Effect of a Wrist Motion Storage Biofeedback System (WMSBS) on Wrist Motion during Keyboard Typing Work

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Abstract. [Purpose] The purpose of this study was to examine the effect of a wrist motion storage biofeedback system on wrist range of motion during keyboard typing work. [Subjects] For this study, we recruited 10 computer workers as volunteers. [Methods] Wrist flexion, extension, ulnar deviation, and radial deviation angles were analyzed using a 3-D motion analysis system. [Results] The wrist flexion, extension, ulnar deviation, and radial deviation angles decreased significantly in keyboard typing work with the wrist motion storage biofeedback system. [Conclusion] We suggest that the wrist motion storage biofeedback system promotes the adoption of a beneficial wrist posture, which may be effective at preventing computer work-related wrist disorders, such as carpal tunnel syndrome.

Key words: Biofeedback, Carpal tunnel syndrome, Keyboard typing work

(INTRODUCTION

Carpal tunnel syndrome (CTS) is a common and costly problem in the general population, especially among manual workers. Several studies have found a greater prevalence of CTS in workers who perform highly repetitive manual jobs. Keyboard use is one common type of highly repetitive daily task, and is associated with musculoskeletal disorders of the upper extremity. The median nerve exhibits acute changes in response to keyboard tasks, which is further evidence of a potential causal relationship between computer keyboard use and median nerve injuries such as CTS. Keyboard use is commonly considered the cause of CTS and is accepted in workers’ compensation claims in many countries. In clinical settings, correction of poor habitual posture is a common treatment approach for individuals with neck and shoulder disorders and feedback systems have proved especially useful in this kind of treatment. Although several studies have investigated the effect of feedback systems on poor habitual posture correction, a lack of evidence remains for the effectiveness of biofeedback devices on poor wrist motions. For this reason, we developed a biofeedback system for detecting wrist motion. The purpose of this study was to examine the effects of the wrist motion storage biofeedback system on wrist range of motion during keyboard typing work.

SUBJECTS AND METHODS

The study subjects were 10 computer workers aged 20–29 years (26.6 ± 3.8 years, mean ± SD) whose average height and weight were 177.1 ± 3.7 cm and 68.5 ± 6.2 kg, respectively. An ultrasonic movement analysis system, CMS-MS (Zebris Medizintechnik, Isny, Germany) was used to record wrist flexion, extension, ulnar deviation, and radial deviation angles during keyboard typing work, which were sampled at a rate of 50 Hz. Two triple markers were used to analyze the wrist kinematic data. They were attached to the dorsum of the hand and the distal 1/3 of the forearm. We developed a Wrist Motion Storage Biofeedback System (WMSBS), which consists of an accelerometer, storage program, and biofeedback using a pop-up program. The capacitive components of an accelerometer are commonly used to convert mechanical motion into an electrical signal. The analog signal was converted to a digital signal with an A/D converter (NI USB-6009, National Instruments, Austin, Texas, USA). The WMSBS was attached to the dorsum of the hand. The WMSBS can measure linear motion as the wrist moves. The movement threshold was detected and visual feedback was provided through graphic software as a user-friendly interface using LabVIEW (National Instruments, Austin, Texas, USA). The WMSBS was attached to the dorsum of the hand. The WMSBS can measure linear motion as the wrist moves. The movement threshold was detected and visual feedback was provided through graphic software as a user-friendly interface using LabVIEW (National Instruments, Austin, Texas, USA). The WMSBS has a storage function for total wrist movement, and can record physical movements quickly. Another function provides a changing color bar on the screen (from green to red) if too much of the wrist movement exceeds the movement threshold. When the WMSBS detects excessive cumulative wrist movements, including wrist flexion (X-axis), extension (X-axis), ulnar deviation (Y-axis), and radial deviation (Y-axis), it highlights the words “Maintain a Neutral Wrist Posture!” in a pop-up window. In this study, the workstation for typing work was a desktop computer and a 17-inch LCD monitor. A height-
adjustable chair was adjusted so that each subject’s hips and knees were flexed at 90°. All subjects performed 300–400 words of typing work for 15 minutes with and without the WMSBS using an English typing program produced by Hansoft. SPSS version 12.0 (SPSS, Chicago, IL, USA) was used to identify significant differences in wrist motions with and without WMSBS. The paired t-test was used to examine the significance of differences in the data collected with or without the WMSBS. Significance was accepted for values of p<0.05.

RESULTS

The mean angles of wrist extension, ulnar deviation, and radial deviation were more significantly decreased during keyboard typing work with WMSBS than without (p<0.05). No significant difference was noted in wrist flexion angle. The mean angles of wrist flexion, extension, ulnar deviation, and radial deviation were 6±2.7°, 24±9.2°, 8±5.4°, and 18±6° during keyboard typing work with WMSBS, and 7±4.1°, 37±11.6°, 15±6.0°, and 29±5° during keyboard typing work without WMSBS, respectively.

DISCUSSION

Overall, CTS is ranked sixth among the recognized occupational diseases5). Surgical intervention for CTS treatment involves opening the carpal tunnel for median nerve passage at the wrist. Nonsurgical treatments include splinting and ergonomic interventions. The most important feature of these non-surgical treatments is that the hand is used with the wrist positioned in a neutral position6). Several ergonomic studies have reported that the use of devices as well as assessment tools and interventions can re-educate wrist posture7). An optimized feedback device may be important in rehabilitation for identifying which components of the posture alignment need the greatest re-education in individual patients8). Therefore, the development of a biofeedback device is required for computer work-related wrist disorder, such as CTS. We developed a WMSBS to detect cumulative wrist movements. The main purpose of this study was to show the effect of the WMSBS during keyboard typing work. Wrist extension, ulnar deviation, and radial deviation angles were more significantly decreased during keyboard typing work with the WMSBS than without. Keyboard use may be described as highly repetitive work, but it does not resemble other types of repetitive activities3). One study showed that the prevalence of CTS among keyboard typing workers was almost three times higher than that in the general population. An epidemiological study has shown that the risk of CTS is increased with keyboard use9). Another study showed that cumulative keyboard use was associated with the occurrence of CTS among employees and that cumulative keyboard use remained an important factor in the development of CTS10). We determined whether a WMSBS using a biofeedback program had a positive effect on re-education of the proper wrist posture and prevention of cumulative wrist movements. We suggest that the WMSBS promotes the adoption of a beneficial wrist posture, which may be effective at preventing computer work-related wrist disorders, such as carpal tunnel syndrome.

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