Ergonomic Evaluation of New Wrist Rest on Using Computer Mouse

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Abstract

Literatures reviewing showed that excessive computer use, particularly mouse usage might be an occupational risk factor for carpal tunnel syndrome. The purpose of this study was to evaluate the wrist rest on EMG activities of forearm muscle and wrist postures while using computer mouse. Thirteen participants applied the computer mouse to play the FreeCell game for ten minutes on four conditions of usage wrist rest (wrist band, wrist pad, wrist belt with pad, no wrist rest). Electromyography activities of the pronator teres muscle groups and wrist postures were recorded by Biometric data acquisition system. Results of ANOVA showed that there are not significant differences in EMG activities between four conditions. Further, using computer mouse with wrist rest reduced significantly the wrist deviation and dorsiflexion. There are the largest ulnar deviation and dorsiflexion while using computer mouse with no wrist rest. Although mouse pad could decrease the dorsiflexion, ulnar deviation did not control. Thus, the wrist belt with pad could keep the wrist on neutral posture and the better comfort rating.

Key words: ergonomics, carpal tunnel syndrome, wrist rest, product design

Introduction

Literatures reviewing showed that excessive computer use, particularly mouse usage might be an occupational risk factor for carpal tunnel syndrome [1]. Carpal tunnel syndrome (CTS) is a compression neuropathy of the median nerve as it passes through the carpal tunnel. It is regarded as the most frequent compression neuropathy. Based on both clinical symptoms and nerve conduction tests (NCT), overall prevalences of 3.0-5.8% among women and 0.6–2.1% among men have been found in general population samples [2, 3].

Fagarasanu and Kumar [4] outlined relevant information about CTS risk factors present in data entry task and their implications, with a special emphasis on different extreme postures determined by conventional and alternate keyboards, pointing devices and their role in the development of CTS. The ergonomic assessment of new devices should precede their introduction and not follow it. Because of the adoption of the graphical user interfaces, pointing devices (e.g. computer mouse, trackballs) are present in every office environment. In most applications the use of the mouse accounts for almost 60% of total time [5] with a maximum level of usage of 65-70% in drawing applications [6].

Shiri and Falah-Hassani [1] have reported contradictory results on the role of keyboard or mouse use in carpal tunnel syndrome (CTS). In this meta-analysis (N = 5202) conducted among office workers, CTS was positively associated with computer/typewriter use (OR = 1.34), mouse use (OR = 1.93), frequent computer use (OR = 1.89), frequent mouse use (OR = 1.84, 95%) and with years of computer work (OR = 1.92, for long vs. short). A systematic review of studies of computer work and CTS was performed [2]. Measurements of carpal tunnel pressure (CTP) under conditions typically observed among computer users showed pressure values below levels considered harmful. However, during actual mouse use one study showed an increase of CTP to potentially harmful levels. The long term effects of prolonged or repeatedly increased pressures at these levels are not known. The purpose of this study was to evaluate the wrist rest on EMG activities of forearm muscle and wrist postures while using computer mouse.

Methods

A. Participants

This study recruited thirteen subjects, including 11 men and 2 women and their dominant hands are the right hand. Mean age of subjects is 24 years old. All participants were healthy and reported no musculoskeletal problems that might influence performance detrimentally. They were instructed to avoid vigorous physical activity and drinking alcohol during the 12 hours prior to the experiment.

B. Wrist rest

In this study, three types of wrist rest which involved wrist band, wrist pad and wrist belt with pad were evaluated. Some dimensions presented in Table I.

