Effects of an Unstable Dual Foot Support on the Trunk Flexion Angle and RF, L4-ES, EO Muscle Activities during Computer Work

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Abstract. [Purpose] The purpose of this study was to show the effects of an unstable dual foot support on the trunk flexion angle and rectus femoris (RF), L4 level erector spinae (L4-ES), and external oblique (EO) muscles activities during computer work. [Subjects] Fourteen computer workers were recruited. [Methods] The subjects performed computer work with and without an unstable dual foot support, and the muscle activities of the RF, L4-ES, EO were measured. [Results] The trunk flexion angle significantly decreased during working with the unstable dual foot support compared to without. The normalized EMG data of the RF, L4-ES and EO muscles significantly increased during working with the unstable dual foot support compared to without. [Conclusion] We suggest that the unstable dual foot support would be a portable and cost effective assistive tool for encourage an optimal sitting posture in computer workers.

Key words: Computer worker, Sitting posture, Unstable foot support

INTRODUCTION

Recent studies suggest that maintaining good alignment of the body in the sitting position can prevent or reduce posture-related pain1, 2). Prolonged sitting postures, in combination with poor workstation ergonomics, have been significantly implicated in the development of musculoskeletal problems during computer work3, 4). Numerous studies have investigated the impact of chair design in ameliorating neck and shoulder pain, including the design of seat type, seat height, backrest type, backrest angle, lumbar support, and armrest type5, 6). For example, van Dieen et al.7) showed that dynamic office chairs potentially offer advantages over fixed chairs. For this reason, some studies have developed the unstable ball-backrest8) and the unstable seat support9). However, few studies have investigated the effect of an unstable foot support. The purpose of this study was to show the effects of an unstable dual foot support on the trunk flexion angle and rectus femoris, L4 level erector spinae, and external oblique muscle activities during computer work.

SUBJECTS AND METHODS

This study recruited fourteen computer workers who were 28–33 years of age (29.1 ± 2.5 years, mean ± SD); they were 177.2 ± 6.5 cm tall and weighed 65.2 ± 5.5 kg. Subjects with injury or neurological deficits of the upper extremities and trunk occurring during the previous year were excluded from the study. The muscle activities of the rectus femoris (RF), L4 level erector spinae (L4-ES), and external oblique (EO) muscles were recorded using a MP150 system and circular surface EMG disposable electrodes (35 mm diameter). All EMG signals were sampled at 1000 Hz, and then analyzed using Acqknowledge 3.9.1 software (Biopac Systems, Santa Barbara, CA, USA). The amplitude was normalized to the maximum voluntary isometric contraction. The trunk flexion angles were measured and recorded with a 3-D motion analysis system (CMS-HS, Zebris Medizintechnik, Isny, Germany). The trunk flexion angle was measured from the line of the left acromion to the L1 spinous process, and the line from the L1 spinous process to the left greater trochanter. An unstable dual foot support was developed for this study. It consisted of two small wooden wobble boards, 7 inches in diameter and 4 inches high. This size was determined by a pilot study. It was the most effective size for ensuring proper sitting posture as well as being the most comfortable size for doing computer work. The subjects performed computer work while supporting the middle of both the right and left foot on these small wooden wobble boards. Our study also used an office chair, made of polyester, leather, and a mix of synthetic materials, but we removed the backrest in order to measure the trunk flexion angle. The distance between the keyboard and trunk was set at 0.3 m. The use of a height-adjustable computer table and a chair with armrests but no backrest ensured that the elbows, shoulders, hips, and knees joints were flexed at 90°. All subjects performed 300–400 words worth of typing work, with and without the unstable foot support, for 15 minutes using an English typing program produced by Hansoft.
for statistical analysis. The paired t-test was used to test the significance of differences in trunk flexion angles and muscle activities when computer work was performed with or without the unstable dual foot support. The alpha level for statistical significance was chosen as 0.05.

RESULTS

The trunk flexion angle significantly decreased (p<0.05) when computer work was performed with (18.5±7.1°) compared to without (26.9±10.8°) the unstable dual foot supports. The normalized EMG data of the RF muscle significantly increased (p<0.05) during work with (18.8±7.0%) compared to without (11.2±6.4%) the unstable dual foot supports. The normalized EMG data of the L4-ES muscle showed significant increase (p<0.05) during work with (34.6±10.3%) compared to without (22.6±12.0%) the unstable dual foot support. The normalized EMG data of the EO muscle showed a significant increase (p<0.05) during work with (22.8±12.5%) compared to without (12.4±8.7%) the unstable dual foot support.

DISCUSSION

The trunk flexion angle significantly decreased when computer work was performed with the unstable dual foot support compared to work done without support. It is important to teach seated workers to maintain the correct sitting posture when performing desk work. The ideal seated posture is where the lumbar spine has some degree of extension (erect), whereas a poor posture is where the lumbar spine is slumped. Erect sitting posture is considered to be a state of musculoskeletal balance that minimizes the stresses and strains acting on the body. Our present study showed that the RF muscle activity significantly increased when work was performed with the unstable dual foot support. Clinical literature suggests that anterior pelvic rotation in the sagittal plane is associated with the rectus femoris, while the erector spinae works with the pelvis as a coupled-forced generator. We thought that RF activity would be increased by the unstable dual foot support, producing anterior pelvic rotation, which would help to maintain an erect sitting posture. Our present study showed that the activity of the L4-ES and EO muscles significantly increased during work with the unstable dual foot support. Co-contraction of abdominal muscles and the lumbar multifidus has the potential to provide a dynamic corset for the lumbar spine, thereby enhancing its segmental stability during functional tasks and the maintenance of neutral spinal postures. In clinical settings, passive postures such as slumped sitting have been identified as predictive of chronic lower back pain. We suggest that the unstable dual foot support would be a portable and cost effective assistive tool for encouraging the adoption of an optimal sitting posture by computer workers.

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