INTRODUCTION

• Use of ankle foot orthoses (AFOs) in cerebral palsy (CP) improves gait, activity levels, metabolic cost
• Variety of AFOs available
• Little evidence to guide AFO prescription
• Inconsistent prescriptions – variable, often unsatisfactory results

PURPOSE: To compare two orthotic approaches in children with CP
• Cascade Dynamic AFO (DAFO)
• Ultraflex adjustable dynamic response (ADR) AFO

METHODS

• 10 children with CP (15 sides)
  - Age 4-12 years
  - GMFCS I (n=6), GMFCS III (n=4)
  - Equinus and/or crouch gait
• Participants wore Cascade DAFOs x 4 weeks and Ultraflex ADRs x 4 weeks
  - Randomized order, same shoes
• DAFOs: style determined by manufacturer based on video and PT evaluation
• ADRs: design specifics determined by manufacturer based on video and PT evaluation
  o All but 1 had heel wedging of 0.25-1.5 cm
  o Settings ‘tuned’ by experienced pediatric orthotist to optimize knee/ankle position during stance

• 3D gait analysis at baseline and after each 4 week brace wear period
  - Data collected barefoot and braced
• StepWatch activity monitor (SAM) attached posteriorly to braces
  - Recorded over 4 week wear period
• Satisfaction and quality of life questionnaires
  - Orthotics and Prosthetics User’s Survey (OPUS)
• Paired t-tests
  o Braced vs. barefoot (within session)
  o DAFO vs. ADR (between sessions)

RESULTS

TEMPORAL-SPATIAL (N=15)

<table>
<thead>
<tr>
<th></th>
<th>Velocity (m/s)</th>
<th>Cadence (steps/min)</th>
<th>Stride length (m)</th>
<th>Double limb stance time (% GC)</th>
<th>Dorsiflexion mean in stance</th>
<th>Dorsiflexion mean in swing</th>
<th>Knee flexion peak in loading response</th>
<th>Knee extension peak in loading</th>
<th>Knee extension moment peak in mid-stance</th>
<th>Hip extension moment peak in mid-stance</th>
<th>Hip flexion moment peak in late stance</th>
<th>Posterior tibial moment in stance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAFO</td>
<td>0.06 (0.02, 0.10)</td>
<td>-8.1 (-12.2, -3.9)</td>
<td>0.11 (0.07, 0.15)</td>
<td>-2.2 (-5.2, 0.7)</td>
<td>13.2 (5.3, 21.0)</td>
<td>17.0 (10.3, 21.8)</td>
<td>1.6 (2.4, 5.5)</td>
<td>-2.1 (-5.7, 1.5)</td>
<td>-0.3 (-1.7, 1.2)</td>
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<tr>
<td>ADR</td>
<td>0.06 (0.03, 0.09)</td>
<td>-10.5 (-17.1, -3.9)</td>
<td>0.12 (0.09, 0.14)</td>
<td>-0.4 (-1.7, 0.5)</td>
<td>5.6 (0.8, 12.0)</td>
<td>8.3 (2.4, 15.4)</td>
<td>0.41 (2.4, 5.6)</td>
<td>-1.4 (-4.8, 2.0)</td>
<td>0.52 (1.3, 3.4)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>0.006</td>
<td>0.001</td>
<td>0.0002</td>
<td>0.02</td>
<td>0.003</td>
<td>0.001</td>
<td>0.40</td>
<td>0.12</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.23</td>
<td>0.02</td>
<td>0.0001</td>
<td>0.23</td>
<td>0.08</td>
<td>0.005</td>
<td>0.40</td>
<td>0.26</td>
<td>0.01</td>
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</tbody>
</table>

KINETIC (N=15)

<table>
<thead>
<tr>
<th></th>
<th>Dorsiflexion moment in loading response</th>
<th>Plantarflexion moment in late stance</th>
<th>Knee flexion peak in mid-off stance</th>
<th>Knee extension moment peak in mid-stance</th>
<th>Hip flexion moment peak in mid-stance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAFO</td>
<td>0.24 (-0.44, -0.04)</td>
<td>0.19 (0.03, 0.34)</td>
<td>0.57 (-0.54, 0.01)</td>
<td>-0.13 (-0.34, 0.09)</td>
<td>-0.11 (-0.26, 0.05)</td>
</tr>
<tr>
<td>ADR</td>
<td>-0.19 (-0.51, 0.13)</td>
<td>0.04 (0.06, 0.42)</td>
<td>-0.64 (-0.81, -0.07)</td>
<td>-0.11 (-0.29, 0.06)</td>
<td>-0.08 (-0.31, 0.46)</td>
</tr>
<tr>
<td>Difference</td>
<td>0.20</td>
<td>0.05</td>
<td>0.21</td>
<td>0.17</td>
<td>0.14</td>
</tr>
<tr>
<td>P-value</td>
<td>0.06</td>
<td>0.01</td>
<td>0.12</td>
<td>0.01</td>
<td>0.01</td>
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</table>

STEPWATCH ACTIVITY MONITORING

<table>
<thead>
<tr>
<th></th>
<th>DAFO</th>
<th>ADR</th>
<th>Difference (DAFO-ADR)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps per day</td>
<td>5692 ± 4100</td>
<td>5224 ± 3657</td>
<td>729 (72, 1530)</td>
<td>0.07</td>
</tr>
<tr>
<td>Days used (%)</td>
<td>67.8 ± 18.1</td>
<td>64.0 ± 21.3</td>
<td>3.8 (-10.7, 18.3)</td>
<td>0.57</td>
</tr>
<tr>
<td>Total time per day (hours)</td>
<td>9.3 ± 2.4</td>
<td>8.9 ± 2.4</td>
<td>0.90 (0.27, 2.1)</td>
<td>0.12</td>
</tr>
<tr>
<td>Active time per day (hours)</td>
<td>3.9 ± 1.8</td>
<td>3.2 ± 1.7</td>
<td>0.70 (0.1, 1.3)</td>
<td>0.02</td>
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</tbody>
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PODCI & OPUS Questionnaires

• No difference between braces for PODCI (p=0.10) or OPUS function, quality of life, and service satisfaction (p=0.46)
• OPUS device satisfaction higher in DAFOs compared to ADRs (p=0.002)

CONCLUSIONS

• Both braces were effective in altering barefoot gait patterns
  - Longer stride length
  - Improved upright posture (hip extension)
  - Less equinus (more dorsiflexion in stance and swing)
• DAFOs placed ankles in dorsiflexion in stance — more knee flexion
• ADRs placed ankles in slight plantarflexion in stance — less knee flexion
  - Better preservation of push-off power
  - Dorsiflexion ROM and plantarflexion spasticity unchanged
• Both braces improved gait compared with barefoot
• ADRs produced better knee extension and push off power, but satisfaction and activity levels were higher in DAFOs