Comparison of the effect of flat computer mouse pad and computer mouse pad with wrist support on the activity of chosen muscles groups

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Abstract

Background: Prolonged office work fosters musculoskeletal tension and mental exhaustion. This can be caused by an inadequately adapted workstation, a lack of postural changes by the employee, or their ignorance of ergonomics at work. An ergonomic pad with a gel cushion under the wrist is dedicated for office workers.

Aims: This study aimed to compare the neuromuscular exertion of selected muscles during work at a computer using a computer mouse pad with a gel wrist cushion and a flat mouse pad.

Material and methods: A group of 21 volunteers underwent unilateral neuromuscular exercise assessment using surface electromyography (sEMG) of selected muscles of the upper limb and shoulder girdle, i.e., the wrist radial extensor muscle, the wrist radial flexor muscle, the anterior part of the deltoid muscle, and the descending part of the trapezius muscle while working at a computer using a computer mouse pad with a gel cushion and a flat pad. The percentage of movement task duration below, within, and above 20-30% maximal voluntary contraction (MVC) was analyzed concerning the duration of the entire activity when using a particular pad.

Results: There were no statistically significant differences in the activity of any examined muscles when working with the gel pad or the flat pad. For both pads, the examined muscles were active at less than 20 % of MVC for almost the entire movement activity duration.

Conclusion: A comparative analysis showed no differences in neuromuscular effort in the examined muscles when working at a computer using both computer mouse pads. In both cases, the effort was at a moderate level.

Key words

surface electromyography, ergonomics, office work, gel mouse pad.

Introduction

Work plays an important role in every adult's life. It is estimated that it consumes approximately ⅔ of our lives. Nowadays, an increasing number of individuals work in front of a computer, which is why the workstation needs to provide comfort and enable effective work, especially when sitting at a desk for several hours [1,2].

The basic requirements for health and safety at work and the work organization at computer workstations are included in a legal act, the Decree of the Minister of Labor and Social Policy of 1 December 1998. This regulation requires the employer to adapt workplaces to the requirements contained therein and to provide information on all aspects of health protection at the workplace and training for employees on health and safety at work [3,4,5].

It is acknowledged that providing employees with an ergonomically compliant workstation only entails an additional financial outlay to be borne by the employer. However, employers often do not realize that the financial outlay put into prevention will protect them from an increase in accidents in the workplace and, consequently, in the costs incurred for the treatment of overload and occupational health conditions. [1,2,6].

Prolonged office work fosters musculoskeletal tension and mental exhaustion. This can be caused by an inadequately adapted workstation, a lack of postural changes by the employee or their ignorance of ergonomics at work [7].

There are many types of computer mouse pads available on the market today. They come in many sizes and shapes. For example, an ergonomic pad with a gel cushion under the wrist is dedicated to office workers. The manufacturers of such pads assure that the pad enables a comfortable, correct hand position and reduces pressure on the median nerve in the carpal tunnel.

Aims

This study aimed to evaluate the so-called neuromuscular exertion of selected muscles during work at a computer using a computer mouse pad with a gel wrist cushion compared to a flat mouse pad.

Material and methods

Each subject was informed about the objectives and research methods and signed an informed consent form to participate in the study. The researchers received approval from the Bioethics Committee of the Medical University of Wroclaw.

Characteristics of the studied materials

The study group consisted of 21 students from the Silesian Piasts Wroclaw Medical University in Poland who met all the inclusion criteria listed below. Inclusion criteria comprised: signing a consent form to participate in the study, no history of upper limb injuries and/or conditions, no history of spinal injuries and/or conditions, normal range of movement in the joints of the dominant upper limb, normal muscle strength acting on the joints of the dominant upper limb, equal to 5 on the Lovett scale. There were 13 women and 8 men in the study group who were between 20 and 26 years old; $x=23.05\pm1.02$ years. In all subjects, the dominant limb and the limb operating the computer mouse was the right upper limb.

Research methods

Prior to assessing muscle activity using surface electromyography (sEMG), medical history and physical examination were carried out on each participant. The medical history of the participant included a clinical interview, and the physical examination included measurement of movement range using a standard goniometer and the Lovett test for the upper limbs [8].

The computer program used for the study was GoFitts, with which all subjects performed identical sequences of computer mouse movements. Scott MacKenzie is the author of the program [9]. The task was to click the mouse on illuminated circular discs arranged in a circular pattern (**Figure 1**). The sequence started when the first highlighted disc was clicked on, the next highlighted disc was on the opposite side of the layout, and so on.

The participant used two computer mouse pads consecutively while working at the computer. The flat pad was Hama Mouse Pad 00054768 with dimensions of 22.3 x 18.3 x 0.6 cm (**Figure 2**), and the gel pad was Trust Big Foot Mouse Pad with wrist support (dimensions of 23.6 x 20.5 x 1.6 cm, **Figure 3**).

