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## The Biomechanical Differences among Carrying Methods of Single-Strap Bag during Gait in Healthy Women

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### SUMMARY

This study investigated kinematic and kinetic differences of upper and lower extremities among three different carrying methods of single-strap bag during gait. Ten right-handed healthy woman (age:  $21.7 \pm 1.7$  yrs, height:  $1.61 \pm 0.03$  m, body mass:  $57.1 \pm 4.2$  kg) with no orthopedic pathologies history within six month participated in this study. A three-dimensional motion analysis with 8 infrared cameras (SF: 100Hz) and a force plate instrumented treadmill (SF: 1000Hz) were performed to analyze trunk and lower extremity joints kinematics and kinetics during gait with different carrying ways of single-strap bag. The load of the single-strap bag was 5% of each participant's body weight. Based on the results of this study, trunk lateral flexion increased significantly to the left (unloaded side) when carrying with the hand and on the forearm compared to normal gait. However, there were no significant differences in lower-extremities joint angle. Also, right side (loaded side) vertical ground reaction force increased significantly when carrying a single-strap bag compared to normal gait. Finally, a significant increase was found for lower-extremities joint moment among the carrying ways. These differences would indicate that subjects try to maintain normal gait patterns using the kinetic adjustment. Especially, when carrying with the hand and on the forearm, there were the greatest effects on the human body during gait.

### INTRODUCTION

As most women prefer the single-strap bag(or handbag), many studies have focused on musculoskeletal problem related to the scoliosis or the compensation for asymmetric loads [1, 2, 3]. However, previous studies have determined the effects among the difference in bag loads. Moreover, these studies have chosen bag loads of 10-30% of individual's body weight, which are not realistic loads in the daily life [4, 5]. In addition, few studies have investigated the effect of different carrying methods of single-strap bag during gait. Therefore, the purpose of this study was to investigate kinematic and kinetic differences of upper and lower extremities among different carrying methods of single-strap bag during gait.

### METHODS

### Subjects

Ten healthy women (age:  $21.7 \pm 1.7$  yrs, height:  $1.61 \pm 0.03$  m, body mass:  $57.1 \pm 4.2$  kg) participated. They were all right-handed free from any orthopedic pathologies within six month and all.

### Experiment setup

Eight infrared cameras (Qualysis Oqus 300, Sweden) and a force plate instrumented treadmill (Bertec FIT, USA) were used to measure continuous five gait cycle. The sampling rates of the cameras and treadmill were 100 Hz and 1000 Hz, respectively. Treadmill speeds were normalized according to Froude number of 0.25 and participants were applied to the familiarization period for five minutes with the treadmill. Each participant was asked to perform with four conditions: normal gait, carrying a single-strap bag with the hand, on the forearm and over the shoulder in the dominant side. The load of the single-strap bag was 5% of each participant's body weight.

After experiment, trunk angle and lower-extremities joint angle were computed in frontal and sagittal plane, respectively. Also, vertical ground reaction forces and lower-extremities joint moment were computed.

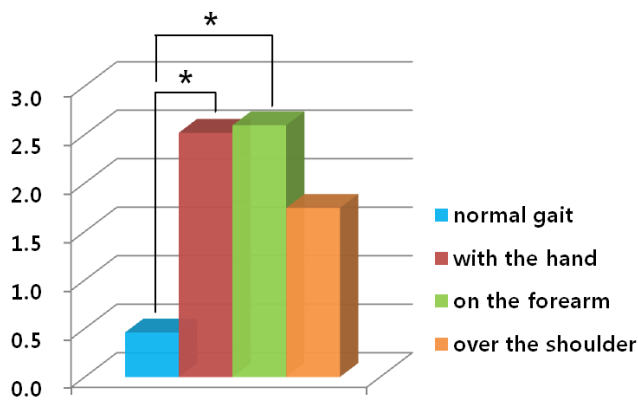
### Statistics

One way ANOVA with repeated measures was used to verify the statistical differences among three different carrying methods of single-strap bag. Bonferroni correction was used as a post-hoc analysis when significances were found. In this study significance level was set as  $\alpha = .05$ .

### RESULTS

In kinematic analysis, trunk lateral flexion increased significantly to the left (unloaded side) when carrying with the hand and on the forearm compared to normal gait (Figure 1). However, there were no significant differences in lower-extremities joint angle.

In kinetic analysis, right side (loaded side) vertical ground reaction force increased significantly when carrying a single-strap bag compared to normal gait. Also, significant increase was found for lower-extremities joint moment (Table 1).



**Figure 1: Trunk lateral flexion to unloaded side.**

## DISCUSSION AND CONCLUSIONS

The differences in kinetics were found while no differences existed in kinematics during carrying a single-strap bag. These differences would indicate that subjects try to maintain normal gait patterns using the kinetic adjustment. Especially, when carrying with the hand and on the forearm, there were the greatest effects on the human body during gait.

## REFERENCES

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**Table 1: Kinetic variables**

	Normal gait	With the hand	On the forearm	Over the Shoulder	<i>p</i> -value
Vertical GRF (Nm/kg)	1.13(0.05)	1.21(0.05)*	1.20(0.06)*	1.19(0.06)*	.000
Ankle joint moment (Nm/kg)	1.56(0.11)	1.62(0.14)*	1.62(0.14)*	1.61(0.16)	.004
Knee joint moment (Nm/kg)	0.34(0.13)	0.42(0.14)*	0.38(0.11)	0.41(0.08)	.010
Hip joint moment (Nm/kg)	1.11(0.20)	1.19(0.21)	1.24(0.17)*	1.23(0.24)	.000

\* indicates significant difference compared to normal gait.