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The Effect of Table Height on the Thickness of Neck Muscle during Computer Work

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Abstract

In modern society, using the Video Display Terminal (VDT) such as a personal computer or a smart-phone is universal that results in the increasing of upper extremity musculoskeletal diseases. The purpose of this study was to investigate the relationship between sternocleidomastoid muscle, upper trapezius muscle thickness and the height of table while the computer working. 15 healthy adult males and 15 females were recruited and agreed to participate as subjects in the study after a preliminary research. After setting 5cm, 15cm and 25cm height difference between the knee and the table, the subjects performed the computer work five minutes for each height while maintaining the working position of the machine and were measured the thickness of sternocleidomastoid and upper trapezius. As a result, there were significant difference for the change of thickness of upper trapezius and sternocleidomastoid muscle that were measured after the working of the computer on the height difference between the knee and the table in 5cm, 15cm and 25cm ($p<.05$). The thickness of all the sternocleidomastoid muscle and upper trapezius is thinnest at the time of the height difference in 15cm.

Keywords: Computer Work, Sternocleidomastoid Muscle, Ultrasonography, Upper Trapezius Muscle

1. Introduction

In modern society, using the Video Display Terminal (VDT) such as a personal computer or a smart-phone is universal that results in the increasing of upper extremity musculoskeletal diseases[25]. Among these, a computer has rapidly become a significant part of our daily life[1,2,6,24]. When we are working on keyboards, tensions on neck and shoulder muscles are affected by some factors, which are angle of thoracic vertebra and lumbar vertebra, posture of cervical vertebra, posture of upper arms, position and design of keyboards, skills of work and resting times. Using computer keyboards for a long time causes many musculoskeletal diseases[7]. Even though previous studies have shown that many young people and office workers complain about their musculoskeletal disease, public attention on this matter is insufficient[13].

The weight of head imposes heavy strain on cervical vertebra, and muscle spasms are increasing when the wrong posture according to the result of an electromyogram[15]. Muscle stabilization on head and neck parts is accomplished by relatively short and segment muscles like deep muscle group such as longus colli muscle and longus capitis muscle. Relatively short muscle fibers exert fine, cooperated controls to stabilize head and neck parts. Other long and thick muscles such as sternocleidomastoid muscle and upper trapezius muscle help this, so stabilization of head and neck parts is increase[17].

There are the study on what effect typing work in the ergonomic computer device has on muscle activity of upper trapezius muscle[26], the study on neck muscle activity and neck movement according to the position of document during computer work[8], and the study on what effects the height of computer monitor and desk design have on muscle activity[19]. In these study, muscle activities of the upper extremity showed difference according to change of working conditions. There were many studies about working conditions, but the study whose sole subjects are the height of worktable are insufficient. In addition, the study using ultrasonography is insufficient.

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The equipment for the study on muscle activity are invasive EMG[27], surface EMG[21], magnetic resonance imaging and computer resonance imaging, but these equipment have limitation such as high price. However, ultrasonography is mobile, and real time muscle activity examination is possible[14], muscles can be measurement selectively, and it is visual biofeedback system that can observe changes during muscle contraction[28]. Because the thickness of muscles is measured by cross-section area and distance, atrophy and hypertrophy of the muscles can be checked real time.

Therefore, in this study, change of thickness on sternocleidomastoid muscle and upper trapezius muscle according to change of the height between knees and table during computer work through ultrasonography.

2. Methods

2.1 Subjects

The subjects of this study are healthy men and women in their 20s, who haven't had musculoskeletal, neurological, orthopedic disease on neck, shoulders and upper extremity, and who listened to enough explanations about the research's objective and methods, and then agreed to participated in this study before the study was started. Total 30 subjects, 15 males (average age 20 ± 1.5) and 15 females (average age 20 ± 1.0) were selected, and physical features of the objects are shown on (Table 1).

This study was approved by IRB (Institutional Review Board) institutional bioethics committee.

Table 1. General characteristics

Sex	Male(n=15)	Female(n=15)
Age(year)	20±1.0	20±1.5
Height(cm)	160.0±4.3	175.6±3.7
Weight(kg)	55.7±6.4	65.9±5.8

Mean ± standard deviation

2.2 Measuring Methods

The subjects had their knee joints 90 degree angle and their feet touched on the floor to fix the lower extremity while working on the computer. For persons who can't touch their feet on the floor, stools were provided. Since the backs of chairs were fixed, their backs were fixed on the backs of chairs. Laptop computers were used, and the angle of monitors the position of keyboards was same for all the subjects.

