Gait Changes Caused by the Habits and Methods of Carrying a Handbag

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Abstract. [Purpose] The purpose of this study was to provide information to help maintain correct posture by identifying gait changes caused by the habits and methods of carrying bags. [Method] The subjects were 34 healthy right-handed women. Among them, 18 subjects had the habit of carrying bags on their right side, and 16 subjects had the habit of carrying bags on their left side. The subjects were instructed to walk while carrying a bag, which weighted approximately 10% of the subjects’ average weight, in four different ways; holding it in the left hand, carrying it over the left shoulder, holding it in the right hand, and carrying it over the right shoulder. The subjects’ gait were measured using a gait analyzer. [Results] Subjects who habitually carried bags on their right exhibited changes in gait variables related to walking distance. In addition, their gait velocities were relatively faster. On the other hand, differences in temporal and spatial gait variables were not exhibited when the bag was carried using the four methods. [Conclusion] When the weight of a bag is appropriate, bag-carrying habits had significant effects on gaits. Therefore, people who carry bags should avoid the habit of carrying them on only one side.

Key words: Gait, Methods of carrying bag, Habits of carrying bag

INTRODUCTION

People use bags to carry various items that they need in daily life. Adults use handbags or shoulder bags, which places a load on one hand or one shoulder, respectively1). Students generally use backpacks or athletic bags that are carried over one shoulder2). Overly heavy bags, inadequate carrying methods, and bag locations distribute the weight inappropriately, which can cause abnormal posture and consequent muscle pain and spinal disorders3). However, as people are accustomed to carrying bags, they are inclined to neglect problems that are caused by the weight of the bags and how they are carried on the body. If the bag is viewed as a piece of baggage with a certain weight, the effects of its location or weight should be considered. In particular, as the transport of baggage and the action of walking are correlated, the effects of transporting a bag on walking should be taken into account. Walking is a complex exercise pattern formed by the effect of neuromuscular, biomechanical, and kinesiological changes that take place over a long period, starting at birth. When the head, neck, and trunk are aligned normally, the resulting stability and appropriate range of motion (ROM) allow alternative movements4). In normal walking, the center of pressure (COP) shifts in a regular and symmetric manner, according to whether the direction is up, down, left, or right, and the extremities move in harmony accordingly5). The weight, location, and method of carrying a bag cause the physical response of maintaining balance when the location of the weight line changes. Moreover, in moving forward, the body uses an adaptation mechanism in order to rearrange the body segments in an abnormal posture6). Such poor gait patterns can result in serious fatigue. In addition, a long-term increase in fatigue can create problems with weight distribution and is a direct cause of disorders and diseases7).

In Korea, studies have been undertaken to resolve problems caused by methods of carrying bags and to suggest correct carrying methods. However, most studies have focused on either elementary school students8, 9) or bags10–12). Therefore, the present study was performed to analyze gait changes in healthy women according to their bag-carrying habits and methods, and thereby provide information to help maintain correct posture.

SUBJECTS AND METHODS

The study’s subjects were 34 women in their 30s who resided in S City and were using the region’s cultural center. Those with orthopedic disorders, neurosurgical disorders, functional or anatomical differences in lower limb lengths, or visual impairment were excluded from the sample. The research period was from August 1 to September 30, 2011. Based on the Declaration of Helsinki, the study’s purpose and method were fully explained to the potential subjects. Those who volunteered to participate joined the experiment. In Korea, people are generally instructed to use the right hand. Most home appliances are designed for use by right-handed people. Therefore, the inclusion criteria specified right-handed participants. Of the 34 subjects, 18 (21.4 ± 6.5 yrs, 158.3 ± 4.4 cm, 51.1 ± 6.7 kg) had the habit of carry-
The handbag used in this study had a wide rectangular shape (33 × 23 × 16 cm), which Korean women favor. As a single-strap bag, it could be either held in the hand or carried over the shoulder. A previous study suggested that bag’s appropriate weight should be a maximum 10% of its carrier’s weight. Given this, after measuring the average weight of the subjects, a sandbag was inserted into the handbag. The average weight of the subjects was about 52 kg. Thus, a sandbag weighing 4.6 kg was inserted in the handbag, which weighted 600 g.

Adults mainly use handbags that are either carried over the shoulder or held in the hand. Hence, the subjects were instructed to carry the bag in four ways: in the left hand, over the left shoulder, in the right hand, and over the right shoulder. When the subjects carried the handbag over the shoulder, they were instructed to adjust the handbag’s length at the level of the iliac crest in the flank. A gait analyzer (Walk Way MG-1000, Anima Co., Japan) was used to measure the gaits. Before the experiment, in order to prevent unnatural movements, the subjects were instructed to do light stretching. They then did walking exercises three times on the gait analyzer in order to produce natural motions. During the measurements, the subjects wore a comfortable tracksuit and socks without shoes. They were instructed to begin on the right foot. In order to measure their natural gait while carrying the bags, the participants walked for about three minutes before the measurement procedure, looking forward and naturally swinging both arms. Once in each posture, they walked four times, with a 3-minute break between each posture.

SPSS 12.0 was used to process the statistical data on habits and methods of carrying the handbag. The analysis detected no interaction between handbag-carrying habits and methods. An independent samples t-test was conducted to identify gait differences according to handbag-carrying habits. A one-way ANOVA was performed to identify gait differences according to handbag-carrying methods. The statistical significance level was set at p<0.05.

