Development and Characterization of Passive Knee Mechanisms (FreeGait) for Improving Crouch

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Introduction
- Orthotics are a common treatment option for individuals with cerebral palsy (CP) who have crouch or excessive knee flexion in gait [1].
- Passive orthoses for crouch limit excessive knee flexion using 1) a leaf spring design, (Cascade DAFO 3.5); or 2) adjustable dynamic response technology (Ultraflex ADR) that resists ankle dorsiflexion and/or knee flexion.
- Both passive approaches may improve stride length, hip extension in stance and dorsiflexion in swing compared with barefoot walking [2].
- Robotic exoskeletons can also significantly improve walking kinematics just by providing low-level knee extension assistance during stance and late swing phase of walking in children with CP [3].
- Whereas previous passive systems resist excessive crouch, the FreeGait mechanisms are designed to provide the benefits of knee extension assistance without requiring the complexity of a robotic exoskeleton.

Objective
Develop a non-motorized exoskeleton to improve walking kinematics of crouch gait. Our hypothesis: providing knee extension assistance proportional to knee flexion angle would improve knee extension and gait speed, as well as improve or maintain knee extensor muscle activity.

Methods
Two spring-based knee orthoses were developed to provide adaptive knee extension assistance by manipulating the stiffness and moment arm of the spring.
The assistive torque profiles of each orthosis were evaluated through simulated walking performed with a Biodex dynamometer.

Results & Discussion
<table>
<thead>
<tr>
<th>Design</th>
<th>Weight (kg)</th>
<th>Frontal Plane Width (cm)</th>
<th>Torque RMS (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.4</td>
<td>3.0</td>
<td>0.4 (2 spring)</td>
</tr>
<tr>
<td>II</td>
<td>0.6</td>
<td>6.5</td>
<td>0.2 (3-spring)</td>
</tr>
</tbody>
</table>

Acknowledgements

Supported by NIH summer mentorship program (Munoz) & NIH Clinical Center Intramural Research Program

References