Comparing the effect of two types of spring-like AFOs on gait in plantarflexor weakness: A pilot study

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**Introduction**

- In polio survivors with calf muscle weakness, a spring-like ankle-foot orthosis can be prescribed to improve stability by countering excessive ankle dorsiflexion, and reduce walking energy cost by taking over ankle work.1,2
- The advantage of a spring-hinged AFO (SH-AFO) is that stiffness can be adjusted independently towards plantar- and dorsiflexion, which is not possible in a dorsal-leaf-spring AFO (DLS-AFO).
- However, it is unknown if the SH-AFO is stiff enough to provide adequate resistance in flaccid paresis.
- Evidence on what type of AFO improves gait the most in polio is lacking. Also, the effect of spring stiffness of each AFO is unknown.

**Aim**

To evaluate the effect of a DLS-AFO and a SH-AFO with various degrees of spring stiffness in two polio survivors with calf muscle weakness on:
- Ankle & knee angle during stance
- Walking energy cost
- Satisfaction

**Methods**

**Patients:** Two polio survivors where included. One with mild calf muscle weakness (MRC 3, patient 1) and one with severe calf muscle weakness (MRC 0, patient 2). Both had normal strength of the upper leg muscles and no joint contractures.

**AFOs:** For both patients a DLS-AFO (Figure 1) and a SH-AFO (Figure 2) where custom made. For each AFO, five different stiffness levels were tested. The stiffness range for the DLS-AFO was larger compared to the DH-AFO stiffness range (Table 1).

**Measurements:** The ankle and knee angle where measured during a 3D gait analysis (Vicon 8-camera MX1.3 system).

Walking energy cost was assessed during a 6-min walking test at comfortable walking speed (Cosmed K4b²).

Patient satisfaction was scored on a numeric rating scale (NRS) from 0-10, with 10 as most satisfying.

**Table 1. Spring stiffness (k) in Nm/deg for both AFOs. k1 is most compliant, k5 stiffest.**

<table>
<thead>
<tr>
<th></th>
<th>DLS-AFO</th>
<th>SH-AFO</th>
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<tbody>
<tr>
<td>k1</td>
<td>0.8</td>
<td>0.1</td>
</tr>
<tr>
<td>k2</td>
<td>1.2</td>
<td>0.3</td>
</tr>
<tr>
<td>k3</td>
<td>2.5</td>
<td>0.7</td>
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<tr>
<td>k4</td>
<td>5.8</td>
<td>1.1</td>
</tr>
<tr>
<td>k5</td>
<td>7.3</td>
<td>2.3</td>
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**Results**

**Ankle:** Dorsiflexion decreased with increasing stiffness in both types of AFOs (Figure 3). Plantarflexion decreased with increasing stiffness for the DLS-AFO, but remained similar with the SH-AFO (Figure 3).

**Knee:** In patient 1, the SH-AFO reduced excessive knee flexion during single stance (10-50%) while the DLS-AFO did not (Figure 4). The opposite was seen in patient 2.

**Walking energy cost:** The stiffness level and AFO type that resulted in the greatest walking energy cost reduction differed between patients (Figure 5). Greatest effects where seen between stiffness levels.

**Satisfaction:** Patient 1 preferred the SH-AFO k2: NRS 8. Patient 2 preferred the DLS-AFO k5: NRS 8.

**Conclusion**

- Both AFO types can improve gait in polio survivors with calf muscle weakness.
- Conditions for optimal outcome, such as the degree of calf muscle weakness, AFO ROM settings and AFO alignment needs further investigation.
- The optimal absolute degree of spring stiffness is AFO-type dependent.

**Future research**

The optimization of spring-like AFOs to improve gait in calf muscle weakness will be further investigated in a nonrandomized self-controlled experimental study in 2015 (funded by the Prinses Beatrix Sierfonds, Netherlands).

**References**