Journal of Hand Therapy xxx (2016) 1–9

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

Scientific/Clinical Article

Hand rest and wrist support are effective in preventing fatigue during prolonged typing

Bianca Callegari PT, PhD [a,b,*], Marília Maniglia de Resende PT, Msc [c], Manoel da Silva Filho PhD [a]

[a] Institute of Biological Sciences, Federal University of Pará, Belém, Pará, Brazil
[b] Laboratory of Human Movement Studies, Institute of Health Sciences, Federal University of Pará, Belém, Pará, Brazil
[c] Estácio Pará College, Belém, Pará, Brazil

A R T I C L E   I N F O

Article history:
Received 11 May 2016
Received in revised form
8 November 2016
Accepted 20 November 2016
Available online xxx

Keywords:
Surface electromyography
Prevention
Work-related musculoskeletal disorders
Muscular fatigue

A B S T R A C T

Study Design: Case series (longitudinal).
Introduction: Only few reports concerning the efficacy of commonly used strategies for preventing upper limb occupational disorders associated with prolonged typing exist.
Purpose of the Study: We aimed to investigate whether the duration of typing and the use of 2 strategies (hand rest and wrist support) changes muscle physiological response and therefore the electromyography records.
Methods: We enrolled 25 volunteers, who were unfamiliar with the task and did not have musculoskeletal disorders. The subjects underwent 3 prolonged typing protocols to investigate the efficacy of the 2 adopted strategies in reducing the trapezius, biceps brachii, and extensor digitorum communis fatigue.
Results: Typing for 1 hour induced muscular fatigue (60%-67% of the subjects). The extensor digitorum communis muscle exhibited the highest percentage of fatigue (72%-84%) after 1 and 4 hours of typing (1 hour, $P = .04$; 4 hours, $P = .02$). Fatigue levels in this muscle were significantly reduced (24%) with the use of pause typing (4 hours, $P = .045$), whereas biceps brachii muscle fatigue was reduced (32%) only with the use of wrist supports ($P = .02$, after 4 hours). Trapezius muscle fatigue was unaffected by the tested occupational strategies (1 hour, $P = .62$; 4 hours, $P = .85$).
Discussion: Despite presenting an overall tendency for fatigue detected during the application of the protocols, the assessed muscles exhibited different behavior patterns, depending on both the preventive strategy applied and the muscle mechanical role during the task.
Conclusion: Hand rest and wrist support can successfully reduce muscle fatigue in specific upper limb muscles during prolonged typing, leading to a muscle-selective reduction in the occurrence of fatigue and thus provide direct evidence that they may prevent work-related musculoskeletal disorders.
Level of Evidence: N/A

Introduction

Work-related musculoskeletal disorders (WMSDs) arise from movements, such as bending, gripping, holding, twisting, and typing.[1] These common movements are not particularly harmful in the ordinary activities of daily life, although some work patterns may act as risk factors to development of WMSDs. Relevant risk factors include fixed or constrained body positions, continual movement repetition, force concentrated on small parts of the body, and work pace that does not allow sufficient recovery between movements.[1,2]

The upper limb and shoulder region are particularly susceptible to musculoskeletal disorders due to repetitive work,[3,4] and the popularization of computers has led to an increase in the number of cases of WMSDs associated with typing.[1] The neck and upper limb muscles contract during typing, using chemical energy from sugars and producing byproducts, such as lactic acid, which are eliminated in the blood.[5] If this task is sustained and muscle contraction is maintained for a long time, the ability to supply and use oxygen to and by the muscles is compromised. Consequently, the substances produced by the muscles accumulate and are not eliminated fast enough.[6] This causes muscular fatigue, which is defined as a decrease in functional capacity to perform physical actions and/or to produce and maintain required force.[5] Thus, muscle fatigue in prolonged typing arises from

This research was supported by the following grants: Pará Amazon Research Support Foundation (FAPESPA) number 180/2012; CAPES/COFECUBE research grant number 819-14, and Coordination for the Improvement of Higher Education Personnel (CAPES).

* Corresponding author. Laboratory of Human Movement Studies, Instituto de Ciências da Saúde, Avenida Generalissimo Deodoro, nº1, Belém, PA 66055-240, Brazil. Tel.: + 55 91 982210054.
E-mail address: callegaribi@uol.com.br (B. Callegari).

0894-1130/$ – see front matter © 2016 Hanley & Belfus, an imprint of Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jht.2016.11.008

the sustained activation of motor units in postural neck and upper limb muscles, resulting in metabolic overload.

Muscle fatigue plays an important initiating role in musculoskeletal disorders, which progress in stages from mild to severe. During the early stage, pain and fatigue of the affected limb occur during the work shift but disappear at night and during days off. With progression, pain, fatigue, and weakness persist at rest, resulting in severe reduction of work performance.[7]

Studies have shown that patients with WMSDs have increased muscle activation and fatigue earlier during a task than healthy controls.[8] In addition, there is evidence supporting the important contribution of altered muscle activation patterns in symptomatic computer users.[9] Healthy adults actively adjust their motion strategies to likely counteract muscle fatigue while fulfilling task requirements, and evidence suggests that higher levels of muscle activity during work represented higher risks for developing WMSD.[10]

Surface electromyography (sEMG) has been identified as a useful diagnostic tool to assist the ergonomic aspects of the work place and also for identifying muscle fatigue in WMSDs.[9,11,12] In brief, sEMG recordings of muscle electrical activity during the performance of repetitive tasks, such as typing, enable assessment of the behavior of motor units and can detect the presence of muscle fatigue, a major indicator of myo-osteoarticular overload, which in turn causes WMSDs.[13,14] Therefore, we believe that laboratory studies increase the precision in estimating exposure-load relationships that can be used to help the development of healthy musculoskeletal work environments. Hence, sEMG offers an approach well suited to explore physiological responses and discomfort at the computer.

