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Comparison of the Cervical Extension Angle and the Upper Trapezius Muscle Activity between Overhead Work and Below-knee Work

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Abstract. [Purpose] The purpose of this study was to compare the cervical extension angle and the upper trapezius muscle activity between overhead work and below-knee work. [Subjects] Twelve males aged 20–30 years, were recruited. [Methods] We measured the cervical extension angle and upper trapezius muscle activity during overhead work and below-knee work. [Results] The results show that the cervical extension angle and upper trapezius muscle activity were significantly increased during below-knee work compared to overhead work. [Conclusion] Below-knee work is more likely to cause neck and shoulder pain than overhead work. Therefore, future studies should investigate below-knee work in detail.

Key words: Below-knee work, Cervical extension, Shoulder pain

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INTRODUCTION

Work-related musculoskeletal disorders are a group of painful disorders of the muscles, tendons, and nerves that can be induced by work activities that are frequent and repetitive, or that involve awkward postures[1)]. Overhead work is strongly associated with the development of upper extremity discomfort and disorders[2, 3)]. Several risk factors may contribute to upper extremity discomfort, including task repetition, high load, awkward postures, direct pressure, vibration and prolonged constrained postures[4)]. Specifically, prolonged activity in overhead working postures strains and fatigues the shoulder muscles[5)]. There is a high prevalence of shoulder musculoskeletal disorders in the general population, with risks in elevated arm work reported, particularly for jobs requiring overhead work[6, 7)]. However, these elevated arm work is required not only in overhead works, but also in knee-high work with trunk flexion. No studies have evaluated knee-high work with trunk flexion. Therefore, this study compared the cervical extension angles and the upper trapezius muscle activities observed in overhead work with those observed in below-knee work.

SUBJECTS AND METHODS

Twelve males, aged 20–30 years, with a mean height and weight of 175.6 ± 4.1 cm and 68.2 ± 6.7 kg, respectively, participated in this study. The subjects had no history of musculoskeletal disorders or pain associated with the upper extremity in the past 6 months. Ethical approval was obtained from the Yonsei University Faculty of Health Science Human Ethics Committee, and all subjects provided their written informed consent prior to participation in the study. The angle of cervical extension was measured using a cervical range of motion instrument (Performance Attainment Associates, St. Paul, MN, USA). EMG data were collected using a Biopac MP150WSW (Biopac System, Santa Barbara, CA, USA). The sampling rate of the sEMG signal was 1,000 Hz, and signals were band-pass filtered between 20–450 Hz. The surface electrodes were placed on the right shoulder 2 cm lateral to the midpoint of a line drawn between the C7 spinous process and the posterolateral acromion for the upper trapezius. To normalize the sEMG data, the maximum voluntary isometric contraction (MVIC) of each muscle was measured using a manual muscle test. The subjects performed assembly of 30 bolts and nuts for 3 minutes at the two different heights. Condition 1 was overhead work. Subjects performed the assembly work on a board at a height of 20 cm above the head while standing. Condition 2 was below-knee work. Subjects performed assembly work on a board 5 cm below the knees with the knees in extension. We measured the cervical extension angle of the initial working position and the upper trapezius muscle activity of the last 30 seconds of the 3 minutes of the overhead and below-knee work. SPSS (Chicago, IL, USA) was used for statistical analysis. The paired t-test was used to analyze the significance of the differences in the cervical extension angle and upper trapezius muscle activity between overhead work and below-knee work. The alpha level for statistical significance was chosen as 0.05.

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RESULTS

The cervical extension angle was significantly increased during below-knee work (52.5 ± 9.1 degrees) compared to overhead work (40.2 ± 8.7 degrees) ($p<0.05$). The upper trapezius muscle activity was significantly increased during below-knee work (62.5 ± 12.0%) compared to overhead work (51.6 ± 15.5%) ($p<0.05$).

DISCUSSION

The purpose of this study was to compare the cervical extension angles and the upper trapezius muscle activities of overhead work and below-knee work. The results show that the cervical extension angle and upper trapezius muscle activity were significantly increased during below-knee work compared to overhead work. Long-term overhead work results in strain and fatigue of the shoulder muscles, because arm elevation is associated with shoulder muscle fatigue[5, 8]. Herberts et al.[8] found that localized muscle fatigue accumulates in the trapezius muscles in an overhead posture. Overhead work requires arm elevation and head extension, and it is influenced by arm posture, primarily by the elevation angle[9]. Below-knee work may continuously produce greater cervical extension for vision during assembly work. We consider that the cervical extensor loading in the below-knee work was greater than the cervical extensor loading in the overhead work, because the cervical extension of below-knee work produces a greater external moment arm[10]. Also, the shoulder elevator muscle activation in below-knee work is greater than in overhead work because of trunk flexion[10]. Therefore, below-knee work is more likely to cause neck and shoulder pain than overhead work. Below-knee work is commonly performed in the automobile and shipbuilding industries. However, in industry and in reserch, the risk factors of below-knee work have been neglected compared to overhead work. This study is the first use the term “below-knee work”. Therefore, future studies should perform detailed researches of below-knee work.

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