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Original Article

The effect of forward head posture on muscle activity during neck protraction and retraction

Kyeong-Jin Lee[1)], Hee-Young Han[1)], Song-Hee Cheon, PT, PhD[1)], So-Hyun Park, PT, PhD[1)], Min-Sik Yong, PT, PhD[1)*]

[1)] *Department of Physical Therapy, Youngsan University: 288 Joonam-ro, Yangsan, Kyeongsangnam-do, Republic of Korea*

Abstract. [Purpose] The present study was performed to investigate whether forward head posture (FHP) affects muscle activity. [Subjects and Methods] Twenty subjects attending Y university in Gyeongsangnam-do, Republic of Korea. They were divided into two groups according to craniovertebral angle: a control group (n=10) and a FHP group (n=10). Electromyography electrodes were attached to the upper fibers of the trapezius, middle fibers of the trapezius, the splenii (splenius capitis and splenius cervicis), and the sternocleidomastoid (SCM) muscle to measure muscle activity during the neck protraction and retraction. [Results] EMG activities of the middle trapezius, splenii, and SCM muscle showed significant differences between the control group and the FHP group. However, the EMG activity of the upper trapezius muscle showed no significant difference between the two groups during neck protraction and retraction. [Conclusion] The results suggest that FHP alters the muscle activity in neck protraction and retraction.

Key words: Forward head posture, Muscle activity, Electromyography

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INTRODUCTION

When maintenance of musculoskeletal balance occurs, the stress and strain on the body are minimized, and this condition is considered proper posture[1, 2)]. It is well-known that many factors including vision, the cerebellum and vestibular function have an influence on the maintenance of balance[3)]. In particular, Barett et al.[4)] stated that joint position sense plays an important role in the maintenance. Since the position sense is affected by mechanoreceptors located in muscles, muscle-related problem are also considered to be major factors influencing balance[3, 5)].

Forward head posture (FHP) is one of the most common types of postural abnormality, and it is generally described as an anterior position of the head in relation to the vertical line of the body's center of gravity[6, 7)]. Many researchers have reported that several factors, including headache, neck pain, and musculoskeletal disorders such as temporomandibular disorders or rounded shoulders, are related to FHP[1, 8)]. In addition, FHP leads to lengthening and weakness of the anterior cervical muscles as well as shortening of the posterior cervical muscles. If imbalances in cervical muscles resulting from postural misalignment are prolonged, an excessive load is imposed on the joint and muscle, thereby making the problems caused by FHP chronic[7)].

Recently, the use of computers or smart phones has become increasingly common, and their use has made FHP more common[3)]. Against this background, it has been suggested that further studies regarding FHP are necessary for patients suffering from FHP. The present study investigated whether there are differences in the muscle activities between subjects with forward head posture and with normal head posture.

SUBJECTS AND METHODS

Twenty subjects attending Y university in Gyeongsangnam-do, the Republic of Korea participated in the present study. They were divided into two groups according to the craniovertebral angle: a control group (n=10) and a FHP group (n=10) (Table 1). Lateral views of each subjects were photographed to measure the craniovertebral angle which was defined as the angle between the horizontal line passing through C7 and the line extending from the tragus of the external auditory meatus to C7. The base of camera was set at the height of the subjects shoulders. The tragus was marked, and a pointer as taped to the skin overlying C7 spinous process[6, 9)]. Subjects with an angle less than 53° were put in the FHP group[2, 6, 10)]. All the subjects were informed of the purpose of the present study and provided their written informed consent prior to their participation. The present study adhered to the ethical principles of the Declaration of Helsinki.

Electromyography activities were collected using a

*Corresponding author. Min-Sik Yong (E-mail: peast4ever@naver.com)

TELEMYO 2400 (Noraxon, USA). A sampling rate of 1,000 Hz was used for EMG signal acquisition, and the signals were full-wave rectified. Band pass filtering at 30–500 Hz was performed using MyoResearch-XP 1.07 (Noraxon, USA) software, and the signals were also notch filtered at 60 Hz to remove noise. The values of maximum voluntary isometric contractions (MVIC) of each muscle was used to normalize the values of the muscle activities. EMG electrodes were attached to four sites: the upper fibers of the trapezius, the middle fibers of the trapezius, the splenii (splenius capitis and splenius cervicis), and the sternocleidomastoid (SCM) muscle.

