UNILATERAL TRANSTIBIAL AMPUTEE DYNAMIC STABILITY MARGIN DURING TREADMILL WALKING

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INTRODUCTION
Walking is laterally unstable. Therefore, to maintain balance active control is necessary. In individuals with a transtibial amputation (TTA), proprioception and muscular control are compromised contributing to 52% of lower limb amputees falling at least once per year (Miller, 2002). To better understand lateral stability, this project looked at the ML dynamic stability margin for able bodied and TTA subjects. The ML dynamic stability margin ($b_{\text{min}}$), developed by Hof et al., is defined as the minimum distance between an individual’s base of support (BOS) and velocity-adjusted center of mass (XCOM) during walking (Figure 1). It was hypothesized that unilateral TTA will have greater $b_{\text{min}}$ values on their prosthetic side as compared to able bodied subjects.

METHOD
This study was approved by the Georgia Institute of Technology Institutional Review Board and funded by the NIH (NINDS NS069655).

Subjects: All subjects had no cognitive or musculoskeletal deficits (outside of amputation). Subject characteristics are summarized in Table 1. All TTA subjects had unilateral traumatic amputations and could walk at different speeds without an assistive device. The prosthetic socket fit with <5 ply.

<table>
<thead>
<tr>
<th>Subject Type</th>
<th>Control Subjects (N=7)</th>
<th>TTA Subjects (N=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>31.4</td>
<td>44.4</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>6/1</td>
<td>4/1</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>66.5</td>
<td>93.8</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>177.8</td>
<td>184.2</td>
</tr>
<tr>
<td>Amputated Side (left/right)</td>
<td>N/A</td>
<td>4/1</td>
</tr>
</tbody>
</table>

Table 1. Subject characteristics.

Apparatus & Procedures: Each subject filled out a brief survey on their physical health and prosthetic use before starting. Full body reflective markers were then placed and subjects walked 1.0 m/s on a force plate (1080 Hz, AMTI; Watertown, MA) instrumented split belt treadmill for 3 30-second trials. 3-D kinematic data was collected using a 6-camera motion capture system (120 Hz, Vicon Motion Capture Systems; Los Angelos, CA).

Data Analysis: Raw data was filtered in Vicon and then exported for further filtering, calculations and statistics in MATLAB (Natick, MA) and Microsoft Excel (Microsoft, 2007). BOS and XCOM data were calculated from force plate and toe marker data. $b_{\text{min}}$ values were compared using an unpaired t-test assuming unequal variance. Significance was set at $p>0.05$.

RESULTS
TTA subjects had larger $b_{\text{min}}$ values on their prosthetic side as compared to controls, but there was no significant difference between $b_{\text{min}}$ for TTA subjects sound side and controls (Figure 2). TTA subjects had a larger BOS compared to controls. The inter-leg variance within the TT amputee group (.00277) was larger than the control group (.00019).

DISCUSSION & CONCLUSION
In order to stabilize themselves, TTA subjects minimized the ML displacement of their COM, increased their BOS and concentrated their COM towards their sound side. These findings verify clinical observations and demonstrate that asymmetry is present even if not visually perceived. Future research with a larger subject pool may be able to isolate variables for subcategories in stability within the TTA population.

REFERENCES