INTRODUCTION

Age-related decline in the balance control system is thought to contribute to the risk of traumatic falls responsible for hip or wrist fractures. Whole body dynamic stability, as demonstrated by center of mass (COM) trajectory and peak velocity components, was shown to be well-modulated in young adults (Chou, 2001), during level walking and obstacle crossing conditions. In a sample of elderly vestibular patients, Chou (2003) reported significant differences from a sample of age-matched peers in medio-lateral (M/L) COM range of motion (ROM), and peak M/L velocity, however no differences in temporal-distance (T-D) gait parameters. The purpose of this study was to determine the age-related differences in dynamic stability between healthy young and elderly. It was hypothesized that the aged population would be similar in all parameters.

METHODS

Thirteen young adults (7 male / 6 female; 25.7yrs, 171.8cm, 74.2kg) and eleven elderly adults (6 male / 5 female; 72.0yrs, 168.7cm, 72.2kg) were recruited for this study within the guidelines of the University I.R.B. All participants were determined to be free of neuromuscular or orthopedic pathologies. Subjects were asked to walk at a self-selected pace during level and obstructed gait tasks. An obstacle consisting of two upright standards and a lightweight crossbar, represented a single obstacle at a height of 2.5, 5, 10, and 15% body height (BH). Obstacle heights were randomized with 3 trials being collected for each condition. Whole body motion data was collected using a six-camera ExpertVision system (Motion Analysis Corp., Santa Rosa, CA) and an adapted Kadaba marker set. Segment anthropometric tables were used to estimate COM position data as a weighted sum. Velocities and accelerations were estimated using the GCVSPL algorithm. Center of pressure (COP) position was estimated from the ground reaction forces/moments collected from two force platforms (AMTI, Newton, MA), and the distance between COM and COP position was calculated for each frame of data. The following parameters were analyzed for the effects of age group and obstacle height (two-factor ANOVA with repeated measures of obstacle height): antero-posterior (A/P), M/L and vertical ROM, and peak A/P, M/L, upward and downward velocities of the COM; peak posterior, anterior and M/L COM-COP distances, and the time-corresponding COM velocities. T-D parameters were also tested.

RESULTS AND DISCUSSION

The effect of age was significant (p<0.05) in A/P ROM of the COM and the peak anterior COM-COP distance. Elderly adults allowed less A/P ROM and less A/P COM-COP distance, indicating a more conservative strategy in maintaining forward progression (see Table 1).

Increasing obstacle height resulted in significant increase of the following variables; A/P, M/L and vertical ROM, and peak M/L, upward and downward velocities of the COM; peak posterior and anterior COM-COP distances. Significant decrease was discovered for A/P velocity of the COM at the time of greatest anterior COM-COP distance, as obstacle height increased. This decrease in A/P velocity of the COM suggests that more effort is being made to avoid foot-obstacle contact than to maintain forward progression.

No age differences were found for the T-D parameters. As obstacle height increased however, so did stride time and step width. Gait velocity was found to decrease with increased obstacle height.

SUMMARY

As age-related declines occur in the balance control system, it is reasonable to expect that a reduced ability to maintain dynamic stability would be evident in increased ROM and velocity of the COM. The evidence gathered in this study indicates that healthy elderly adults were able to adequately maintain dynamic stability during locomotion. Specifically, with respect to the M/L sway demonstrated by elderly vestibular patients (Chou, 2003), the present healthy elderly sample exhibited a well-maintained dynamic stability. The only age-related differences (A/P ROM, and maximum anterior COM-COP distance) indicate a conservative reduction in the A/P COM motion to maintain a controllable distance between the COM and COP. As obstacle height increased, this indication was confirmed by a decrease in A/P velocity when the COM-COP distance was greatest.

REFERENCES


ACKNOWLEDGEMENTS

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Table 1: Group differences (mean ± SD).

<table>
<thead>
<tr>
<th>Condition</th>
<th>2.5% BH</th>
<th>5% BH</th>
<th>10% BH</th>
<th>15% BH</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Y E</td>
<td>Y E</td>
<td>Y E</td>
<td>Y E</td>
</tr>
<tr>
<td>A/P ROM</td>
<td>1.41±0.14 1.32±0.08</td>
<td>1.47±0.14 1.36±0.14</td>
<td>1.48±0.14 1.36±0.11</td>
<td>1.51±0.15 1.35±0.15</td>
</tr>
<tr>
<td>A, CM-CP</td>
<td>0.26±0.04 0.23±0.03</td>
<td>0.30±0.05 0.26±0.04</td>
<td>0.30±0.04 0.26±0.05</td>
<td>0.31±0.05 0.25±0.04</td>
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