Effects of two workstation positions for below-knee assembly work on upper extremity muscle activity

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Abstract. [Purpose] This study was performed to determine which set of below-knee working conditions minimizes upper extremity muscle activity and which of upward- or downward-direction workstations poses the greater risk of upper extremity disorder. [Subjects] The study population consisted of 15 young male workers. [Methods] EMG activities of the right anterior deltoid, biceps brachii, and lower trapezius muscles were measured in two below-knee assembly workstation positions. [Results] The anterior deltoid and biceps brachii muscle activities of Position 1 were significantly higher than those of Position 2. The lower trapezius muscle activity of Position 2 was significantly higher than that of Position 1. [Conclusion] Upward-direction workstations appear to pose a greater risk of upper extremity disorder than downward-direction workstations in below-knee assembly work.

Key words: Below knee assembly work, Electromyography, Upper extremity disorder

INTRODUCTION

Assembly work is strongly associated with the development of upper extremity discomfort and disorders1). A common concern is that assembly workers must work under conditions of sustained knee flexion and trunk flexion. Many previous studies have indicated that these postures can be risk factors of work-related musculoskeletal discomfort2, 3). Several risk factors may contribute to upper extremity disorders, including repetitive work, high hand force, vibration, stooped postures, and prolonged constrained postures4). Chopp et al.5) reported the impact of work configuration, target angle, and hand force direction on upper extremity muscle activity during submaximal overhead work. Especially, positioning overhead work in front of the body with exertion directed forward decreases upper extremity muscle activity. Workstation position is strongly associated with work direction and development of upper extremity disorders6). However, there have been few studies of upper extremity muscle activity changes related to workstation position in below-knee assembly work. The present study was performed to examine the physical risk factors associated with upper extremity disorders during below-knee assembly work performed in two workstation positions.

SUBJECTS AND METHODS

The study population consisted of 15 young, male, right-hand-dominant workers with a mean age of 21.1 ± 1.3 years, mean height of 176.1 ± 6.7 cm, and mean weight of 70.9 ± 10.9 kg. The subjects were not accustomed to below-knee assembly work. They had no past history of orthopedic disorders affecting the neck or shoulder region, and had no history of neurological disorders. Each subject provided informed consent before participating in this study. This study was approved by the Inje University Faculty of Health Sciences Human Ethics Committee. Surface EMG was used to collect raw EMG data using a Trigno wireless system (Delsys, Boston, MA). EMG data were normalized to the maximum voluntary isometric contraction of each muscle, which was measured by the same examiner. Three surface electrodes were placed on the muscles of the dominant (right) side: the anterior deltoid, the biceps brachii, and the lower trapezius7). All subjects performed below-knee nut and bolt assembly work for 3 min using the same workstation. The experimental protocol specified two below-knee assembly workstation positions: 1) one hand doing below-knee assembly work with an upward-direction workstation, and 2) one hand doing below-knee assembly work with a downward-direction workstation. All the subjects were required to sustain trunk and knee flexion in the working posture. The test order was randomized. EMG signals were collected for 3 min, and the first and last 10 s were discarded. The participants worked barefoot, during data collection. The SPSS statistical package (SPSS, ver. 20.0; IBM, Armonk, NY, USA) was used to analyze the differences in the anterior deltoid, biceps brachii, and lower trapezius muscle activities between Positions 1 and 2, during below-
knee assembly work, using the paired t test. In all analyses, p < 0.05 was taken to indicate statistical significance.

RESULTS

The anterior deltoid muscle activity in Position 1 (35.3 ± 17.9) was significantly higher than that in Position 2 (24.0 ± 13.8) (p < 0.05). The biceps brachii muscle activity in Position 1 (21.3 ± 14.9) was significantly higher than that in Position 2 (5.3 ± 3.2) (p < 0.05). The lower trapezius muscle activity in Position 2 (50.3 ± 26.8) was significantly higher than that in Position 1 (20.5 ± 19.9) (p < 0.05).

DISCUSSION

The results of the present study indicate that the activities of the anterior deltoid and biceps brachii muscles increase significantly in below-knee assembly work with an upward-direction workstation compared to a downward-direction workstation. Haslegrave et al.8 examined the isometric strength capabilities of force exertion in six directions (push, pull, medial, lateral, up, down) and reported that participants were most capable in the vertical direction (up or down). Nimbarth et al.9 reported that the sternocleidomastoid muscle was most active in an extended neck posture, while the upper trapezius muscle was most active in a flexed neck posture. Shin et al.9 reported that performing overhead tasks using a neutral neck posture and one hand decreased upper extremity muscle activity compared to two-handed overhead work with an extended neck posture. Yoo11 found that cervical extension angle and upper trapezius muscle activity significantly increased during below-knee work compared to overhead work. Choop et al.5 reported that normalized electromyographic activity was greater in the backward than the forward and downward directions. In addition, pulling backwards yielded a higher level of total activity than all other hand force directions. In the present study, the activity of the lower trapezius muscle increased significantly in below-knee assembly work with a downward-direction workstation compared to an upward-direction workstation. Together, these observations suggest that the increase in workers’ below-knee lower trapezius muscle activity causes an increase in scapular stability during below-knee work at a downward-direction workstation.

The present results indicate that, among the workstation positions tested, muscle demands during below-knee assembly work are lower at a downward-direction workstation than at an upward-direction workstation. The present results indicate that below-knee workers should consider the workstation position.

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