Preferred Setting of Keyboard and Mouse for Using a Supine Computer Workstation

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Abstract. The purpose of this study was to investigate the differences in performance and muscle effort between guideline and preferred setting of keyboard and mouse when using a computer in supine posture. The guideline setting is according to the rules of standard sitting posture; and the preferred setting is freely determined by the subjects. Ten healthy adults and ten people with disabilities of the lower extremities participated in this study. The experimental tasks included typing and mouse dragging tasks. The task performances and electromyography (EMG) were collected. The participants had significantly higher performances and lower muscle effort when using the mouse under preferred setting, as compared with the guideline setting. However, little difference in typing performance was found between the guideline and preferred settings. The results of this study are helpful to designing a supine computer workstation.

Keywords: Universal design, EMG, typing posture, mouse operation.

1 Introduction

The computer plays an important role in modern life, commonly used in daily life, both personal and professional use, and all industries rely on computer technology to enhance productivity and efficiency. General computer users have no ergonomic knowledge of computers, as frequency and duration of use increases, users feel related muscular and skeletal problems such as sore, painful and stiff muscles in the neck/shoulder, lumbar, and upper extremities, such parts have higher risk of muscular and skeletal discomfort by computer operation [1], and these problems develop slowly along with computer use, there are two major causes, the first is incorrect sitting postures, the second is too long a duration of continuous use of a computer.

Most general computer operations consist of mouse, keyboard, and monitor watching, and work is largely repeated, especially for document processing, data entry, and researchers, furthermore, computer operation is done in a static sitting position, after prolonged periods, muscular and skeleton discomfort easily occurs, some literatures have pointed out that, dedicated personnel, performing computer related operations, had much more frequent muscular and skeleton soreness, pain and complaints [2].

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With technology advances, the population began to notice product health and safety importance, hence many computer-related workstations and aid equipments are developed to assist computer users and reduce discomfort of muscle and bones, such as the ergonomic mouse, ergonomic chair, ergonomic workstations, and arm support apparatus. These equipments have only limited effects of alleviating muscular and skeletal discomfort, and offer temporary convenience or comfort to users because current computer operations are static and in prolonged sitting positions, giving rise to muscular and skeletal discomfort.

Modern employment of most people means prolonged operation of a computer in a sitting position, thus, fatigue easily occurs, and in the home, when changing posture to lying down, and using a computer for entertainment, chatting, or typing, while at ease, not only can release psychological stress, but also alleviate muscular and skeletal burdens. Lower-extremity disadvantaged population often feel very uncomfortable, sore muscles from the daily use of a computer, those not adapted to prolonged sitting [3], experience great discomfort related to computer operations and body posture. Therefore, this study was dedicated to understanding how to set up a keyboard and a mouse when using a computer in supine posture. It is hoped that people could lie in bed and operate a computer, feeling comfortable, convenience of operation, and alleviating muscular and skeletal discomfort [4].

The goal of this study was to study and compare the effect of keyboard and mouse setting during computer work with a supine posture. More specifically, the study was designed to test the following hypotheses during copy typing and mouse dragging tasks:

(a) Preferred setting will result in better performance and lower muscle effort compared with the guideline setting during copy typing task.
(b) Preferred setting will result in better performance and lower muscle effort compared with the guideline setting during mouse dragging task.

2 Methods

Ten healthy adults and ten people with disabilities of the lower extremities participated in this study. All participants used the mouse with their right hand. The healthy participants use the computer for over ten hours per week. All the handicapped participants had experience of computer use.

The experimental tasks included copy typing, mouse dragging and mouse stability operations. Participants completed a 20min copy typing task in each of two conditions: (a) guideline setting of keyboard and mouse; (b) preferred setting of keyboard and mouse. Testing order was randomized. Participants were given a 15min break between the two conditions. Immediately following the typing task, the mouse dragging task was performed. The mouse dragging task required the participant to move the mouse quickly following a tortuous path presented on the screen (Fig 1). During standardized computer work, the work performance in terms of typing score, typing speed, and mouse task completion time were registered.

In the guideline setting condition, the keyboard and mouse were arranged to let the participant' elbow bend at 90 degree, as shown in Fig. 2. In the preferred setting condition, an adjustable keyboard tray and mouse tray were used to be adjusted freely by the participant, as shown in Fig. 3.

