 (n = 25)	Group 2 (n = 25)
Forward head posture	CVA (°)	54.5 (± 4.2)	53.0 (± 6.3)*
Round shoulder	Scapular index	67.5 (± 4.2)	65.5 (± 6.5)*
Respiratory function test	FVC (l)	3.3 (± 0.9)	2.8 (± 0.9)
	FEV1 (l)	3.0 (± 0.8)	2.5 (± 0.8)
	FEV1/FVC (%)	91.9 (± 9.9)	91.1 (± 8.6)
	PEF (l/sec)	6.2 (± 2.3)	4.3 (± 1.5)*

Values are expressed as mean (± standard deviation)
FHP is represented by caraniovertebral angle (CVA), greater CVA values indicatess a lower FHP
*significant difference between the 2 groups ($p < 0.05$)

than 4 hours per day, had lower scapular index. Many previous studies established that many sedentary workers tended to have a rounded shoulder posture. In our study, the use of smartphones, as well as prolonged sitting caused the typical rounded shoulder[18]. The other study showed that rounded shoulders is strongly associated with FHP[19]. Fernandez and colleague reported that neck musculoskeletal disorder (such as altered cervical posture) is related to thoracic kyphosis and rounded shoulder posture. Their hypothesis was that irregular lower trapezius condition and serratus anterior positions by abnormal scapular tilt can lead to rounded shoulder posture[5, 19].

In respiratory function, Only PEF showed significant difference between the two groups. However, other variables (FVC, FEV1, FEV1/FVC) also showed lower values like PEF in subjects using smartphone for prolonged duration. There are recent researches about the correlation between posture and respiratory function. Baghery et al. reported that respiratory function in slumped sitting is significantly lower than in other postures such as normal sitting or standing[20]. Similarly, kyphotic posture caused by using a smartphone for a long time can impair respiratory function.

The result of this study showed that using a smartphone for a prolonged duration could negatively effect both posture and respiratory function. These results may be used to promote awareness about smartphone usage. For health considerations, we need to pay attention to the duration of usage, as well as posture while using smartphones. This study has some limitations. The number of subjects was relatively small and we did not investigate the statistical relationship between posture and respiratory function. Another limitation is that we could not determine possible solutions to these problems. Therefore, future studies should further extend on this study in order to evaluate the missing insights and determine possible solutions to the problems caused by prolonged smartphone usage.

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