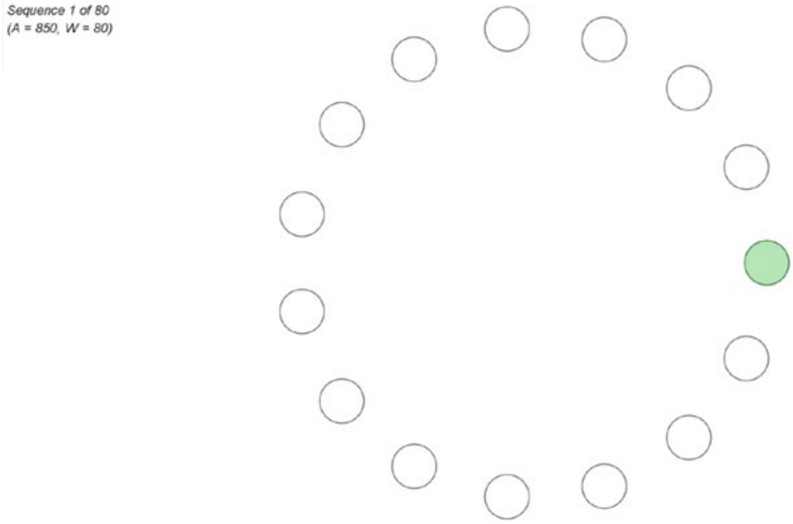

Figure 1. View of 15 targets on a circle plan in GoFitts software.

Figure 2. The flat pad used in the study.

Figure 2. The gel pad used in the study.

Prior to sEMG recordings, the subjects had to be properly prepared. The preparation mainly involved cleaning the skin for the electrodes (removing hair from the areas where the electrodes were to be glued, disinfecting, and degreasing the skin). All procedures related to the sEMG examination were carried out according to the guidelines of the SENIAM project [10].

Electrodes were glued onto the skin after this preparation (**Figures 4-6**). The muscles that were examined were the descending part of the trapezius muscle, the anterior part of the shoulder muscle, the wrist flexor radialis muscle, and the wrist extensor radialis muscle of the subject's dominant upper limb, which operated a computer mouse.

The test station was adjusted to the anthropometric features of the test subject (seat height of the chair so that a right angle is maintained at the knee joints and height of the laptop screen so that its upper edge is at the subject's eye level).

Muscle activity testing began with the relaxation of the subject's entire dominant upper limb. Throughout the movement task, the activity of the studied muscles was recorded in the Noraxon myoMuscle software. For the first 7.5 minutes of the study, the subject's task was to click the mouse on the illuminated discs in the GoFitts program using a gel pad. This was followed by a 5-minute break. Then, a further 7.5 minutes of recording muscle activity was carried out using a flat computer mouse pad.

The final stage of the study was to induce maximal voluntary contraction (MVC) of the examined dominant upper limb muscles. This measurement was carried out using the subject's starting position, and the resistance applied by the examiner at 5, as in the Lovett test, to induce a maximum random isometric contraction of the examined muscle.

Figure 4. Electrodes and wireless sensors for the descending part of the trapezius muscle.

Figure 5. Electrodes and sensors for the anterior part of the deltoid muscle and the wrist radial extensor muscle.

Figure 6. Electrodes and wireless sensors for the wrist radial flexor muscle.

Statistical analysis

The collected data was analyzed using TIBCO Statistica software (TIBCO Software Inc., Palo Alto, CA, USA). The so-called neuromuscular effort during a movement task was analyzed. The main parameter analyzed was the percentage of movement task duration below, in the middle, and above 20-30% of the MVC in relation to the duration of the entire activity using a given mouse pad. The results were interpreted based on the Noraxon user guide, that is: below 20-30% MVC – moderate activity, in the range of 20-30% MVC – submaximal activity, above 20-30% MVC – severe activity. The student's t-test for independent samples was used, and the level of statistical significance was set at $p < 0.050$.

Results

The vast majority of the duration (greater than 95%) of the wrist radial extensor muscle movement task was within the range of less than 20-30% of the MVC during work with both the gel pad and flat pad (**Table 1**). This means that the activity of the wrist radial extensor muscle can be assessed as moderate in the context of neuromuscular effort during computer work.

The neuromuscular activity of the other muscles examined also indicates moderate effort during the movement task. More than 99% of the movement task duration was within the range of less than 20-30% of the MVC when working with a gel pad and a flat pad (**Tables 2-4**). There were no statistically significant differences between the neuromuscular effort of the muscles examined when working with a gel pad when compared to a flat pad.

Table 1. Comparison of the percentage of movement task duration in a given MVC percentage range between a gel pad and a flat pad for the wrist radial extensor muscle.