TABLE I
THREE TYPES OF WRIST REST

Wrist rest	Dimensions
	Wrist band Length 8.5cm Width 7 cm Thickness 2cm

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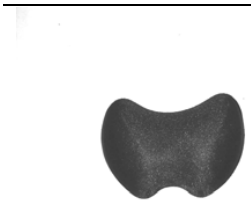


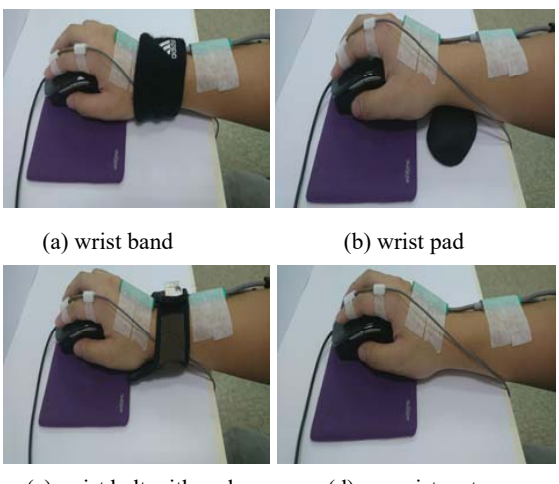
Gel wrist pad
Length 14 cm
Width 8 cm
Thickness 2.3 cm

Wrist belt with pad
Length 24 cm
Width 10 cm
Thickness 0.5cm

C. Ergonomic evaluation test

Each participant applied the computer mouse to play the FreeCell game for ten minutes on four conditions of usage wrist rest (wrist band, wrist pad, wrist belt with pad, no wrist rest). Please refer to Fig 1. Electromyography (EMG) activities of the pronator teres muscle groups and wrist postures were recorded by Biometric data acquisition system (DataLog MWX8, Biometric Ltd., UK). Reference voluntary contraction for normalization was obtained during maximum isometric voluntary contraction (MVC) of the specific muscle group for two trials of about 5 seconds each. Reference voluntary contraction value was calculated as ratio between the work task load and MVC.

The order of each trial was randomly assigned to each participant to minimize sequencing effects. A minimal rest period of five minutes (more if required) was provided between trials. During the rest periods, participants took off the mounting system and were asked to stay seated, relaxed, and to remain silent.



(a) wrist band (b) wrist pad

(c) wrist belt with pad (d) no wrist rest

Fig. 1 Four conditions of usage wrist rest (wrist band, wrist pad, wrist belt with pad, no wrist rest)

D. Data analysis

A randomized complete block design (blocks as individual participants) with within-subject factors (four conditions of usage wrist rest) was used for this study. The dependent variables were EMG (%) for pronator teres and angles of wrist. Further, analysis of variance (ANOVA) was utilized to identify significant differences between conditions for dependent variables. Statistical significance was set at a probability level of 0.05.

Results

Results of ergonomic evaluation test are given in Table II. There are not significant differences in EMG of pronator teres between four conditions of usage wrist rest. For angles of wrist, the higher ulnar deviation had found in no wrist rest (17.3). When applied the wrist belt with pad, there is less ulnar deviation (12.6). In addition, there are significant differences in dorsiflexion between four conditions ($F(3, 36) = 14.2$, $p < 0.001$). The less dorsiflexion was found in using wrist pad. By contrast, the higher dorsiflexion had found in no wrist rest. For ranger of motion, wrist band and wrist belt with pad could effectively limit the movement of the wrist in ulnar deviation. However, ranger of motion in dorsiflexion

Subjective ratings for comfort of four conditions were evaluated using a 10-point rating scale (from very low to very high). The scores are more than six in using wrist pad (6.4) and wrist belt with pad (6.6). Of course, there is the lowest comfort score in no writ rest (Fig. 3).

TABLE II
RESULTS OF ERGONOMIC EVALUATION TEST

Variables	wrist band	wrist pad	wrist belt with pad	no wrist rest
% EMG	22.4	19.8	23.9	22.2
Ulnar deviation	13.0*	13.8	12.6	17.3
Dorsiflexion	19.3***	12.2	17.7	24.8

