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Effect of the Spacing of Backpack Shoulder Straps on Cervical Muscle Activity, Acromion and Scapular Position, and Upper Trapezius Pain

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Abstract. [Purpose] This study investigated the effect of the spacing of backpack shoulder straps on cervical muscle activity, acromion and scapular position, and upper trapezius (UT) pain. [Subjects] Fourteen males aged 20–32 years, were recruited. [Methods] We measured the MPS (midcervical paraspinal) activity, acromial angle, scapular distance, and UT pain after gait carrying a backpack with different shoulder strap spacings. [Results] The MPS, scapular inferior distance, and UT pressure pain threshold was significantly decreased and the acromion angle was significantly increased when carrying a backpack with wide shoulder straps compared to narrow shoulder straps. [Conclusion] A backpack with wide shoulder straps may cause scapular depression syndrome and chronic UT pain.

Key words: Backpack, Scapular position, Shoulder straps

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INTRODUCTION

Most of the studies about the effects of carrying bags have focused on musculoskeletal pain and altered spinal curvature. Moreover, those studies did not investigate backpacks[1)]. To prevent musculoskeletal injury, the optimal backpack load has been recommended[2)]. Although a backpack is symmetrically positioned as the load is carried and distributed on both shoulders, the load changes body posture and balance through posterior translation of the center of pressure[3)]. A number of backpack carrying studies have been conducted by the military which have focused on the physiological, biomechanical, and medical aspects of backpack carrying[3)]. The epidemiological and clinical literature have identified a strong association between spinal posture and the use of a backpack[2, 4)]. Carrying a backpack also causes postural changes which appear as excessive forward head angle, and forward shoulder and changed scapular positions[2, 4)], and researchers have studied various backpack types and designs with the aim of preventing injuries associated with prolonged load carrying[5)]. In the present study, we investigated the effect of the spacing of backpack shoulder straps on cervical muscle activity, acromion angle, scapular distance and upper trapezius pain threshold after gait with a backpack.

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SUBJECTS AND METHODS

Fourteen males, aged 20–32 years, with a mean height and weight of 176.1 ± 5.0 cm and 67.1 ± 4.9 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. EMG data were collected using a Biopac MP100WSW (Biopac System, Santa Barbara, CA, USA). The midcervical paraspinal (MPS) electrodes were placed on 2 cm lateral to the midline of the spine at approximately the C4 level. A palpation meter (PALM; Performance Attainment Associates, St. Paul, MN, USA) was used to measure the distance and inclination between two bony landmarks of the body. The acromion angle was determined using the PALM as the inclination angle between the acromion and the C7 spinous process. The scapular inferior distance was determined using the PALM as distance from the inferior angle to the spinal process using PALM. A dolorimeter (Fabrication Enterprises, White Plains, NY, USA) pressure algometer was used to measure the upper trapezius (UT) pressure pain threshold. The shoulder strap spacing was 20 cm for the narrow strap spacing and 30 cm for the wide strap spacing. We created wide and narrow strap spacings using two of the same type of backpack. The subjects were asked to walk for 15 min on a treadmill at a speed of 1.5 m/s while carrying a backpack containing a 10 kg load. The subjects adjusted the lengths of the shoulder straps so that the positional centre was placed between the T11 and T12 levels[4)]. The Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) was used for statistical analyses. The paired t-test were used to analyze the differences in

MPS activity, acromion angle, scapular distance, and the UT pressure pain threshold after walking with a backpack with narrow and wide shoulder strap intervals. The alpha level for statistical significance was chosen as 0.05.

RESULTS

The MPS EMG activity was significantly decreased after walking with the wide shoulder straps (16.8 ± 8.7%) compared to the narrow shoulder straps (26.2 ± 6.3%) ($p<0.05$). The acromion angle was significantly increased after walking with the wide shoulder straps (18.6 ± 6.2°) compared to the narrow shoulder straps (12.1 ± 5.5 °) ($p<0.05$). The scapular inferior distance was significantly decreased after walking with the wide shoulder straps (7.0 ± 2.6 cm) compared to the narrow shoulder straps (8.6 ± 2.0 cm) ($p<0.05$). The UT pressure pain threshold was significantly decreased after walking with the wide shoulder straps (6.0 ± 1.8 lb) compared to the narrow shoulder straps (8.6 ± 2.0 lb) ($p<0.05$).

DISCUSSION

This study investigated the effect of different spacings of backpack shoulder straps on cervical muscle activity, acromion and scapular position, and upper trapezius pain after walking with a backpack. The different shoulder strap spacings changed the position of the weight support of the backpack. The MPS activity was significantly decreased when using the wide spacing straps compared to the narrow interval straps. In terms of the passive length–tension relationship, the production of muscular tension can be accomplished by adopting a lengthening position above the resting length[6]. Similarly, posture maintenance with a low muscular requirement can be adopted using a backpack with a wide shoulder strap spacing. Posture is maintained with passive structural tension rather than with active muscular effort[6]. The backpack weight with the wide interval straps was positioned laterally on the shoulders. The acromion angle was significantly increased and the scapular inferior distance was significantly decreased with the wide shoulder strap spacing. These results indicate that scapular depression and downward rotation occurred in the subjects when they carried the backpack with the wide strap spacing. The UT pressure pain threshold was also significantly decreased with the wide shoulder strap spacing compared to the narrow shoulder strap spacing. We consider that the pain sensitivity of the UT might be increased by scapular depression and downward rotation, causing weakness due to overstretching of the UT[7, 8]. Scapular depression syndrome is associated with lengthening or weakening and a lower pressure pain threshold in the UT muscle[9]. A prolonged time in the depressed scapular position, in particular, may lead to chronic UT pain[7, 8]. A backpack with wide shoulder strap spacing requires a lower muscular requirement of the cervical muscles, but wearing a backpack with wide interval shoulder strap spacing may produce scapular depression syndrome and chronic UT pain.

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