Statistical anslysis was performed using SPSS for Windows (version 18.0). In order to assess EMG activities according to neck protraction and retraction between the control group and the FHP group, the independent t-test was performed. All the measurements were expressed as the mean±standard deviation and significance was accepted at values of $p<005$.

RESULTS

The EMG activities of the splenii and SCM muscle showed significant differences between the control group and the FHP group during neck protraction ($p<0.05$) (Table 2). The EMG activity of middle trapezius muscle showed a significant difference between the two groups during neck retraction ($p<0.05$) (Table 2). However, there was no significant difference in the EMG activity of the upper trapezius muscle between the two groups during neck protraction and retraction.

Table 1. General characteristics of the subjects

	Control group	FHP group
Age (years)	20.7±1.3	21±1.4
Height (cm)	172.0±4.3	173.9±6.3
Weight (kg)	70.0±17.5	67.5±10.5

Values are expressed as the Mean±SD.

DISCUSSION

Almost everywhere, including homes, schools, and offices, computers and smart phones are commonly used today. Although this usage is efficient in terms of improvement in work productivity, it has also several negative aspects, e.g. headaches and visual problems, and musculoskeletal disorders are the most important negative factor resulting from the regular use of computers and smart phones[11, 12].

The present study investigated muscle activities of the upper trapezius, middle trapezius, splenii, and SCM in accordance with head posture. Higher values of activities in all muscles was shown in the control group compared with the FHP group when subjects performed neck protraction and retraction. These results implies that FHP is associated with reduced muscle activity.

FHP, head-on-trunk misalignment, leads to increased lordosis of the lower cervical spine as well as rounded shoulders accompanied by increased kyphosis of the thoracic spine. These musculoskeletal disorders change the balance of the muscles around the neck[3, 7]. Cesar et al.[13] reported that FHP usually results in shortening of not only the cervical extensor muscles including the splenii and upper trapezius, but also the SCM muscle. In addition, FHP causes weakness of the cervical flexor muscles as well as scapular retractors such as the middle trapezuis. The ability of a muscle to generate force is influenced by its length. When a muscle is shortened or lengthened compared to its resting position, its ability to generate force is reduced. In other words, the change in muscle length affects muscle activity, and this is associated with a force-length relationship[14, 15].

The results of the present study show that there were significant differences in the EMG activities of the splenii and SCM muscles between the control group and the FHP group during neck protraction. There was a significant difference in the EMG activity of the middle trapezius muscle between the groups during neck retraction. These results suggest that reduced length of the splenii and SCM muscles as well as increased length and weakness of the middle trapezuis muscle resulting from FHP affect EMG activity.

However, there was no significant difference in the EMG activity of the upper trapezius muscle between the groups. Although the upper trapezius is one of the muscles shortened

Table 2. Comparison of EMG activities during neck protraction and retraction between the control group and the FHP group (Unit: %MVIC)

Muscle	Movement	Control group	FHP group
SCM	Protraction	5.93±2.81	3.63±2.24*
	Retraction	4.72±3.00	2.98±1.62
Splenii	Protraction	10.75±9.41	5.34±3.81*
	Retraction	10.00±6.78	6.21±4.68
Upper Trapezius	Protraction	5.60±6.57	3.58±3.31
	Retraction	4.18±4.09	3.45±3.38
Middle Trapezius	Protraction	14.65±6.76	11.44±3.87
	Retraction	15.50±6.97	9.51±4.11*

Values are expressed as the Mean±SD.
*$p<0.05$

by FHP, a possible reason why no significant difference was found in this muscle is that the upper trapezius may not play a major role in neck protraction and retraction. The present study did not investigate the EMG activities of other muscles associated with FHP. In order to elucidate changes in EMG activities accompanied by different neck movements in FHP, further study of other FHP-related muscles should be encouraged.

In conclusion, FHP reduces the EMG activities of the middle trapezius, splenii, and SCM muscle. These results suggest that these reduced activities result from changes in muscle length due to FHP and are associated with a reduced ability to generate force.

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