

Effects of different computer typing speeds on acceleration and peak contact pressure of the fingertips during computer typing

WON-GYU YOO¹⁾

¹⁾ Department of Physical Therapy, College of Biomedical Science and Engineering, Inje University: 607 Obangdong, Gimhae, Gyeongsangnam-do 621-749, Republic of Korea

Abstract. [Purpose] This study showed the effects of different computer typing speeds on acceleration and peak contact pressure of the fingertips during computer typing. [Subjects] Twenty-one male computer workers voluntarily consented to participate in this study. They consisted of 7 workers who could type 200–300 characteristics/minute, 7 workers who could type 300–400 characteristics/minute, and 7 workers who could type 400–500 characteristics/minute. [Methods] This study was used to measure the acceleration and peak contact pressure of the fingertips for different typing speed groups using an accelerometer and CONFORMat system. [Results] The fingertip contact pressure was increased in the high typing speed group compared with the low and medium typing speed groups. The fingertip acceleration was increased in the high typing speed group compared with the low and medium typing speed groups. [Conclusion] The results of the present study indicate that a fast typing speed cause continuous pressure stress to be applied to the fingers, thereby creating pain in the fingers.

Key words: Computer typing, Computer workstation, Peak contact pressure

(This article was submitted Apr. 7, 2014, and was accepted Jul. 15, 2014)

INTRODUCTION

Many office workers spend long hours sitting at their desks while doing their jobs¹⁾. Work-related musculoskeletal disorders, also called overuse injuries, account for a significant proportion of work injuries²⁾. Several risk factors are associated with the development or exacerbation of work-related musculoskeletal disorders in the workplace, including physical and biomechanical factors, and the inherent predisposition of the individual²⁾. Furthermore, work-related upper extremity disorders are the most common form of occupational disease^{3, 4)}. Keyboard use is one common type of highly repetitive daily task and is associated with musculoskeletal disorders of the upper extremity⁵⁾. A previous study showed that cumulative keyboard use was associated with the occurrence of wrist disorder or pain among employees and that cumulative keyboard use remained an important factor in the development of carpal tunnel syndrome^{6, 7)}. Continuous keyboard typing could cause not only wrist pain but also constant stress on the fingers⁸⁾. However, few studies have been conducted on the stress on the fingers according to the computer typing speed. Therefore, this study investigated effects of different computer typing speeds on acceleration and peak contact

pressure of the fingertips during computer typing.

SUBJECTS AND METHODS

Twenty-one male computer workers voluntarily consented to participate in this study. They consisted of 7 workers who could type 200–300 characteristics/minute (low typing speed group), 7 workers who could type 300–400 characteristics/minute (medium typing speed group), and 7 workers who could type 400–500 characteristics/minute (high typing speed group). Their average age, height, and weight were 26.3 ± 2.5 years, 174.9 ± 2.7 cm, and 66.5 ± 4.7 kg, respectively. Each subject provided informed consent before participating in the study. This study was approved by the Yonsei University Faculty of Health Sciences Human Ethics Committee. The CONFORMat System (Tekscan, Boston, MA, USA) was used to measure the magnitude of fingertip contact pressure for the different typing speed groups. A sampling rate of 60 Hz was achieved due to the extreme thinness and relatively high spring constant of the sensor materials. We attached an accelerometer to the third proximal phalanx. 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, TX, USA). The accelerometer detected linear motion with the aid of graphic software featuring a user-friendly interface in LabVIEW (National Instruments). This study measured the acceleration of the fingers for the different typing speed groups. All subjects performed keyboard typing at a routine computer work sta-

Corresponding author. Won-gyu Yoo (E-mail: won7y@inje.ac.kr)

©2015 The Society of Physical Therapy Science. Published by IPEC Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License <<http://creativecommons.org/licenses/by-nc-nd/3.0/>>.

tion. The routine computer workstation featured a 23-inch monitor, a keyboard and a mouse on a table, and a swivel chair with five wheels. To allow analysis of lumbar motion, the armrest and backrest were removed. Both the table and chair were adjustable in terms of height and were initially set to ensure that the elbows, hips, and knees were flexed at 90°. The keyboard was positioned frontally, 30 cm from the trunk, the monitor was reclined by 20°, and the top of the display was set at eye level. All subjects performed keyboard typing work consisting of 1,000 words using a keyboard. The CONFormat System was positioned underneath the keyboard. SPSS version 12.0 (SPSS, Chicago, IL, USA) was used to assess differences in forward head and lumbar flexion angles. The paired t-test was used to explore the significance of differences in acceleration and peak contact pressure of the fingertips. Significance was accepted for values of $p < 0.05$.