The results of the analysis of the relation between handbag-carrying habits and methods, showed no interaction. With regard to gait differences according to handbag-carrying habits, statistically significant differences were exhibited in stride length, step length, step width, gait angle, and time (p<0.01). However, the toe-out angle showed no difference. No statistically significant changes were exhibited in the stance, swing, and double stance phases (Table 1). Subjects with the habit of carrying bags on their right side revealed relatively larger strides and step lengths, whereas their step widths and gait angles were relatively smaller. Therefore, distance variables related to walking distance exhibited differences according to handbag-carrying habits. The variable of time was found to be shorter in subjects with the habit of carrying bags on their right side, which resulted in an overall faster gait velocity. As a result, in terms of the temporal gait variables, only certain variables exhibited differences according to handbag-carrying habits.

In terms of gait differences according to handbag-carrying methods, the variables of stride length, step length, step width, gait angle, toe-out angle, time, stance phase, swing phase, and double stance phase showed no statistically significant differences. This suggested that no differences occurred in both temporal and spatial gait variables according to handbag-carrying methods (Table 1).

**DISCUSSION**

The purpose of this study was to provide information about maintaining correct posture while carrying a handbag by identifying appropriate bag-carrying habits and methods. The methods of carrying a handbag in the hand or over the shoulder were both revealed to have no effects on gait velocity or other gait components. Park’s study showed that the pattern of either carrying or holding bags did not influence plantar foot pressure, and no differences in plantar foot pressure were exhibited between backpacks and shoulder bags. The results of that study are in agreement with the present study’s findings that bag-carrying methods do not influence temporal and spatial gait variables.

In the present study, compared with subjects that habitually carried bags on their left side, subjects that usually

### Table 1. Walking characteristics according to handbag-carrying habits and methods

| Carrying habit | Stride length (cm) | Step length (cm) | Step width (cm) | Gait angle (°) | Toe out angle (cm) | Time (sec) | Stance phase (sec) | Swing phase (sec) | Double stance phase (sec) |
|---------------|--------------------|------------------|-----------------|---------------|-------------------|------------|-------------------|----------------------|------------------------|
| Rt side       | 106.8±9.2***       | 53.3±4.9***      | 6.4±2.6**       | 7.1±3.1***    | 5.5±3.3           | 1.0±0.3*** | 0.7±0.1           | 0.4±0.0              | 0.1±0.0                |
| Lt side       | 102.9±1.5          | 51.1±7.9         | 7.5±2.7         | 8.9±4.3       | 5.4±4.1           | 1.1±0.3    | 0.7±1.0           | 0.4±0.1              | 0.1±0.0                |
| Rt hand       | 103.9±11.8         | 51.7±6.2         | 6.6±2.9         | 7.7±3.8       | 5.4±3.6           | 1.0±0.3    | 0.7±0.1           | 0.4±0.0              | 0.1±0.0                |
| Lt shoulder   | 104.6±12.5         | 52.2±6.5         | 7.3±2.5         | 8.3±3.5       | 5.3±3.6           | 1.0±0.3    | 0.7±0.1           | 0.4±0.1              | 0.1±0.0                |
| Rt shoulder   | 105.2±12.8         | 52.4±6.8         | 7.0±2.5         | 8.1±3.7       | 5.8±3.8           | 1.0±0.3    | 0.7±0.1           | 0.4±0.1              | 0.1±0.0                |
| Lt shoulder   | 106.4±12.9         | 52.9±6.9         | 6.8±3.0         | 7.8±4.3       | 5.6±3.7           | 1.0±0.3    | 0.7±0.1           | 0.4±0.1              | 0.1±0.0                |

**p<0.01
carried bags on their right side exhibited longer stride and step lengths and narrower step widths and gait angles. Because increased stride and step lengths led to narrower step widths and gait angles, subjects that habitually carried bags on their right side were likely to have higher levels of stable gait. The toe-out angle is related to the degree of internal and external rotations of the lower extremities during the stance phase. Consequently, carrying a bag with an appropriate weight was revealed to have no influence on the toe-out angle.

According to An, asymmetric bag loads do not greatly influence the symmetry of foot contact times. In addition, an increase in the load applied to one foot during the stance phase decreases step width and increases cadence. Kim et al. reported that when subjects walked without a bag, step lengths were found to be longest, whereas the longest bag length resulted in the shortest step length. Based on these results, they found that bag length influences step width. Asymmetric loads vary according to bag-carrying methods, causing instability and relocation of the COP. In response, a mechanism for posture adaptation is activated to maintain physical balance, which subsequently results in posture changes in the trunk and extremities. When people walk while carrying a heavy bag over a shoulder or in a hand, the foot on the same side has a larger ground reaction force than the opposite foot, thereby increasing asymmetry. Moreover, during walking, this foot requires larger muscular strength, propulsive force, and energy consumption. Constant exposure to such asymmetrical loads can also cause physical problems that lead to inadequate posture. A previous study found that in cases of carrying a bag with a strap on one side and carrying a sports bag designed to be carried on one side, the elevation of the shoulder that supported the strap and the trunk lateral rotation on the opposite side increased.

In the present study, the right-handed subjects who habitually carried bags on their right side had fast gait velocities. However, their overall gait patterns were not evaluated. Thus, future studies should identify gait changes in subjects while they carry a bag in their dominant hand. In conclusion, this study found that when the bag’s weight was appropriate (maximum 10% of its carrier’s weight), the effects of the carrying method were insignificant. In other words, only bag-carrying habits had significant effects on gaits. Therefore, it may be necessary for people to be aware of the negative effects on posture caused by their bag-carrying habits.

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