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Original Article

Effect of the difficulty level of a biofeedback device for postural correction on the orbicularis oculi and upper trapezius muscle activity and trunk flexion angle during computer work

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Abstract. [Purpose] The purpose of this study was to investigate the effect of the difficulty level of a biofeedback device for postural correction on the orbicularis oculi and upper trapezius muscle activity and trunk flexion angle during computer work. [Subjects] Ten computer workers were included in this study. [Methods] The biofeedback tool used in this study provided visual and auditory feedback with regard to changes in trunk flexion angle under two different conditions during computer work: The first condition was when there was an increase of more than 10 degrees in a standard sitting posture. The second condition was when there was an increase of more than 20 degrees in the same posture. [Results] The trunk flexion angle showed no significant difference between conditions. The muscle activities of the orbicularis oculi and upper trapezius under condition 1 (high difficulty level) was significantly increased compared with those under condition 2 (low difficulty level). [Conclusion] This result showed that frequent feedback with greater sensitivity can trigger stress and lead to the outbreak of other illnesses.
Key words: Biofeedback device, Computer user, Orbicularis oculi muscle

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INTRODUCTION

Recently, many studies have suggested the use of therapeutic or exercise tools with biofeedback, which provides additional information about users by detecting subtle changes in the body with sensors[1–3)]. Many therapists give visual and auditory feedback, even during clinical trials[4)]. In particular, there is active research being conducted on the development of a biofeedback tool for people who work at a computer for long hours while sitting in a bad posture[1–3)]. Researchers have been boosting the sensor capacity of biofeedback tools in order to improve the effectiveness of posture exercises and other exercises[1–3)]. Such improvement in the tools offers quick feedback of subtle changes in the body[4)]. In particular, visual and auditory feedbacks are often used in clinical trials. Biofeedback tools with greater sensitivity are under development, and those tools will offer a greater amount of feedback at a greater frequency[1–3)]. However, too much information can trigger stress for patients. Patients suffering from illness or pain tend to respond more sensitively to tests in a stressful environment. Therefore, it is important to minimize the number of factors that can trigger stress in patients during clinical trials[4)]. Nevertheless, there have been hardly any studies conducted on the effects of feedback on the stress level of patients. So, this study investigated the effect of the difficulty level of a biofeedback device for postural correction on the muscle activities of the orbicularis oculi and upper trapezius and trunk flexion angle during computer work.

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SUBJECTS AND METHODS

Ten computer workers (mean ± SD, 25.4±2.0 years) were included in this study. The participants were 175.1 ± 2.7 cm tall and weighed 66.1 ± 3.7 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. The subjects received an explanation about the purpose and methods of the study prior to their participation and provided informed consent according to the ethical principles of the Declaration of Helsinki. The muscle activities of the right orbicularis oculi and upper trapezius were recorded with a MP150 system (Biopac Systems, Santa Barbara, CA, USA) using surface electrodes. 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 and expressed as a percentage of the reference voluntary contraction. An ultrasonic movement analysis system, CMS-MS (zebris Medical GmbH, Isny, Germany) was used to record the trunk flexion angles during computer work within the sagittal plane. Two triple markers were attached to 12th thoracic spinous process and 1st sacral prominence for evaluating the trunk flexion angle. The trunk flexion angle was assessed with the lumbar flexion angle relative to the pelvis. The initial calibration position was obtained by holding the line from the tragus to the acromion parallel to the vertical line with the chin retracted, with a plumb line suspended from the ceiling to provide a vertical and magnification reference. All the procedures were performed by the same investigator to minimize variability of marker placement. The receiver was fixed approximately 2 m from and perpendicular to the subject's sagittal plane. The data were sampled at 25 Hz and stored on a personal computer for later analysis. Each study subject spent 30 minutes typing 600–800 words using Microsoft Word (Microsoft, Redmond, WA, USA). The biofeedback tool provides visual and auditory feedback with regard to changes in trunk flexion angle under two different conditions: The first condition was when there was an increase of more than 10 degrees in a standard sitting posture. The second condition was when there was an increase of more than 20 degrees in the same posture. The biofeedback program for trunk flexion angle noted as "please change your posture for your health" with beep sound. The biofeedback was offered by setting trunk flexion angles at each condition (low or high difficulty level). The subjects used Bluetooth earphones to minimize the possibility of bothering other people and the possibility of altering neck kinematics due to tension form the cable of corded set earphones. The SPSS statistical package (version 18.0; SPSS, Chicago, IL, USA) was used to analyze the differences in the muscle activities of the orbicularis oculi and upper trapezius and trunk flexion angle during computer work. The paired t-test was utilized to detect statistical significance, with the level set at $p < 0.05$.

