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Original Article

Comparison of Orbicularis Oculi Muscle Activity during Computer Work with Single and Dual Monitors

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Abstract. [Purpose] This study compared the orbicularis oculi muscle activity during computer work with single and dual monitors. [Subjects] Ten computer workers 22–27 years of age were included in this study. [Methods] Subjects performed computer work with single or dual monitors, and the activity of the right orbicularis oculi muscle was measured with a MP150 system. [Results] The muscle activity of the orbicularis oculi under condition 1 was significantly decreased compared with that under conditions 2 or 3. The muscle activity of the orbicularis oculi under condition 3 was significantly increased compared with that under condition 2. [Conclusion] The present study found that the use of dual monitors increased orbicularis oculi activity; therefore, to decrease eye fatigue in computer users, computer workstations that use either a single monitor, or identical monitors from the same manufacturer in a dual setup, are recommended.

Key words: Electromyography, Eye-related pain, Orbicularis oculi

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INTRODUCTION

Computer users often experience pain in their neck and shoulder muscles[1)]. Multiple studies advocate the use of ergonomic computer workstations that minimize tension in these muscles[1)]. In recent years, increasing numbers of workers have reported tension and pain in the muscles around their eyes along with headaches resulting from computer work[2)]. However, few studies have focused on methods to reduce pain and tension in the muscles around the eyes, perhaps because evaluating eye fatigue is difficult. Electromyography (EMG) is the most commonly used physiological measurement tool, and facial EMG is sensitive enough to distinguish subtle changes in emotion[3)]. Studies measuring the activity of the orbicularis oculi muscles have been conducted on diverse populations, and orbicularis oculi activity has become an important predictor of eye fatigue[4, 5)]. Although newer computers have large monitors on which multiple tasks can be performed, an increasing number of users link two monitors to create a large display. Despite this trend, no studies have examined the effect of dual monitor use on the muscles surrounding the eyes. Therefore, this study compared the orbicularis oculi muscle activity during computer work with single and dual monitors.

SUBJECTS AND METHODS

Ten computer workers who were 22 to 27 years of age (mean ± SD, 25.4±2.0 years) were included in this study. The participants were 173.2 ± 5.2 cm tall and weighed 63.2 ± 4.7 kg. Subjects with a history of injury or neurological deficit in their upper extremities or trunk during the previous year were excluded from the study. Informed consent was obtained from each subject prior to study participation. This study was approved by the Inje University Faculty of Health Sciences Human Ethics Committee. The activity of the right orbicularis oculi muscle was recorded with a MP150 system (Biopac Systems, Santa Barbara, CA, USA) using an EL254S (4 mm, Ag/Agcl) electrode. All EMG signals were sampled at 1,000 Hz and analyzed with the AcqKnowledge 3.9.1 software (Biopac Systems, Santa Barbara, CA, USA). The amplitude was normalized to the maximum voluntary isometric contraction. The subjects performed computer work under three conditions. Under condition 1, a single monitor was used (L-company, 20 in), and subjects typed text that was displayed in a PDF file on the right side of a divided display into a program on the left side of the divided display. Under condition 2, two identical monitors were used in a dual display (L-company, 20-inch), and subjects typed text from a PDF file displayed on the right monitor into a program on the left monitor. Under condition 3, two different monitors were used to construct a dual display (an L-company 20-inch monitor and an S-company 20-inch monitor), and the subjects typed text from a PDF file on the right monitor into a program on the left monitor. For each condition, the workstation included a keyboard and mouse on a table and a swivel chair with

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five wheels. The resolution of all computer monitors was set to 1,068 × 1,050. To allow for lumbar motion analysis, the armrest and backrest were removed from the chair. The workstation table and chair could be adjusted for height and were initially set to ensure that the elbows, hips, and knees were flexed at 90°. The keyboard and mouse were positioned 30 cm from the trunk, the monitor was reclined by 20°, and the top of the display was set at eye level. Each study subject spent 15 minutes typing 300–400 words using Microsoft Word (Microsoft, Redmond, WA, USA) at each of the three workstations. The Statistical Package for the Social Sciences (SPSS, Chicago, IL, USA) was used for statistical analysis. Repeated-measures one-way ANOVA was used to compare results among groups. p-values less than 0.05 were considered statistically significant.

RESULTS

The muscle activity of the orbicularis oculi under condition 1 (9.8 ± 4.0%) was significantly decreased compared with that under condition 2 (12.6 ± 5.7%) or 3 (15.6 ± 6.3%) ($p < 0.05$). The muscle activity of the orbicularis oculi under condition 3 was significantly increased compared with that under condition 2 ($p < 0.05$).

DISCUSSION

In the current study, EMG was used to measure orbicularis oculi activity in computer users and evaluate tension in the muscles surrounding the eyes. Eye fatigue was greater when using a dual monitor. Activity in the muscles around the eyes was increased due to the increased movement of the head and eyes from one monitor to the other, which required constant refocusing and increased pupil action due to the larger screen area[6, 7]. Eye blink, a component of the startle response, can be measured by recording the phasic EMG activity in the orbicularis oculi. The blink reflex varies with emotional valence; a greater response is induced by unpleasant stimuli, and the response is increased by stress[8]. Therefore, a consistent increase in the muscle activity of the orbicularis oculi is closely related to and likely a cause of eye fatigue, headache, and stress in those who use computers for long periods[6–8]. Additionally, the present study found that the activity of the orbicular oculi increased when a dual monitor setup that comprised monitors from different manufacturers was used, compared with that when both monitors were from the same manufacturer. Despite using the same resolution, brightness, and contrast settings on the monitors from the different manufacturers, subtle differences in brightness and resolution required the eyes to readjust their focus, which increased the activity of the muscles surrounding the eyes[6, 7]. Thus, dual monitors are not recommended, as they increase tension in the muscles surrounding the eye. If a dual monitor setup is necessary, the use of two identical models from the same manufacturer is recommended. Yoo et al.[9] suggested that improved computer workstations could prevent musculoskeletal disorders. A previous study also found that differences in computer workstations were associated with differences in fatigue[10]. The present study found that the use of dual monitors increased orbicularis oculi activity; therefore, to decrease eye fatigue in computer users, computer workstations that use either a single monitor or identical monitors from the same manufacturer in a dual setup, are recommended.

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