Evaluation of the Effect of Removable Cast Walkers on Spinal Alignment and Gait

Christopher Girgis B.A¹, Rachel Domijancic², Emily Mosher³, Sai Yalla PhD¹, Stephanie Wu DPM¹, Ryan Crews, MS, CCRP¹

¹Center for Lower Extremity Ambulatory Research (CLEAR), Scholl College of Podiatric Medicine at Rosalind Franklin University of Medicine and Science,
²Lake Forest College,
³DePaul University
Disclosure

This study was partially funded by National Institute of Diabetes and Digestive and Kidney Diseases Grant: 5T35DK074390

There are no conflicts of interest to disclose.
Introduction
• Offloading is a critical part of treating the diabetic foot ulcer (DFU)
• Removable cast walkers (RCW) are commonly used to offload DFU
• Treatment adherence with RCW can be problematic
  • only 28% on average and high adherence was considered 60% (n=20, 7 day monitoring period)[Armstrong et al 2003]
  • ~60% on average (n=79, 6 weeks monitoring period)[Crews et al, 2016]
Causes for non adherence

- Induced limb length discrepancy (LLD) causing
  - Knee and hip pain [Defrin et al 2005]
  - Increased demand on knee extensors [Zhang et al 2006]
  - Increased oxygen consumption and perceived exertion [Gurney et al 2001]
- Limited evidence exists on effects of RCW on spine alignment during gait
Purpose

Objectively evaluate the effect of

• RCW
• Contralateral limb lift

on spinal alignment and gait
Methods

• 15 participants (13M; 2 F)

• Inclusion Criteria:
  • 18 years of age or older
  • Ambulatory without need for assistive device (cane/crutch)

• Exclusion Criteria:
  • Previous diagnosis of scoliosis
  • LLD that required treatment/intervention
  • History of back or lower extremity neuromuscular/skeletal surgery

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.33</td>
<td>2.47</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>23.71</td>
<td>2.80</td>
</tr>
</tbody>
</table>
Methods

• Three different footwear conditions were evaluated:
  • Laboratory standardized shoes
  • RCW with standardized shoe on contralateral foot
  • RCW and standardized shoe plus lift on contralateral foot
• Quiet standing and treadmill walking was assessed in each condition
During walking gait parameters were measured using body worn sensors (LegSys+, Biosensics, Massachusetts, USA).

**Methods**

**Variables measured:**

- Stride length
- Swing and Stance
- Knee range of motion
- Center of mass displacement

**Graphs:**

- Gyroscope movement
- Tri axial accelerometer signal
Methods

• 3D skeletal spine alignment was assessed using an optical non-radiation system (Formetric 4D, Diers, Schlangenbad, Germany)

Pelvic Tilt

Lordotic angle

Pelvic Tilt
Results

Quiet standing:
Compared to control condition of Standardized Shoes

- Sagittal imbalance was significantly altered with RCW+Shoe (ANOVA, p=0.026)
- No significant changes with RCW+Lift (ANOVA, p>0.05)
Results

Walking:

Compared to control condition of *Standardized Shoes*

- Pelvic tilt (ANOVA, p=0.003) and lordotic angle (ANOVA, p=0.033) altered with use of *RCW+Shoe*
- No significant changes with *RCW+Lift* (p>0.05)
Results

Gait parameters:

Compared to control condition of Standardized Shoes

• No significant differences were found in Knee range of motion (ROM) and Center of Mass displacement (CoM D) compared to RCW+Shoe and RCW+Lift (ANOVA, p>0.05)

<table>
<thead>
<tr>
<th></th>
<th>n=10</th>
<th>Standard Shoe</th>
<th>RCW+Shoe</th>
<th>RCW+Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee ROM (°)</td>
<td>69.28±11.54</td>
<td>64.49±9.96</td>
<td>66.61±8.86</td>
<td></td>
</tr>
<tr>
<td>CoM D (cm)</td>
<td>0.87±0.28</td>
<td>0.321±0.396</td>
<td>-0.062±0.38</td>
<td></td>
</tr>
</tbody>
</table>
Limitations

• Young healthy participants
• Single RCW was evaluated
• Contralateral lift was not customized to match RCW/Shoe offset
  • However, lift is inexpensively and commercially available
• Assessments limited to initial exposure to device, long term adaptations uncertain
• The RCW induced changes in spinal alignment that could contribute to back pain and subsequently poor RCW adherence

• However, a contralateral lift may improve RCW adherence by mitigating spinal alignment which may increase adherence

• This study lays a foundation for future studies to explore functional and behavioral adaptations to RCW use and the efficacy of using a contralateral lift
References


• Defrin, R., et al., Conservative correction of leg-length discrepancies of 10mm or less for the relief of chronic low back pain. Archives of physical medicine and rehabilitation, 2005. 86(11): p. 2075-2080


Thank you