Home-based Robot-assisted Ankle Rehabilitation for Chronic Stroke Survivors

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Background

• Stroke is the leading cause of disability in the US.

• Foot drop, a major sequella associated with stroke, contributes to locomotor impairments.

• Robot-assisted ankle rehabilitation is one approach that has recently been shown to improve lower extremity function and locomotion in stroke survivors (Mirelman et al 2008, Forrester et al 2011, Forrester et al 2013, Waldman et al 2013).

• Robotic training, however, is typically confined to large clinics or research laboratories. This limits patients access, and limits widespread adoption of the technology.
Purpose

• To investigate the effects of home-based robot-assisted ankle rehabilitation on strength, locomotion and quality of life in chronic stroke survivors.
Methods

• Screen and Consent

Initial Evaluation

Baseline Period

• Baseline Testing:
  • Weeks -2, -1, 0
    • Dynamometry
    • GAITRite™
    • 6 MWT
    • SIS

Intervention Period

• Intervention:
  • 3x/week for 12 weeks

• Testing:
  • Weeks 4 and 8
    • Dynamometry
    • GAITRite™
    • 6 MWT
    • SIS

Follow up Period

• Follow up Testing:
  • Weeks 12 and 16
    • Dynamometry
    • GAITRite™
    • 6 MWT
    • SIS
Methods

• Intervention:
  – robot-assisted ankle rehabilitation using the Foot Mentor™ for 60 minutes a day, 3 times a week, for 12 weeks in the home
Participants

• 10 Participants enrolled in the study
• 7 Completed the study
  – 2 participants withdrew due to non-study related health issues
  – 1 participant removed from the study due to non adherence.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Side</th>
<th>Gender</th>
<th>Time Since Injury (Months)</th>
<th>Total # of sessions</th>
<th>Total Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1</td>
<td>57</td>
<td>Left</td>
<td>Male</td>
<td>47</td>
<td>34</td>
<td>2040</td>
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<tr>
<td>Subject 3</td>
<td>48</td>
<td>Left</td>
<td>Male</td>
<td>188</td>
<td>26</td>
<td>1569</td>
</tr>
<tr>
<td>Subject 4</td>
<td>52</td>
<td>Left</td>
<td>Male</td>
<td>46</td>
<td>35</td>
<td>2290</td>
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<tr>
<td>Subject 5</td>
<td>71</td>
<td>Left</td>
<td>Male</td>
<td>8</td>
<td>31</td>
<td>1597</td>
</tr>
<tr>
<td>Subject 6</td>
<td>70</td>
<td>Right</td>
<td>Male</td>
<td>67</td>
<td>30</td>
<td>1482</td>
</tr>
<tr>
<td>Subject 7</td>
<td>60</td>
<td>Right</td>
<td>Male</td>
<td>35</td>
<td>35</td>
<td>2556</td>
</tr>
<tr>
<td>Subject 8</td>
<td>64</td>
<td>Left</td>
<td>Male</td>
<td>77</td>
<td>37</td>
<td>2595</td>
</tr>
</tbody>
</table>
Data Analysis

- Kolmogorov-Smirnov test performed on all data
- A One-Way Repeated Measure ANOVA with Dunnett’s post hoc was performed on walking speed and walking distance
- Friedman’s ANOVA with Dunn’s post hoc was performed on Dorsiflexion force and the Stroke Impact Scale
Results

- **Dorsiflexion Strength**

<table>
<thead>
<tr>
<th></th>
<th>Baseline (avg. ± SEM)</th>
<th>4 Weeks</th>
<th>8 Weeks</th>
<th>12 Weeks</th>
<th>16 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVIC (ft*lbs)</td>
<td>23.8±5.4</td>
<td>25.4±5.6</td>
<td>25.4±5.3</td>
<td><strong>29.7±5.9</strong>*</td>
<td>28.6±6.6</td>
</tr>
</tbody>
</table>

- Significant improvements observed at week 12.
- The average improvement was 28.6% from baseline.
## Results

### Walking Speed and Distance

<table>
<thead>
<tr>
<th></th>
<th>Baseline (avg. +/- SEM)</th>
<th>4 Weeks</th>
<th>8 Weeks</th>
<th>12 Weeks</th>
<th>16 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self Selected (m/s)</strong></td>
<td>0.97±.03</td>
<td>1.08±.06*</td>
<td>1.11±.07*</td>
<td>1.14±.06*</td>
<td>1.11±.06*</td>
</tr>
<tr>
<td><strong>Fast Paced (m/s)</strong></td>
<td>1.32±.15</td>
<td>1.37±.15</td>
<td>1.36±.13</td>
<td>1.41±.17</td>
<td>1.34±.20</td>
</tr>
<tr>
<td><strong>6MWT (m)</strong></td>
<td>308.43±16</td>
<td><strong>335.13±19</strong>*</td>
<td>330.85±19</td>
<td><strong>338.24±20</strong>*</td>
<td>330.83±22</td>
</tr>
</tbody>
</table>

- Significant improvements observed in self selected walking speed and distance
Results

• Quality of Life

<table>
<thead>
<tr>
<th>SIS Physical Domain</th>
<th>Baseline (avg. +/- SEM)</th>
<th>4 Weeks</th>
<th>8 Weeks</th>
<th>12 Weeks</th>
<th>16 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>56.68±5.8</td>
<td>58.59±6.4</td>
<td>59.31±5.6</td>
<td>62.88±5.2*</td>
<td>62.30±4.3*</td>
</tr>
</tbody>
</table>

• Significant improvements observed at weeks 12 and 16
Results

• No significant changes were observed in the spatiotemporal parameters of gait
Discussion

• Home-based robot-assisted ankle rehabilitation is safe and feasible.

• Taken together, the results of this study indicate that the participants demonstrated significant improvements in dorsiflexion strength, gait velocity, distance walked during the 6 Minute Walk Test, and perceived quality of life.

• These results support previously reported research that investigated laboratory based ankle rehabilitation devices.
Acknowledgments

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• Seth Peterson, PT, DPT
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Questions