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Original Article

Comparison of the thoracic flexion relaxation ratio and pressure pain threshold after overhead assembly work and below knee assembly work

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Abstract. [Purpose] The purpose of this study was to compare the thoracic flexion relaxation ratio following overhead work and below-knee work. [Subjects and Methods] Ten men (20–30 years) were recruited to this study. The thoracic flexion relaxation ratio and pressure pain threshold was measured after both overhead work and below-knee work. [Results] The pressure-pain thresholds of the thoracic erector spinae muscle decreased significantly from initial, to overhead, to below-knee work. Similarly, the thoracic flexion relaxation ratio decreased significantly from initial, to overhead, to below-knee work. [Conclusion] Below-knee work results in greater thoracic pain than overhead work. Future studies should investigate below-knee work in detail. This study confirmed the thoracic relaxation phenomenon in the mid-position of the thoracic erector spinae.

Key words: Below-knee work, Thoracic erector spinae, Thoracic flexion relaxation ratio

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INTRODUCTION

Thoracic pain, sometimes referred to as mid-back or upper back pain, is much less common than lower back or neck pain[1)]. Frequently, thoracic back pain has a benign musculoskeletal origin, but can indicate a more serious underlying problem[1)]. Thoracic pain is usually caused by soft tissue injuries, such as sprains or strains, muscle tension caused by poor posture, or looking downward for an extended time[1)]. This study investigated and compared the thoracic flexion relaxation ratio (FRR) during overhead assembly work and below-knee assembly work.

SUBJECTS AND METHODS

Ten men, aged 20–30 years, with a mean height and weight of 172.5 ± 3.2 cm and 69.1 ± 5.9 kg, respectively, participated in this study. The subjects had no history of musculoskeletal disorders or pain associated with the upper extremity and spine in the preceding 6 months. The study purpose and methods were explained to the subject, who provided informed consent according to the principles of the Declaration of Helsinki. Thoracic erector spinae muscle activity was measured by using an MP150 system (BIOPAC Systems, Santa Barbara, CA) fitted with a pair of 2-cm diameter Ag/AgCl electrodes. The electrodes were placed over the thoracic erector spinae muscles at the T6 level, approximately 2 cm from the spinous process. The trunk flexion and re-extension tasks were divided into flexion, relaxation, and re-extension periods while seated with knee extension. Callaghan et al. identified that flexion-relaxation occurred primarily in thoracic muscles during seated forward flexion, rather than standing full flexion[2)]. The thoracic FRR was calculated by dividing the maximal observed muscle activation level during the 3-s re-extension period by the average activation levels during the 3-s relaxation period. A dolorimeter (Fabrication Enterprises Inc., White Plains, NY, USA) (pressure algometer) was used to measure the pressure

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pain threshold (PPT) of the upper trapezius muscle. The dolorimeter consists of a metal probe that can measure pressures up to 20 lb in 0.25-lb increments. A 1 cm^2 rubber plate delivers pressure from the probe to the body, and the corresponding pressure is obtained from a needle gauge. Subjects were told prior to each test, to verbalize when they started to feel pain. Dolorimeter pressure was delivered at a right angle to the body, in order to measure the PPT of the thoracic erector spinae in T6. The subjects performed assembly of 60 nuts and bolts for 5 minutes at two different heights; overhead work, where subjects performed the assembly work on a board at a height of 20 cm above the head while standing, and below-knee work, where subjects performed assembly work on a board 20 cm below the knees in a squat position. The ordering of these positions was assigned randomly. Subjects were allowed to rest for an hour between trials to prevent muscle fatigue. The thoracic FRR and PPT pre-work, after overhead work and after below-knee work was measured. SPSS (Chicago, IL, USA) was used for statistical analysis. Repeated one-way ANOVA was used to identify significant differences in the FRR of pre-work, overhead, and below-knee readings. The alpha level for statistical significance was defined as 0.05.

RESULTS

The PPT of the thoracic erector spinae muscle decreased significantly from pre-work (7.6 ± 0.5 lb), to overhead work (5.2 ± 1.0 lb), to below-knee work (3.6 ± 2.1 lb) ($p < 0.05$). The thoracic FRR decreased significantly from pre-work (3.6 ± 1.2 lb), to overhead work (3.0 ± 0.8 lb), to below-knee work (2.1 ± 1.4 lb) ($p < 0.05$).

DISCUSSION

This study compared the thoracic FRR between overhead work and below-knee work. These results show that the PPT of the thoracic erector spinae muscle decreased significantly in sequence from pre-work, to overhead work, to below-knee work. Similarly, the thoracic FRR decreased significantly in sequence from pre-work, to overhead work, to below-knee work. Shin et al. found that cervical FRRs on both sides decreased significantly after 10 min of overhead work[3]. Lee et al. found that wearing heavy backpacks decreased cervical FRR[5]. FRRs are used to evaluate treatments; such data objectively quantifies the extent of neck/lumbar disease and disorder[3, 4]. Use of this ratio allows the extent of activation to be normalized amongst individuals, thus facilitating comparisons between chronic neck/back pain patients and healthy controls[3, 4]. The thoracic muscle group is made up of the thoracic components of the longissimus thoracis and the iliocostalis lumborum. Within the literature, the electrode position for observing thoracic erector spinae muscle activity has generally been accepted as 5 cm lateral to the T9 spinous process[2]. However, the T9 level is not located at the center of the thoracic portion. Finally, there is no original research associated with the thoracic relaxation phenomenon with the electrode located not at the T9 level. This study approached the thoracic relaxation phenomenon using the mid-position of the thoracic erector spinae (T6 level). Thus, this study may be the first study examining original thoracic FRR.

Continuous below-knee work may produce greater cervical extension, thoracic flexion, and lumbar flexion—particularly due to squatting for vision during assembly work[5]. A prolonged slouched posture has a tendency to induce excessive thoracic kyphosis, leading to directional susceptibility of movement[1, 5]. Moreover, a prolonged slouched posture, such as that seen during below-knee assembly work, may lengthen or stretch the thoracic and lumbar erector spinae, which may decrease the patient's sense of positioning[1, 6]. Therefore, below-knee work is more likely to cause thoracic musculoskeletal pain than overhead work. Below-knee work is commonly observed in the automobile and shipbuilding industries. Future studies should perform focused research into the effects of below-knee work.

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