EFFECTS OF OBESITY ON BALANCE IN RESPONSE TO SMALL POSTURAL PERTURBATIONS

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INTRODUCTION

Balance may be degraded by obesity (Teasdale et al., 2007). In particular, balance in response to forward postural perturbations would seem to be challenged by increased body mass and the center of mass being displaced anteriorly with respect to the spine. This displacement is due to an increased anterior abdominal mass associated with obesity. However, obese individuals typically exhibit increased muscle strength (Maffiuletti et al., 2007) and have a larger mass moment of inertia about the ankle. These may offset the presumed increase in difficulty during recovery from a forward perturbation.

The goal of this study was to investigate the effects of obesity on balance in response to small postural perturbations. We hypothesized that obese individuals would exhibit poorer balance as a result of their increased body mass.

METHODS

Twenty male subjects including 10 lean (mean ± standard deviation BMI = 21.9 ± 1.4) and 10 obese (BMI = 33.2 ± 2.3) participated in the study and provided informed consent prior to participation. Each subject performed perturbation trials while standing on a force platform. They were instructed to stand relaxed with their eyes closed and hands clasped behind their back. A ballistic pendulum was used to apply forward perturbations of 1, 2, 3, 4, 5, 6 and 8 N·s just inferior to the scapula. These perturbations were small enough so that no step was required to maintain balance. Backward perturbations were also applied intermittently to the sternum to prevent subject anticipation, but they were not included in this study. Four trials were performed at each perturbation magnitude.

Force platform data was sampled at 1000 Hz during all trials (Bertec Corporation, Columbus, OH) and filtered with a low-pass 4th order Butterworth filter (7 Hz cut-off, zero-lag). The anterior-posterior position of the center of pressure (COP) was determined for all trials. Balance was quantified using peak COP displacement from the heel and peak COP velocity.

A 2-way ANOVA was used to investigate the effects of obesity, perturbation magnitude, and their interaction on balance in response to perturbations. Pairwise comparisons were performed using Tukey’s HSD. Weight was also used as a covariate during a secondary analysis to account for the fact that perturbation amplitudes were not relative to body weight.

RESULTS

Peak COP displacement (Figure 1) showed main effects of group (p<0.001), perturbation magnitude (p<0.001), and a group × perturbation magnitude interaction (p<0.001). Similarly, peak COP velocity showed main effects of group (p=0.003), perturbation magnitude (p<0.001), and a group × perturbation magnitude interaction (p=0.009).
Pairwise comparisons revealed differences between groups for both peak COP displacement and velocity at levels of 3, 5, 6, and 8 N·s in that lean measures were always greater than obese.

**DISCUSSION**

Results indicate obese subjects exhibited better balance, as quantified by peak COP displacement and velocity, for perturbations, in general, larger than 3 N·s. This was contrary to our expectations. However, this may be the result of our experimental protocol. Obese subjects have larger mass than lean subjects, and thus will experience a smaller increase in velocity in response to increasing applied impulses (see impulse-momentum relation). This smaller velocity may be more easily controlled than the larger increase in velocity experienced by the lean subjects. When weight was used as a covariate to account for dependence of our balance measures on weight, all differences between lean and obese were lost. In other words, there were no differences in balance between lean and obese when equal perturbations relative to body weight were applied.

**SUMMARY**

Obese subjects exhibited better ability at recovering from small magnitude perturbations compared to lean subjects. However, no differences were found with the secondary analysis accounting for the fact that perturbation magnitudes were not relative to body weight. These findings may help to understand the factors and conditions involved in the increased risk of falls in the obese.

**REFERENCES**
