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The Effects of Carrying a Single-Strap Bag Positioned Differently on Peak Vertical Ground Reaction Forces and Postural Stability: a Pilot Study

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Abstract

Aim: Single-strap bags cause asymmetric load-carrying and postural asymmetry. This study aimed to investigate the effects of a single-strap bag on peak vertical ground reaction forces (PVGRFs) and on postural stability when it is worn in different positions.
Methods: 6 volunteer women were assessed in the Human Movement Laboratory. Force platforms were used to measure both the ground reaction forces (GRFs) during gait cycle and postural sways during a standing task. All of the measures were taken without bag, with bag on shoulder, and with bag on forearm.
Results: Bag carriage on the forearm increased postural sway ($p<0.05$). However, not significant changes were found in PVGRFs.
Conclusion: Single-strap bag usage on the forearm negatively affects women`s balance.

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Introduction

There are numerous studies researching the effects of backpack carriage on the body in both static and dynamic conditions (1-4). The backpack is commonly worn in the daily life of children and young adults, whereas the majority of adults prefer to use other types of bags (5). A single-strap bag carriage is popular among women (1). It causes asymmetrical loading and postural compensation (1,6). These problems increase shearing forces at the joints and compressive forces produced by muscles (1). Moreover, while walking, the pattern

of arm swing is similar among healthy people. However, the bag carriage restricts the arm swing and due to this restriction, diverse changes in body segments like a decrease in hip flexion and an increase in ankle dorsiflexion are indicated (1). Nevertheless, the correct ways to wear a single-strap bag are not clear because only a few studies have investigated the effects of carrying a single-strap bag on gait parameters and postural stability of women (1,5).

Therefore, this pilot study primarily aims to investigate the effects of a single-strap bag on walking and balance while it is positioned differently. A secondary aim of the study is to compare the effects of the bag carriage on the shoulder with the carriage on the forearm.

Materials and Methods

Participants

6 volunteer women were recruited from the University of Brighton students and all gave informed consent. Participants had a mean age, height and weight of 25.6 ± 2.7 years, 163.8 ± 7.1 cm and 68.7 ± 10.3 kg, respectively. The participants having any neuromuscular or musculoskeletal dysfunction in any part of body which would lead to abnormal walking or standing were excluded.

Instrumentation

All data was collected using two standard AMTI force plates (Advanced Mechanical Technology Inc 0R6-7, Watertown, Massachusetts, USA) at 1000Hz. The data of PVGRFs were determined during the heel strike and the toe off phases of gait and recorded as the percentage of body weight. The CoP displacements in anteroposterior (AP) and mediolateral (ML) directions were calculated and recorded as millimeters.

The participants were asked to wear comfortable clothes not to prevent arm swinging while walking. They were barefoot during all tests. A bag (29 cm x 27 cm x 4 cm) with a single strap (1.5 cm) was asked to be carried by the participants` dominant sides which were all right. Sandbags were placed into the bag to adjust the load to 5% of the body weight of the participants. Data was taken with no bag, with bag on shoulder and with bag on forearm, respectively. A rest was allowed between tests if the subjects wished.

To measure the effects of carrying a single-strap bag on GRF during the gait cycle, the subjects were asked to walk at their naturally preferred speed over the force plates. They were instructed to land their right foot on the first platform and therefore, sufficient time was allowed to practice before data was taken. Participants were also asked to look straight ahead whilst walking.

One of the force plates was then used to measure postural stability. The subjects were instructed to take a step with their right foot on force platform and raise the heel of the rear left foot (Figure 1). While maintaining this position, subjects were verbally and randomly asked to move their heads slowly in various directions; right, left, up, or down (7). The test lasted 20 seconds.

Statistical Analysis

Excel and SPSS 17.0 were used to analyse the data sets. Mean and standard deviations

as descriptive statistics were calculated for each variable. Repeated one-way ANOVA was used to analyse the effects of the different bag carriage methods and multiple comparisons were based on Bonferroni`s correction. The significance level was set at p< .05.

Results

Table 1 indicates the results of PVGRFs. Although PVGRFs increased with the usage of bag, difference was not statistically significant (p>o.o5). The analysis of one-way ANOVA showed that carrying the single-strap bag on forearm increased the ML sway significantly (p=0.045).

