Rapid strength and eccentric muscle training in neurorehabilitation

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Introduction

Injuries of the central nervous system affect human gait. Pathological gait patterns are associated with significant changes in basic gait parameters like walking speed, stride length and cadence [1,2]. The importance of rapid power training combined with a specific eccentric muscle training is well known in sports science [3] and also documented for stroke patients [4], but not commonly integrated in neurological rehabilitation concepts.

Methods

31 in-patients (20 male, age 59±13 years) with different neurological conditions such as stroke and multiple sclerosis featuring a Functional Ambulation Category ≥ 3 participated in the GTP+. At the beginning of the 1st session (60 min) a timed 10-meter walk test was performed and documented by video (T1). Subsequently, a customized training was performed and the video documentation (VD) was repeated by the end of this session (T2). Walking speed, double stride length and cadence were calculated and the main gait problems were explained to the patient by using the VD. Then the patient received an intense 30-min gait (including jumps and sprints) and a muscle training with mainly eccentric exercises both three times a week. The entire program lasted on average 3 weeks and ended with a VD (T3).

Purpose

The "Gait training program+" (GTP+) was adapted from a concept published by Götz-Neumann [1] and adapted to our standard neurorehabilitative therapy focusing on improving intramuscular coordination, rapid/explosive strength and eccentric muscle activity. This program aims at patients with a strong motivation to improve their gait.

Results

Already after the 1st session a significant improvement of self-paced walking speed and double stride length was observed (p=0.001). After the performance of the 3-week program all examined gait parameters improved significantly (p<0.001).

Discussion & Conclusions

Our data suggest that neurological patients with persistent gait problems may benefit from a customized gait training such as GTP+, indicating the importance of rapid/explosive strength and eccentric muscle activity in neurorehabilitation.

References

[4] Clark DJ, Patten C: Eccentric versus concentric resistance training to enhance neuromuscular activation and walking speed following stroke. Neurorehabil Neural Repair 2013; 27(4) : 335-344

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Table 1: Patient Characteristics

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Gender</th>
<th>Age (years)</th>
<th>FIM Score</th>
<th>FIM subscores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>Male</td>
<td>58±13</td>
<td>51±12</td>
<td>16±5</td>
</tr>
<tr>
<td>MS</td>
<td>Female</td>
<td>60±15</td>
<td>50±10</td>
<td>15±4</td>
</tr>
</tbody>
</table>

Table 2: Means and standard deviations of gait speed, cadence and stride length at T1, T2 and T3 and results of statistical analysis (t-test)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T1 Mean (m/s)</th>
<th>T1 SD (m/s)</th>
<th>T2 Mean (m/s)</th>
<th>T2 SD (m/s)</th>
<th>T3 Mean (m/s)</th>
<th>T3 SD (m/s)</th>
<th>T1-T2 p</th>
<th>T1-T3 p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>0.88±0.27</td>
<td>0.11±0.05</td>
<td>1.33±0.36</td>
<td>0.09±0.07</td>
<td>1.99±0.33</td>
<td>0.12±0.09</td>
<td>0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cadence</td>
<td>47.8±5.2</td>
<td>4.1±0.5</td>
<td>49.7±4.1</td>
<td>3.8±0.4</td>
<td>50.9±3.2</td>
<td>3.9±0.4</td>
<td>0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stride</td>
<td>0.90±0.13</td>
<td>0.09±0.05</td>
<td>1.12±0.23</td>
<td>0.10±0.07</td>
<td>1.47±0.23</td>
<td>0.11±0.09</td>
<td>0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Figure 1: Change of gait speed from T1-T2 and T1-T3 scaled with clinical relevant changes (diff 0.1m/s)

Figure 2: Distribution of gait speed difference between the beginning and end of the first training session (T2-T1). The red line indicates the mean speed difference (0.8 m/s) over all patients.