Introduction

Community ambulation is one of the most important goals for stroke patients [1]. The spasticity of ankle plantarflexors is primary factor associated with reduced gait speed in chronic stroke [2]. Botulinum toxin injection (BTI) represents the gold standard therapy for focal spasticity [3]. However, it remains unclear whether BTI is really effective in functional improvements [4]. Walking abilities are frequently secondary outcomes and are often poorly investigated.

Purpose

The aim of this study was to assess influence of BTI in ankle plantarflexors on preferred walking speed (PWS) and gait endurance in chronic stroke patients.

Methods

Twelve participants (55.6 ± 11.6 years; 6.5 ± 2.7 years since stroke, BMI 28 ± 5.5 kg/m²) were assessed before (T0) and one month (T1) after BTI at the service of Neuropsychology and Neurorehabilitation (CHUV), Passive range of motion (ROM), spasticity (Modified Ashworth Scale, MAS), strength (Motricity Index, MI), ambulation ability (Functional Ambulation Category, FAC), questionnaire on physical activities (Voorrips) and independence in activities of daily living (Barthel Index, BI) were also evaluated (Fig. 2).

Fig. 1: foot-worn inertial sensor

Fig. 2: Assessment process

Results

A significant improvement was found on passive ankle dorsiflexion (p = 0.031, small effect size) and on MAS in ankle plantarflexors (p = 0.004, medium effect size) (Table 1).

Table 1: Range of motion and spasticity before and after BTI.

<table>
<thead>
<tr>
<th>Variables</th>
<th>T0</th>
<th>NA</th>
<th>A</th>
<th>T1</th>
<th>NA</th>
<th>P value</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM ADF [°]</td>
<td>5.25 ± 14.85</td>
<td>27.63 ± 5.56</td>
<td>0.50 ± 14.96</td>
<td>27.75 ± 5.69</td>
<td>0.023&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>0.38 (S)</td>
<td>0.01</td>
</tr>
<tr>
<td>MAS ADF [0.5]</td>
<td>1.83 ± 0.61</td>
<td>1.59 ± 0.60</td>
<td>1.21 ± 0.32</td>
<td>1.93 ± 0.32</td>
<td>0.004&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>0.73 (M)</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>1</sup> Mean ± standard deviation; <sup>2</sup> A; affected; ADF, ankle dorsiflexion; A, non-affected; MAS, Modified Ashworth Scale; NA, non-affected; ROM, Range of motion.

One month after BTI, PWS was significantly improved from 0.66 m/s to 0.78 m/s (+18%, p = 0.04, small effect size) (Fig. 3).

Fig. 3: Preferred walking speed with stopwatch (PWS) or Physilog (PWSphys) *significant time effect (p < 0.05); **p < 0.001

Spatiotemporal Parameters

Table 2: STP on 10mWT before and after BTI

<table>
<thead>
<tr>
<th>Variables</th>
<th>T0</th>
<th>NA</th>
<th>A</th>
<th>T1</th>
<th>NA</th>
<th>P value</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadence [step/min]</td>
<td>86.9 ± 18.61</td>
<td>82.2 ± 20.3</td>
<td>95.0 ± 26.6</td>
<td>97.8 ± 26.4</td>
<td>0.335&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>0.31 (S)</td>
<td>0.40 (M)</td>
</tr>
<tr>
<td>Stride length [m]</td>
<td>0.96 ± 0.32</td>
<td>0.90 ± 0.31</td>
<td>1.08 ± 0.40</td>
<td>0.96 ± 0.35</td>
<td>0.873&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>0.26 (S)</td>
<td>0.36 (S)</td>
</tr>
<tr>
<td>Stride speed [m/s]</td>
<td>0.71 ± 0.32</td>
<td>0.68 ± 0.32</td>
<td>0.81 ± 0.41</td>
<td>0.80 ± 0.45</td>
<td>0.114&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>0.29 (S)</td>
<td>0.40 (M)</td>
</tr>
<tr>
<td>Loading response [%]</td>
<td>6.54 ± 1.41</td>
<td>7.32 ± 4.35</td>
<td>7.64 ± 3.72</td>
<td>8.29 ± 4.89</td>
<td>0.721</td>
<td>0.51 (M)</td>
<td>0.21 (S)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Mean ± standard deviation; <sup>2</sup> A; affected; STP, Surface Temporal Parameters; A, non-affected.

PWS improvement after BTI was highly correlated with enhancement of NA stride speed (r = 0.91, p = 0.000), NA stride length (r = 0.81, p = 0.002) and A relative loading response duration (r = 0.88, p = 0.000).

Gait endurance

BTI had no significant effect on walking endurance (T0: 268 ± 158 m and T1: 289 ± 187 m; p = 0.133, less than small effect size).

The other outcomes showed no significant effect

Conclusions & Perspectives

(1) BTI alone improved PWS in chronic stroke patients but had no effect on gait endurance after one month.

(2) Decrease in ankle plantarflexors spasticity and increase in passive dorsiflexion appeared to improve the initial stance phase on affected lower limb, thus optimizing swing phase on unaffected side.

⇒ It would be interesting to assess combination of BTI with aerobic training and specific strengthening exercises. This association would optimize the effect of BTI on gait endurance.

References


Contact details

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Communication

Approved by the Swiss Ethics Committees on research involving humans (Swiss Trial Register 2016-00471). Results were presented at the European Congress of Neurorehabilitation 2017 (Lausanne, Switzerland) and at the World Confederation for Physical Therapy 2019 (Geneva, Switzerland)