The computer work was to practice HANCOM typing, the subjects were asked to type as their normal speed, and the typing mistakes were ignored. The height difference between the top of the table and the top of knees were set by 5cm. 15cm and 25cm, which were called Experiment 1, Experiment 2, and Experiment 3. After the experiment was over, the thickness of right sternocleidomastoid muscle and right upper trapezius muscle were measured with ultrasonography while the subjects fixed their eyes on the monitor and maintained their posture the same. After the thickness of right Sternocleidomastoid (SCM) muscle and right upper trapezius (UT) muscle were measured, they took a rest for 5 minutes supine position. After taking a brake, the rest experiments were done in the same way. Each experiment was performed randomly.

2.3 Measuring Equipment and Measuring Parts

To measure the thickness of right sternocleidomastoid muscle and right upper trapezius muscle, B-mode with a 7-10MHz (eZono, eZono 3000, Germany, 2011) was used. Measuring position of sternocleidomastoid muscle's thickness is from the center part of anterior neck to the side of 5cm parallel with the transducer longitudinally[12] (Figure 1). The distance between middle line and 5mm, 10mm to the right from the middle line was measured and summed. The measuring position of upper trapezius muscle's thickness was the spinous process at the level of C6 with the transducer horizon. The distance between the edge of triangle of upper trapezius muscle and 15mm to the right was measured as the thickness[18] (Figure 2).

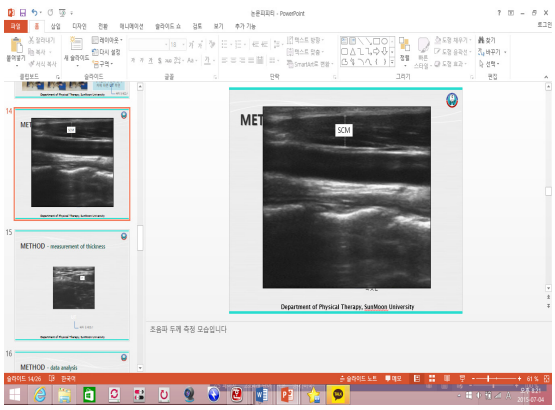

Figure 1. Measurement image of SCM.

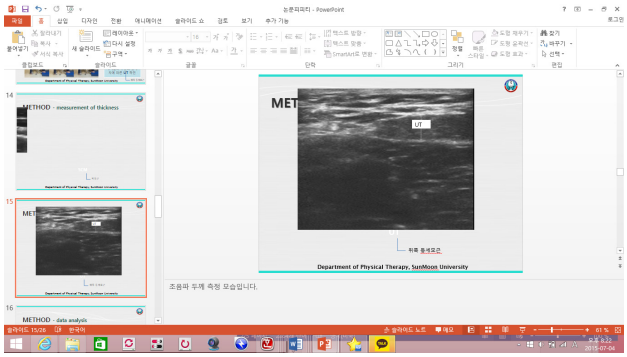

Figure 2. Measurement image of UT.

2.4 Statistical Analysis

All measured values were processed statistically using SPSS 18.0 program for windows. Test of normality was performed Shapiro-Wilk, and normal distribution was satisfied. Percentage and analysis of frequency were used for general characteristics of the subjects. To find the difference of the thickness of sternocleidomastoid muscle and upper trapezius muscle between 5cm, 15cm and 25cm height between table and knees, One way repeated ANOVA was used. To find the difference of each variable, Bonferroni was used for paired comparison, and level of statistical significance was set p<.05.

3. Result

The change of thickness of sternocleidomastoid muscle and upper trapezius muscle was significant when measured after the subjects worked at 5cm, 15cm, 25cm between table and knees (p<.05), and the both muscles were thinnest at 15cm (Table 2). Post-hoc comparison result shows statistically significant difference on sternocleidomastoid muscle and upper trapezius muscle at 5cm and 15cm height difference of table and knees (p<.05). In addition, when 15cm and 25cm were compared, statistically significant difference on sternocleidomastoid muscle and upper trapezius muscle appeared (p<.05). However, when 5cm and 25cm were compared, statistically significant difference appeared on sternocleidomastoid muscle (p<.05), but not significant on upper trapezius muscle (p>.05) (Figure 3).