Wrist radial extensor muscle					
	Gel pad		Flat pad		
	x	SD	x	SD	*p*
Below 20-30% MVC	95.49	20.66	95.25	21.67	0.27
20-30% MVC	3.99	18.26	3.95	18.04	0.57
Above 20-30% MVC	0.52	2.38	0.80	3.64	0.31

Notes: The values in the table are expressed as the arithmetic mean (x) and standard deviation (SD) of the percentage of time a given movement task lasts within a given range of MVC percentage.

Abbreviations: MVC, maximal voluntary contraction; p, level of statistical significance.

Table 2. Comparison of the percentage of movement task duration in a given MVC percentage range between a gel pad and a flat pad for the wrist radial flexor muscle.

Wrist radial flexor muscle					
	Gel pad		Flat pad		
	x	SD	x	SD	*p*
Below 20-30% MVC	99.73	0.87	99.66	0.89	0.32
20-30% MVC	0.21	0.73	0.28	0.78	0.08
Above 20-30% MVC	0.06	0.15	0.06	0.12	0.48

Notes: The values in the table are expressed as the arithmetic mean (x) and standard deviation (SD) of the percentage of time a given movement task lasts within a given range of MVC percentage.

Abbreviations: MVC, maximal voluntary contraction; p, level of statistical significance.

Table 3. Comparison of the percentage of movement task duration in a given MVC percentage range between a gel pad and a flat pad for the anterior part of the deltoid muscle.

Anterior part of the deltoid muscle					
	Gel pad		Flat pad		
	x	SD	x	SD	*p*
Below 20-30% MVC	99.70	0.80	99.57	0.71	0.13
20-30% MVC	0.23	0.66	0.32	0.58	0.12
Above 20-30% MVC	0.06	0.15	0.11	0.18	0.12

Notes: The values in the table are expressed as the arithmetic mean (x) and standard deviation (SD) of the percentage of time a given movement task lasts within a given range of MVC percentage.

Abbreviations: MVC, maximal voluntary contraction; p, level of statistical significance.

Table 4. Comparison of the percentage of movement task duration in a given MVC percentage range between a gel pad and a flat pad for the descending part of the trapezius muscle.

Descending part of the trapezius muscle					
	Gel pad		Flat pad		
	x	SD	x	SD	*p*
Below 20-30% MVC	99.74	0.30	99.56	0.78	0.17
20-30% MVC	0.13	0.15	0.28	0.56	0.13
Above 20-30% MVC	0.13	0.20	0.15	0.25	0.37

Notes: The values in the table are expressed as the arithmetic mean (x) and standard deviation (SD) of the percentage of time a given movement task lasts within a given range of MVC percentage.

Abbreviations: MVC, maximal voluntary contraction; p, level of statistical significance.

Discussion

Many researchers are addressing the topic of office ergonomics. This is linked to the increasing popularity of office work and computer-based remote work. A large percentage of office workers complain about various types of musculoskeletal discomfort, as demonstrated by research conducted by James et al. [11]. A total of 301 employees (academic and administrative) took part in the survey. As many as 80% of employees reported musculoskeletal discomfort, primarily in the neck, shoulders, and lower back, which correlated with the duration of office work. In contrast, Robertson et al. [12] examined the effects of introducing ergonomic workstations among office workers and training them on the principles of office ergonomics. The results of the research indicated that the training and changes positively impacted the workers' posture while sitting at the computer, which reduced the musculoskeletal discomfort reported by the workers. This research has demonstrated the importance of a suitable working environment and knowledge of office ergonomics, as these aspects can directly affect an office worker's quality of life.

A study published by Onyebeke et al. [13] demonstrated that forearm and hand support during computer tasks influences upper limb muscle activity. Sixteen subjects performed several computer tasks in six different forearm and hand support positions. Muscle activity of selected upper limb muscles was recorded using sEMG. The research results revealed that forearm support during computer tasks significantly reduced shoulder girdle muscle activity compared to no forearm support, and the elevated hand rest positively affected wrist straightening. Participants also reported less musculoskeletal discomfort when working with the forearm and hand support.

The aforementioned studies showed that most ergonomic solutions for computer workstations reduce the muscular activity of the upper limb and trunk muscles examined, which are often overloaded during static work. Considering the above-mentioned studies, some limitations can be identified in our research. It is possible that the duration of the movement task was too short to register statistically significant differences between the gel pad and the flat pad. Another limitation may also have been that the study group included a small number of people. Consideration should also be given to the fact that the correct positioning of the chair, desk or monitor screen alone may have influenced the fact that the neuromuscular effort when working with both pads was at a moderate level and the fact that the study group mostly consisted of physiotherapy students who have good habits when it comes to correct posture in front of a computer.

In order to obtain more reliable results in the future, it would be advisable to consider extending the duration of the movement task as well as recruiting a larger study group. Extending the sEMG examination to include different muscles would also be appropriate.

Conclusions

The analysis of the neuromuscular activity of the examined muscles while working at a computer with a computer mouse using a gel wrist pad showed no differences when compared to a flat pad. Therefore, working at the computer using both tested pads can be considered a moderate level of neuromuscular activity.

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