Kinematic Analysis of in vivo Foot Motion and Gender Difference in Healthy Adults

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My disclosure is in the Final AOFAS Program Book. I have no potential conflicts with this presentation.
Gender Difference in Gait

• Only a few attempts to identify gender difference in gait
• Females walk with pelvis tilted more anteriorly, hip joints more flexed-adducted-internally rotated, knee joint in more valgus angles

Pelvic Tilt  Hip Adduction  Hip Rotation

• No report on gender difference in foot kinematics during gait
OrthoTrak Foot3D Model

- OrthoTrak Software (Motion Analysis Co., Santa Rosa, CA)
- 6 segments: Lower leg, Hindfoot, Lateral forefoot, Medial forefoot, Whole forefoot, Hallux
- 10 markers on foot & ankle
Materials & Methods

- 100 young healthy volunteers (50 males & 50 females)
- 3 strides from 5 separate trials
- 12 cameras, 3D optical motion capture system (Motion Analysis Co., Santa Rosa, CA)
- Eva Real-Time software (EVaRT, Motion Analysis Co.)

<table>
<thead>
<tr>
<th></th>
<th>Male (n=50)</th>
<th>Female (n=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>29.2 yrs (22~35)</td>
<td>28.9 yrs (20~35)</td>
</tr>
<tr>
<td>Weight</td>
<td>71.1 kg (51.9 ~ 105.5)</td>
<td>56.0 kg (44.9 ~ 78.4)</td>
</tr>
<tr>
<td>Height</td>
<td>174.0 cm (160.0 ~ 186.8)</td>
<td>160.6 cm (147.6 ~ 173.8)</td>
</tr>
<tr>
<td>BMI</td>
<td>23.4 kg/m² (18.4~32.2)</td>
<td>21.7 kg/m² (16.8~30.9)</td>
</tr>
<tr>
<td>SMD</td>
<td>88.0 cm (77.5 ~ 99)</td>
<td>81.4 cm (72.5 ~ 89)</td>
</tr>
<tr>
<td>Foot length</td>
<td>25.4 cm (22.6 ~ 28.0)</td>
<td>23.0 cm (20.7 ~ 24.9)</td>
</tr>
<tr>
<td>Foot width</td>
<td>10.1 cm (9.1~11.0)</td>
<td>9.2 cm (8.3~10.7)</td>
</tr>
</tbody>
</table>
Results

- **Basic Gait Parameters**

<table>
<thead>
<tr>
<th></th>
<th>Male (n=50)</th>
<th>Female (n=50)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Step length cm</td>
<td>67.06</td>
<td>4.86</td>
<td>63.77</td>
</tr>
<tr>
<td>Stride length cm</td>
<td>134.2</td>
<td>8.71</td>
<td>127.4</td>
</tr>
<tr>
<td>Velocity cm/s</td>
<td>124.0</td>
<td>10.84</td>
<td>125.0</td>
</tr>
<tr>
<td>Cadence steps/min</td>
<td>110.7</td>
<td>6.55</td>
<td>117.6</td>
</tr>
<tr>
<td>Stance Phase % cycle</td>
<td>59.53</td>
<td>1.58</td>
<td>59.29</td>
</tr>
<tr>
<td>FPA (IC) degree</td>
<td>12.92</td>
<td>1.38</td>
<td>8.15</td>
</tr>
<tr>
<td>FPA (MS) degree</td>
<td>11.00</td>
<td>1.43</td>
<td>6.17</td>
</tr>
</tbody>
</table>

FPA, foot progression angle; IC, initial contact phase; MS, mid-stance phase
Results

- Female had larger flexion/extension arc & more valgus rotation in hallux

Range, average ± 1 standard deviation

Male | Female

Hallux
- Hallux Rotation
- Foot Progression

Hindfoot
- HindFoot Rotation
- Pro/Supination

Arch
- Arch Height
- Arch Length
Results

- Female had more dorsiflexed and pronated forefoot motion & larger flexion/extension arc
Summary

• Foot kinematics with OrthoTrak Foot3D system showed relatively low variability in young healthy adults, especially in sagittal plane motion.

• Gender difference in foot kinematics requires different reference value for males and females to interpret in vivo foot motion using 3D multi-segment foot models.
References


Motion Analysis. Foot3D Multi-Segment User’s Manual version 1.1