4. Discussion

This study compared the effects of different heights between table and knees on the thickness of muscles that

Table 2. Difference in thickness of upper trapezius muscle and SCM muscle according to the height difference between table and knee

unit: mm.

	5cm	15cm	25cm	F
SCM	7.16±1.15	6.63±1.25	6.83±1.26	25.663*
UT	5.90±1.54	5.50±1.51	5.81±1.37	3.987*

*$\rho < .05$, *All values are mean± (SD).*

function to support the head and neck parts and to stabilize during computer work. The result shows that when the difference between table and knees is 15cm, the muscles were the thinnest.

In many previous studies, various positions during computer work were selected as a main subject, among which Goostrey et al.[8] study muscle activity of upper trapezius muscle and neck extensor muscle after setting the position of documents as arbitration of the study with the position of documents at the side of the monitor, transparent table on the keyboard and the left side of keyboard. Hassaine et al.[10] reported that the effects of change of table's angle and height on the body posture and muscle activity pattern were compared by electromyography, and the result showed that the tilted table supports the decrease of stress that is maintained by neck muscles[10]. However, in these studies, table's angle and height change were used as arbitration. Studies on the height of table during computer work are not many, and studies in which table's height was independent arbitration during other work are also not many. Therefore, in this study the height difference between table and knees was set as arbitration.

Ultrasonography can visualize the shape and organization of muscles according to muscle's contraction and release, and quantification is also possible[4]. Analyzing ultrasonography images is used to study characteristics of muscles in the non-invasive way in the body[16]. Hodges et al.[11] reported that electromyogram values and change of muscle' thickness have correlation. Sapsford[20] reported that the thickness of abdomen horizontal muscles is significantly increasing during pelvic floor muscle contraction at the position that deep muscle activity is increase. The previous study shows that when muscle activity is increase, muscle contraction occurs and muscles become thick. This leads to assumption that when muscle activity is not active, muscle contraction is less and muscles are thin. In this study, when the height difference between table and knees was 15cm, the muscles

were the thinnest, which leads to assumption that when the height difference between table and knees is 15cm, muscle contraction is less, so muscles were thin.

During computer work, support of forearms causes difference of muscle activity of upper trapezius muscle[23]. Cook et al.[5] compared muscle activity according to support area during computer work. Muscle activity of trapezius muscle and deltoid muscle became significantly low with support of wrist, but no significant difference showed with support of forearms and no support. In the experiment of this research, when the height different between table and knee was 5cm, there was no support, 15cm wrist support and 25cm forearms support. Thus, it can be thought that 5cm and 25cm of height difference were compared, upper trapezius muscle does not show significant change of thickness.

Straker and Mekhora[22] reported that muscle activity on the neck and shoulders increases significantly in the posture of looking down to the video display terminal from 10 degree to 30 degree during work using video display terminal. Greig et al.[9] reported that fatigue is caused by increased muscle load around the neck by looking down to the monitor during laptop computer work. In the experiment of this study, when the height difference between table and knees is 5cm, the thickness of sternocleidomastoid muscle and upper trapezius muscle was the biggest. This means when the height is 5cm, the angle of person who is looking at the video display terminal is downward from 10 degree to 30 degree, so fatigue is caused by increased muscle load and muscle activity increased. Therefore, it is thought that when the height between table and the knees is 5cm, sternocleidomastoid muscle and upper trapezius muscle is the thickest.

The subjects of this study were healthy adults in their 20s, so it is hard to generalize the result. The work time was set as 5 minutes, which is less than normal computer work time, and head and neck parts and posture change of shoulders according to the height of table and the knees were not measured. The interval of table and knees was not subdivided. The heights of subjects were measured, but not the height when they are seated. In future studies, the subjects need to be more various such as youths, middle aged, and seniors, and the subjects should be categorized by their height when seated. The interval of table and knees will be subdivided, so changes on various muscles of upper limbs as well as muscles on the neck and shoulders can be compared.

5. Conclusion

Therefore, in this study, change of thickness on sternocleidomastoid muscle and upper trapezius muscle according to change of the height between knees and table during computer work through ultrasonography

As a result, when the height between the table and the knees is 15cm, the muscles are the thinnest. Therefore, this study can be the basic resource to prevent video display terminal users from developing upper extremity musculoskeletal disease by working at the table adjusted properly between the table and the knees.

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