RESULTS

The mean fingertip contact pressure in the high typing speed group (23.6 ± 6.0 g/cm²) was significantly increased compared with the low and medium typing speed groups (15.3 ± 5.7 g/cm², 18.2 ± 6.4 g/cm²). The mean fingertip acceleration in high typing speed group (5.0 ± 2.6 cm/sec²) was significantly increased compared with the low and medium typing speed groups (2.4 ± 1.0 cm/sec², 3.2 ± 2.7 cm/sec²).

DISCUSSION

Most computer operators complain upper extremity pain after long periods typing work^{9, 10}. A previous study showed that typing speed is not proportional to the severity of pain in keyboard workers with work-related upper extremity disorder and that slower or faster typing speeds do not cause statistically different levels of pain⁸. It has already been reported in previous studies that a typing speed did not influence pain in the upper extremity but that it could incur a negative effect on the wrists or fingers. So, this study investigated effects of different computer typing speeds on the acceleration and peak contact pressure of the fingertips during computer typing. The results showed that the fingertip contact pressure increased in the high speed typing group compared with the low and medium typing speed groups. Also, the fingertip acceleration increased in high speed typing group compared with the low and medium speed typing groups. Computer operators with a high typing speed showed high acceleration during fingertip movement. This high acceleration could cause the fingertips to collide with the keyboard without sufficient deceleration. It is also assumed that the fingertip pressure of computer operators

with a high typing speed would be very large when their fingertips collide with the keyboard. The reason why computer work poses a threat of musculoskeletal pains is due to the high possibility of cumulative traumatic injury^{2, 9}. Even if a computer typing job applies a small load to the finger joints, it could incur cumulative loads because of its characteristics as a repetitive job performed for long periods of time. Normally, stress applied to fingers due to computer work is overlooked easily compared with shoulder or low back pain occurring after computer work. In addition, modern society requires a fast pace in completing computer work⁸. According to our study results, a fast typing speed causes continuous pressure stress to be applied to the fingers, thereby creating pain in the fingers. Furthermore, finger pain due to long hours of computer work is thought to be closely related to finger arthritis in the future⁹.

ACKNOWLEDGEMENTS

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (No. 2012R1A1B4001058).

REFERENCES

- 1) Watanabe S, Eguchi A, Kobara K, et al.: Influence of trunk muscle co-contraction on spinal curvature during sitting for desk work. *Electromyogr Clin Neurophysiol*, 2007, 47: 273–278. [[Medline](#)]
- 2) Szeto GP, Straker LM, O'Sullivan PB: A comparison of symptomatic and asymptomatic office workers performing monotonous keyboard work—2: neck and shoulder kinematics. *Man Ther*, 2005, 10: 281–291. [[Medline](#)] [[CrossRef](#)]
- 3) Werner RA, Franzblau A, Gell N, et al.: A longitudinal study of industrial and clerical workers: predictors of upper extremity tendonitis. *J Occup Rehabil*, 2005, 15: 37–46. [[Medline](#)] [[CrossRef](#)]
- 4) Aarås A, Fostervold KI, Ro O, et al.: Postural load during VDU work: a comparison between various work postures. *Ergonomics*, 1997, 40: 1255–1268. [[Medline](#)] [[CrossRef](#)]
- 5) Rempel DM, Keir PJ, Bach JM: Effect of wrist posture on carpal tunnel pressure while typing. *J Orthop Res*, 2008, 26: 1269–1273. [[Medline](#)] [[CrossRef](#)]
- 6) Liu CW, Chen TW, Wang MC, et al.: Relationship between carpal tunnel syndrome and wrist angle in computer workers. *Kaohsiung J Med Sci*, 2003, 19: 617–623. [[Medline](#)] [[CrossRef](#)]
- 7) Eleftheriou A, Rachiotis G, Varitimidis S, et al.: Cumulative keyboard strokes: a possible risk factor for carpal tunnel syndrome. *J Occup Med Toxicol*, 2012, 7: 16. [[Medline](#)] [[CrossRef](#)]
- 8) Povlsen B: Is typing speed proportional to the severity of pain in keyboard workers with work-related upper limb disorder. *JRSM Short Rep*, 2012, 3: 3. [[Medline](#)] [[CrossRef](#)]
- 9) Sahrmann S: *Diagnosis and treatment of movement impairment syndromes*. New York: Mosby, 2002.
- 10) Yoo WG: Comparison of immediate changes in cervical and lumbar repositioning errors and pain in asymptomatic computer users after computer work. *J Phys Ther Sci*, 2012, 24: 1325–1327. [[CrossRef](#)]