Figure 1 represents the average results of participants` postural sways in ML and AP directions and in the Figure 2, ML displacements of each participant are indicated to compare them in the condition of no bag usage with the condition of bag usage on the forearm.

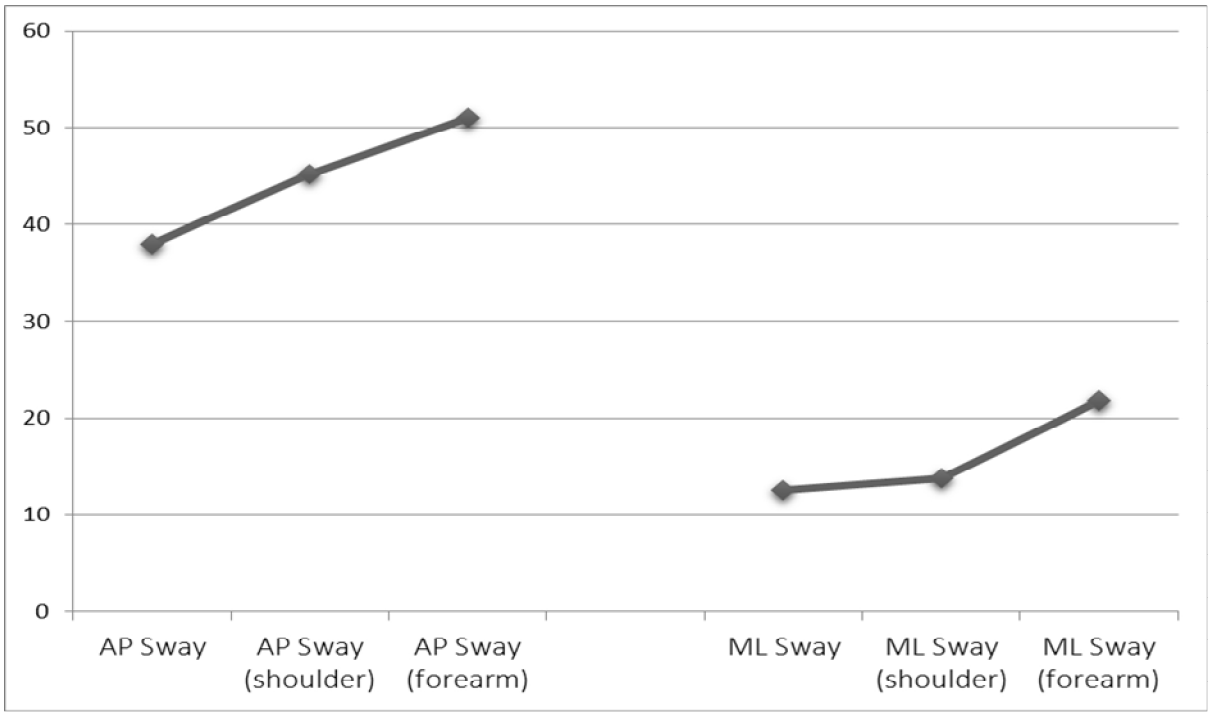

Figure 1. The average results of participants` postural sways in ML and AP directions