Fatigue is known to be reflected in the sEMG signal as an increase of its amplitude and a decrease of its characteristic spectral frequencies.[5] Increases in action potential amplitude and changes in the order of motor unit recruitment contribute to increases in root mean square (RMS) values.[15] When muscle fatigue sets in, the amplitude of the median frequency (MDF) power spectrum increases and shifts to lower frequencies due to motor unit recruitment, decreased action potential firing rate, and desynchronization, or reductions in their conduction velocity.[15,16] These variations are considered to represent physiological strategies that compensate for functional loss by recruiting additional fibers to maintain muscle activity close to the required threshold.[5,15] Luttmann et al[17] proposed the method of joint analysis of spectra and amplitudes (JASA) as a new method to assess fatigue of muscular activity because it simultaneously considers the changes in the EMG amplitude and spectrum throughout the task. Therefore, one great advantage of the JASA method is that the subjects do not have to interrupt the task intermittently to perform isometric contractions, such as the maximum voluntary contraction (MVC) test.[17] In addition, sEMG data are plotted together as a pair of parameters representing the slopes of both parameters (RMS and MDF) used in EMG analysis.

Previous studies have measured the degree of muscle fatigue in several work-related tasks involving the use of computers to assess the occurrence of fatigue-related pain.[12,18] Some of the variables considered in previous studies included body posture at the workstation,[2,19] the use of keyboard and forearm support,[20] work rhythm,[21] mouse use,[20] force applied,[6] and wrist deviation relative to the middle line.[1]

However, few studies have assessed muscle fatigue induced by typing, particularly by prolonged typing, in a systematic and ecological manner while taking occupational strategies, such as supports and stretching pauses, into consideration. One exception was the study by Lin et al, which assessed the extensor digitorum communis (EDC) and flexor digitorum superficialis muscles in individuals subjected to a 2-hour typing task and observed fatigue in 80% of these subjects; in addition, the EDC was the most susceptible muscle to fatigue. Authors used the JASA method and attested that it allows investigators to infer reasonable representations.[22] In another article, Kim and Johnson[23] indicated that 6 hours of keyboard, mouse, and combined mouse and keyboard use caused temporal fatigue-related changes in the physiological state, but their focus was only in the flexor digitorum superficialis muscle.

These results support the need for more scientific research in the area because several questions remain unanswered. First, the upper trapezius (Tz) and biceps brachii (BB) are important muscles from the most prevalent regions affected in WMSD, and unlike EDC, they have rarely been investigated during prolonged typing in the laboratory. In addition, how the duration of typing affects the onset of fatigue is not well answered (i.e., when it begins, increases, or adapts?). Thus, we used 3 different prolonged typing protocols in the present study to simultaneously investigate the occurrence of fatigue in 3 muscles by using sEMG. We also used a modified JASA[17] as an analytical tool to allow for a more precise diagnosis of muscle behavior. We hypothesized that prolonged typing will change the muscle activity, with increase of the sEMG amplitude and a decrease of its frequencies, demonstrated in pairs by the JASA method. In addition, we also hypothesized that this will occur from the first hour of typing for the 3 muscles because they are recruited to sustain the posture and execute the task, regardless of intervention. Finally, we believe that the interventions of rest breaks and wrist rests will be effective in reducing muscle fatigue in all muscles. If these modifications occur, the present study may provide some physiological evidence to help understand the efficacy of the strategies in the occupational environment.

Materials and methods

Participants

We selected 30 right-handed female volunteers[24] who used a computer less than 4 hours per week, between 20 and 30 years old, and are employed in the private municipal service of the city. Females were recruited because the prevalence of complaints in the neck and upper extremities is reported to be approximately twice as high among women than among men.[25] Furthermore, there is mounting evidence that upper extremity force, muscle activity, and postural factors differ between the sexes.[24] Participants were presented to the research proposal, and they signed an informed consent form to participate in this study. The study was approved by the ethics committee of the University of Amazônia (#0375/2005). All data were collected by a physiotherapist with 11 years of professional experience and were securely saved in hard drives at the Laboratory of Human Motricity Studies of the university. Only authors had access to the files. From the initial sample, only 25 participants completed all steps of the research, and their data were included in the analysis.

After medical assessment (performed by a doctor, consisting of anamnesis and orthopedic physical examination) and a typing speed test, we included subjects who were able to type a minimum of 20 and a maximum of 40 words per minute. Prior professional experience in task execution was an exclusion criteria because of the variability commonly found in the method trained people use while typing and because of the high prevalence of musculoskeletal disorders that affect this population.[21] Individuals diagnosed with any musculoskeletal disorders 12 months prior or those who reported the presence of typical WMSD symptoms were excluded from the study.

Surface electromyography

The activity of the upper trapezius (Tz) fibers, biceps brachii (BB), and EDC muscles was recorded by using an EMG device