Fig. 1. The illustration of screen image in the mouse task

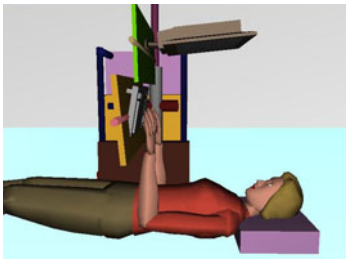

Fig. 2. The guideline setting

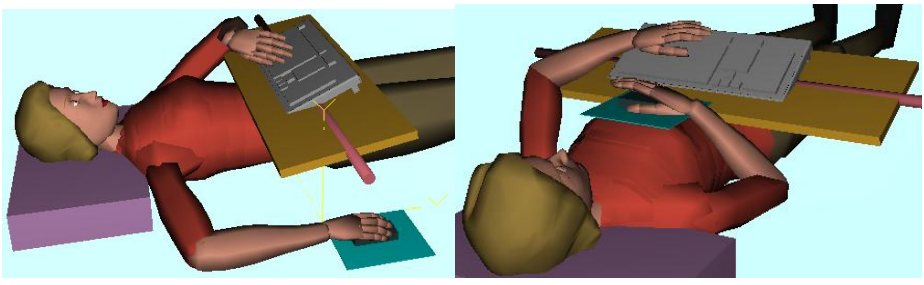

Fig. 3. Two examples of preferred setting

Electromyographic (EMG) activity of the sternocleidomastoid and extensor carpi ulnaris muscle was recorded via a Biopac System MP150. Silver-silver chloride surface electrodes were positioned over the horizontal fibers of these four muscles. All electrodes remained in situ throughout and between the test periods. Root-mean-square(RMS) values of raw EMG signals were calculated for each of the recorded epochs. Mean RMS values were calculated for each task for each participant. These mean values were represented as a proportion of the maximum voluntary contraction (%MVC).

One-way ANOVA was applied to examine the main effect. The level $p < 0.05$ was considered significant.

3 Results

3.1 Work Performances between the Two Settings

The typing score and speed were similar between guideline and preferred settings, as shown in Table 1. The mouse task completion time was significantly shorter with preferred setting compared with guideline setting. However, no significant differences in typing score and typing speed were found between guideline and preferred settings.

Table 1. Mean and standard deviation of operation performances

	Typing score		Typing speed (wpm)		Mouse task completion time (sec)	
Setting	Mean	SD	Mean	SD	Mean	SD
Guideline	691.8	289.4	37.1	14.9	459.1	150.7
Preferred	695.6	316.5	37.2	15.8	368.9*	178.0

*The mean value is significantly different from that in the guideline setting ($p<0.05$)

3.2 EMG Activity between the Two Settings

Surface EMG %MVC values for Sternocleidomastoid and Extensor carpi ulnaris muscles under different setting conditions are listed in Table 2. For the copy typing task, the mean %MVC value of the sternocleidomastoid muscle was significantly greater under guideline setting compared with preferred setting; however, no significant differences in extensor carpi ulnaris muscle activity were found between these two settings. For the mouse dragging task, the mean %MVC value of the extensor carpi ulnaris muscle EMG was significantly greater under guideline setting compared with preferred setting; however, no significant differences in %MVC of sternocleidomastoid muscle EMG were found between these two settings. Overall the preferred setting of keyboard and mouse could lead to lower effort in some muscle no matter during typing or mouse dragging tasks.

Table 2. Mean and standard deviation of %MVC values for the measured two muscles

	Sternocleidomastoid muscle EMG (%MVC)		Extensor carpi ulnaris muscle EMG (%MVC)	
Experimental conditions	Mean	SD	Mean	SD
Copy typing task				
Guideline setting	10.65	11.07	18.79	12.46
Preferred setting	7.84*	10.11	18.68	12.23
Mouse dragging task				
Guideline setting	3.46	2.79	24.83	15.39
Preferred setting	3.77	3.28	16.42*	7.81

*The mean value is significantly different from that in the guideline setting ($p<0.05$)

4 Discussion

In the current study, computer work tasks were performed with a supine workstation either under the guideline setting or under personal preferred setting of keyboard and mouse. Interestingly, all of the participants preferred to put the mouse alongside their right hip. Personal preferred setting could lead to better performance during mouse dragging task, but had no significantly better performance during typing task compared with the guideline setting. This result means that the traditional guideline setting for sitting workstation is not suitable for using a supine workstation, especially dragging a mouse. In addition, the extensor carpi ulnaris muscle EMG results also

confirmed that preferred setting could lead to obviously lower muscle effort (16.42% MVC) during mouse dragging task than that of guideline setting (24.83% MVC).

During the copy typing task, the guideline setting led to a significant increase in the neck EMG activity (10.65% MVC) as compared to the preferred setting (7.84% MVC). This result also suggests that provision of adjustable keyboard and mouse trays may be helpful to the people who require using a computer with a supine posture.

Because this present study evaluated work performance and muscle effort for using a computer with only one supine posture, further research should be conducted to evaluate the effect of lying posture on performance and muscle effort.

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