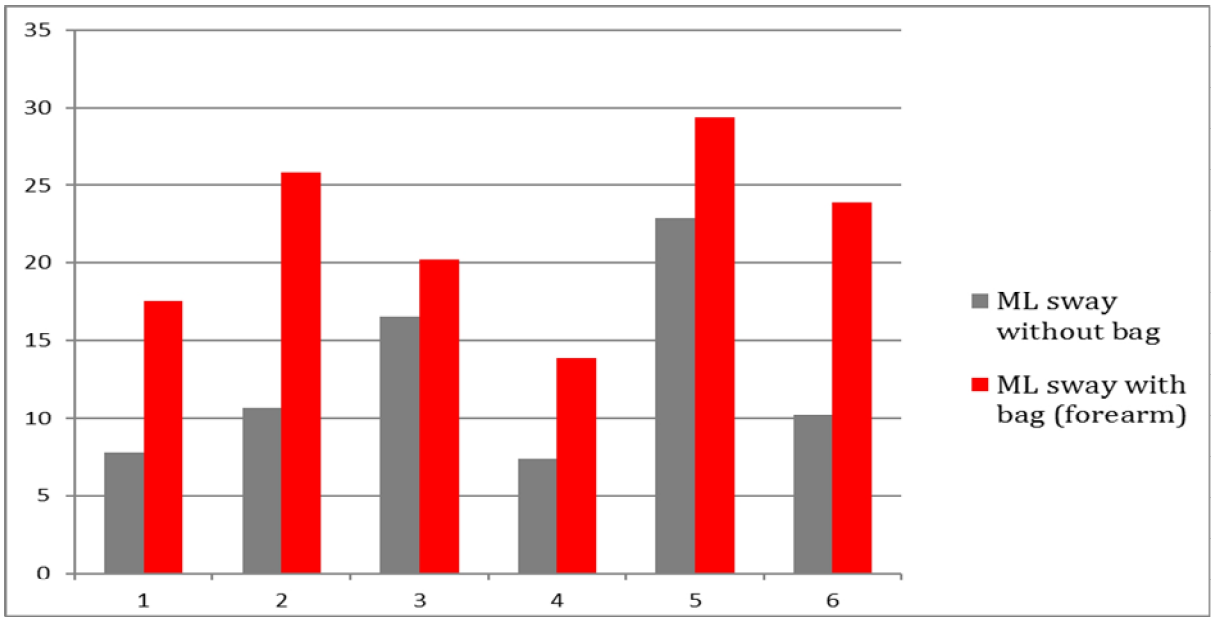

Figure 2. ML displacements of each participant

Discussion

In this research, the effects of a single-strap bag use on postural stability and the PVGRFs while walking were investigated. Carrying a single-strap bag which was 5% of the participants` body weight did influence the postural stability of the participants, but it did not create a significant change in PVGRFs.

Various papers indicated the negative effects of carrying a backpack on static and dynamic postural stability among children and adults (8,9). Inadequate postural stability may cause a number of muscle-skeletal disorders, a loss of balance and falls (8). Although women commonly use bag for long periods during their daily life, no study investigated its impacts on postural stability and gait. Its effects on gait parameters were only shown in the study by An. et al.

Carrying a single strap bag causes asymmetrical loading and constraint arm swing (1). Asymmetrical loading is associated with increased postural sway during standing and it also induces to unstable gait. In the case of constraint arm swing, a greater arm swing amplitude on the opposite side is observed in order to maintain the coordination of the movement of the upper and lower limbs (10). Therefore, a single strap bag may induce to various problems and this study focussed on the effects of using a single strap bag.

An et al. investigated the effects of using a single-strap bag on gait parameters. They assessed the gait of women in four conditions; no bag, bag over the shoulder, bag on the forearm, and bag carried by the hand. They similarly revealed that carrying a single-strap bag over the shoulder should be preferred rather than other conditions. No significant change was found in

walking velocity, but there were significant differences in the findings regarding stride length, heel-to-heel base of support, and toe angle (1).

Authors generally investigated the PVGRFs while drop jumping in various conditions (11,12). Chang et al. compared the PVGRFs of men and women while drop jumping and revealed that women had higher risk of developing foot injuries than men did. In this study, the PVGRFs were collected while women walked. No significant difference was acquired and this could be related to the low load of the bag. Therefore, carrying bag at any position did not affect these values.

Moreover, the study has assessed the effects of the single-strap bag on the postural stability of women. Postural stability plays an important role in preventing injuries regarding balance problems and it is also found related to the falling (13). Therefore, the postural stability of women are frequently investigated (13-15). In this paper, significant finding was determined related to the postural stability and carrying the bag on the forearm caused significant mediolateral sways when they were compared with the sways in no bag condition. Thus, similar to the study by An et al., bag carriage over the shoulder was also supported in this paper.

In conclusion, carrying the bag on the shoulder instead of carrying it on the forearm is supported by this study. This is a pilot study so larger sample size will be included in future. Further research is also required to indicate an adequate bag weight and bag style. Women with different age groups may also be involved in future.

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