RESULTS

The trunk flexion angle showed no significant difference between condition 1 (23.1 ± 5.2 degrees) and condition 2 (25.3 ± 7.6 degrees) ($p > 0.05$). The muscle activity of the orbicularis oculi under condition 1 (15.8 ± 5.2%) was significantly increased compared with that under conditions 2 (11.0 ± 6.2%) ($p < 0.05$). The muscle activity of the upper trapezius under condition 1 (19.5 ± 6.0%) was significantly increased compared with that under condition 2 (12.9 ± 9.2%) ($p < 0.05$).

DISCUSSION

Electromyography is the most frequently used means of measuring physiological functions, and it has been shown that facial electromyography can detect subtle changes triggered by emotions such as stress on a face[5)]. A study on the electromyography of orbicularis oris muscles has been carried out on various subjects to investigate physiological responses such as stress[5)]. Shalev et al. examined the characteristics of physiological responses triggered by post-traumatic stress disorder by measuring the electromyography of orbicularis oris muscles[6)], while Bolbecker et al. studied temporal processing ability as measured by trace eyeblink conditioning. Moreover, upper trapezius muscles are often measured to evaluate patients with hypertonic stress[7)]. So, the present study investigated the effect of the difficulty level of a biofeedback device for postural correction on the muscle activities of the orbicularis oculi and upper trapezius and trunk flexion angle during computer work. The results showed that there was no significant difference in trunk flexion angle between the conditions. However, the muscle activities of the orbicularis oculi and upper trapezius under condition 1 (high difficulty level) were significantly increased compared with those under conditions 2 (low difficulty level). According to the findings of this study, setting a biofeedback tool to respond sensitively to subtle changes in the body (in other words, setting the level of difficulty experienced by a patient when performing a task) was found to increase tension in these two muscles but appeared to have little impact on posture correction. In other words, it would be more meaningful if the tool focused on the frequency of feedback rather than its precision. The two muscles examined in this study are often used in assessing the stress of patients and are known to induce headache and tension in the shoulder muscles when activated[4)]. One of the core startle response components is the eyeblink response[7, 8)]. It is measured by phasic EMG in orbicularis oris muscles. The blink reflex changes linearly in size relative to a strong stimulus in accordance with emotional valence and exhibits a greater response to an unpleasant stimulus[8)], and it becomes larger in the presence of sound that is more stressful than neutral[9)]. Considering the findings of the present study in the light of the aforementioned theories, it is believed that frequent feedback with greater sensitivity can trigger stress and lead to the outbreak of other illnesses.

REFERENCES

1) Yoo WG: Effect of exercise speed and isokinetic feedback on the middle and lower serratus anterior muscles during push-up exercises. J Phys Ther Sci, 2014, 26: 645–646. [Medline] [CrossRef]
2) Park SY, Yoo WG: Effect of EMG-based feedback on posture correction during computer operation. J Occup Health, 2012, 54: 271–277. [Medline] [CrossRef]
3) Yoo WG: Effect of a wrist motion storage biofeedback system (WMSBS) on wrist motion during keyboard typing work. J Phys Ther Sci, 2013, 25: 159–160. [CrossRef]
4) Neumann DA: Kinesiology of the musculoskeletal system: foundations for physical rehabilitation. St Louis: Mosby, 2009.
5) Bolls D, Lang A, Potter F: The effects of message valence and listener arousal on attention, memory, and facial muscular responses to radio advertisements. Communic Res, 2001, 28: 627–651. [CrossRef]
6) Shalev AY, Peri T, Brandes D, et al.: Auditory startle response in trauma survivors with posttraumatic stress disorder: a prospective study. Am J Psychiatry, 2000, 157: 255–261. [Medline] [CrossRef]
7) Bolbecker AR, Mehta CS, Edwards CR, et al.: Eye-blink conditioning deficits indicate temporal processing abnormalities in schizophrenia. Schizophr Res, 2009, 111: 182–191. [Medline] [CrossRef]
8) Lang PJ, Bradley MM, Cuthbert BN: Emotion, attention, and the startle reflex. Psychol Rev, 1990, 97: 377–395. [Medline] [CrossRef]
9) Bradley MM, Lang PJ: Affective reactions to acoustic stimuli. Psychophysiology, 2000, 37: 204–215. [Medline] [CrossRef]