CAN TRAJECTORIES OF INDIVIDUAL BONY LANDMARKS INDICATE MEDIAL-LATERAL INSTABILITY DURING OBSTACLE CROSSING?

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INTRODUCTION

As the elderly population continues to grow, the need for indicators of dynamic instability during locomotion also increases. Such indicators may enhance early identification of at-risk individuals, thereby reducing the risk of traumatic falls. Greenspan et al. (1998) found that falls to the side are a major risk factor for hip fracture. Additionally, Tinetti et al. (1989) showed imbalance and tripping over obstacles to be two of the most common causes of falls in the elderly. Therefore, medial-lateral (M-L) body sway during obstacle crossing may be used to distinguish individuals at risk for sideways falling from healthy individuals.

The whole body center of mass (COM) is commonly calculated in research laboratories to assess stability during locomotion. However, this calculation can be time-intensive and possibly not realistic for all clinical laboratories. If a more direct motion measurement could be made that would effectively distinguish dynamic instability to the same extent as COM, a more expedient assessment would be available to the clinician.

Therefore, the purpose of this study was to determine whether displacement of selected bony landmarks, while negotiating obstacles, could indicate an individual’s M-L instability to the same extent as whole body COM.

METHODS

Eleven subjects, including five healthy elderly adults (mean age, 70.4 years) and six elderly patients with imbalance (mean age, 75.7 years), were recruited for this study. A six-camera ExpertVision™ system (Motion Analysis Corp., Santa Rosa, CA) was used to capture and reconstruct the three-dimensional coordinates of surface markers. A 13-link biomechanical human model was used to compute the coordinates of the whole body’s COM. Subjects were assessed in conditions of unobstructed level walking and when stepping over an obstacle of height corresponding to 2.5%, 5%, 10%, or 15% of the subject’s body height (BH). All trials were conducted at a comfortable self-selected walking speed while barefoot. The order of obstacle height was randomly selected. The bony landmarks selected for comparison were the forehead (HD), right acromion (SHLD), and right anterior superior iliac spine (ASIS). A two-way ANOVA was used to test for group differences in the M-L displacement of these landmarks and COM.

RESULTS AND DISCUSSION

There were significant group differences in ASIS (p=0.022) and COM sway (p=0.025), across all obstacle heights. Group differences in HD and SHLD sway were not significant. However, sway values for all measures were greater in elderly patients.
than in healthy elderly. These results possibly reflect a decreased ability to control segment motion during obstacle crossing in elderly patients.

For all sway measurements, the greatest mean difference between groups was at the lowest obstacle condition (2.5% BH). Elderly patients showed 24.5% greater sway for the HD, 56.5% for the SHLD, 61.5% for the ASIS and 80.8% for the COM during the lowest obstacle condition than healthy elderly.

Although COM sway showed the greatest relative difference between group means in the 2.5% and 5% BH conditions, relative differences in ASIS sway were greater in the 10% and 15% BH conditions (see Figure). This may indicate a more rigid whole-body sway at lower obstacles and more lateral trunk flexion at the greater obstacle heights. These group differences in either ASIS or COM sway possibly result from a decrease in proprioceptive awareness of segment position or neglect of segmental control in a focused effort to clear the obstacle. Due to a pre-existing sense of instability, elderly patients increase foot elevation despite the subsequent increase of M-L pelvic and trunk motion.

**SUMMARY**

These results indicate a distinction between M-L sway for healthy elderly and elderly patients with imbalance. Because both sway measurements of the ASIS and COM demonstrated significant differences between groups, measuring displacement of landmarks on the pelvis or lower trunk may be adequate for indicating M-L instability during obstacle crossing.

**REFERENCES**