*p < 0.05, ** p < 0.01, *** p< 0.001

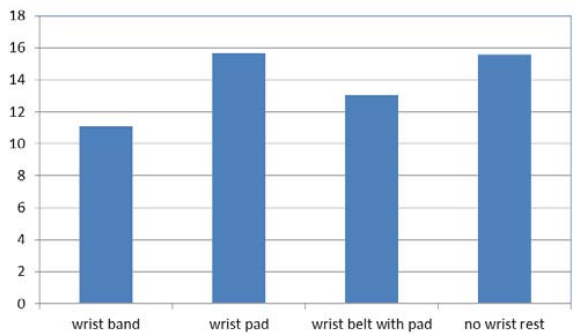


Fig. 2 Range of motion in ulnar deviation

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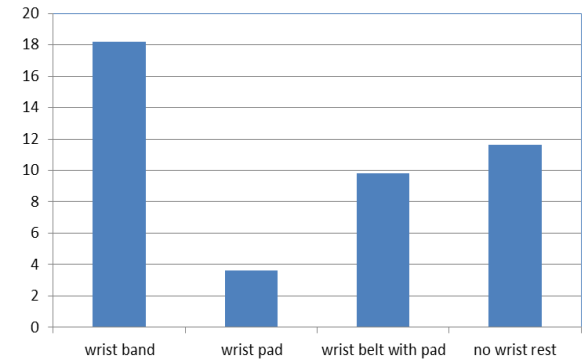

Fig. 3 Range of motion in dorsiflexion

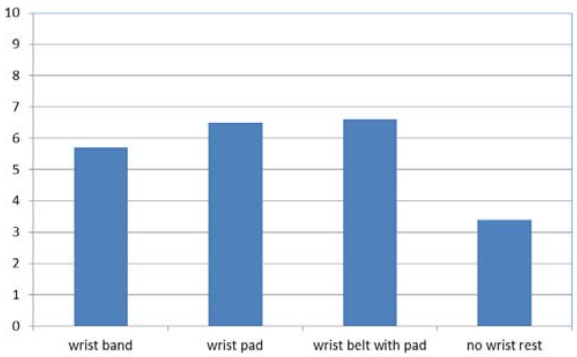

Fig. 4 Subjective ratings for comfort of four conditions

Discussion

Mice were reported to be the most frequently used devices among the VDT users both in term of number of users and in terms of daily time spent in using it [7]. Previous work that address the etiological relationship between the use of pointing devices and musculoskeletal disorders development [5, 8, 9].

During a comparative study between mouse and non-mouse users, Karlqvist et al. [10] reported that 64% of the total mouse working time is spent with more than 15 ulnar deviation. The deviation exceeded 30 in 30% of the mouse task time. Results of this study also showed that ulnar deviation is 17.3 while operating the computer mouse with no wrist rest. Total forearm pronation during mouse use is also common [11]. Both factors play an important role in the CTS pathogenesis.

The training of users, workstations, software and tool redesign, reduction in the duration of highly risky tasks (dragging and double-clicking), and limitation of the duration and proportion of continuous mouse are measures that should be taken in order to decrease the mouse role in CTS development. For the purposes of ergonomic design, a neutral hand posture is one where the hand is straight. Thus, a neutral zone of hand movement could be defined which is bounded by 15-20 dorsiflexion, 20-40 flexion, 20-25 ulnar deviation, and 15 radial deviation. The lowest carpal tunnel pressure in the ranger of 0-15 wrist extension [12]. Good ergonomic design of any hand-operated device should allow the user to work comfortably while hands are moving in the neutral range of motion. Therefore, use of computer mouse with no wrist rest might exceed the neutral range of motion. Damann and Kroemer [13] found wrist support with a mouse pad to improve wrist posture by minimizing wrist extension and radial deviation.

Conclusion

Results of this study showed that there are not significant differences in EMG activities between four conditions. Further, using computer mouse with wrist rest reduced significantly the wrist deviation and dorsiflexion. There are the largest ulnar deviation and dorsiflexion while using computer mouse with no wrist rest. Although mouse pad could decrease the dorsiflexion, ulnar deviation did not control. Thus, the wrist belt with pad could keep the wrist on neutral posture and the better comfort rating.

Acknowledgements

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