Assessing gait adaptability in people with a unilateral amputation on a treadmill with visual context

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Introduction

Gait adaptability, including the ability to avoid obstacles and to make visually guided steps, is essential to move safely through our cluttered world. This aspect of walking ability is important for regaining independent mobility, but is difficult to assess in clinical practice.

The recent development of an instrumented treadmill that enables movement-dependent projection of visual objects (the C-Mill) might provide possibilities for evaluating gait adaptability. This study examined the face and construct validity of a C-Mill-based protocol to objectively assess the ability of persons with a lower-limb amputation to adjust their gait in an online and anticipatory manner to various environmental circumstances.

Methods

> Participants: 12 able-bodied people (CO), 12 people with a transtibial amputation (TT) and 12 people with a transfemoral amputation (TF) participated.

> Experimental setup:
> Participants walked at self-selected speed on an instrumented treadmill with projected visual context (the C-Mill, see Fig. 1).
> Three conditions (Fig. 1):
> - Anticipatory obstacle avoidance: obstacle presentation 4 steps ahead.
> - Reactive obstacle avoidance: obstacle presentation 1 step ahead.
> - Stepping accuracy to regular and irregular (20% and 30% variation in stride length) patterns of visual stepping targets.

> Outcome measures:
> - Obstacle-avoidance success rates (%)
> - Stepping accuracy: variation in foot placement error (mm)
> - Clinical tests: 10m walk test at comfortable (10MWT\textsubscript{comf}) and maximum walking speed (10MWT\textsubscript{max}), Timed Up-and-Go test (TUG), Emory Functional Ambulation Profile-obstacle course (EFAP), Activities-specific balance confidence scale (ABC) and fall history.

Results

> Obstacle-avoidance success rates were lowest in the TF group (Fig. 2)
> - Success rates were significantly lower for TF than CO groups for anticipatory (A, TF: 82.8%, CO: 98.6%) and reactive (B, TF: 47.2%, CO: 81.3%) obstacle avoidance (p<0.005).

> Inferior stepping accuracy was found for TF (43 mm), intermediate for TT (36 mm) and superior for CO (31 mm) (Fig. 3). This effect of Group tended towards significance (‡) (p=0.094).

Table 1. Correlation coefficients between gait adaptability measures and clinimetrics.

<table>
<thead>
<tr>
<th>Obstacle avoidance</th>
<th>10MWT\textsubscript{comf}</th>
<th>10MWT\textsubscript{max}</th>
<th>TUG</th>
<th>EFAP</th>
<th>ABC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticipatory</td>
<td>-0.608</td>
<td>-0.557</td>
<td>-0.425</td>
<td>-0.589</td>
<td>0.257</td>
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<tr>
<td>Reactive</td>
<td>-0.376</td>
<td>-0.288</td>
<td>-0.207</td>
<td>-0.249</td>
<td>0.345</td>
</tr>
<tr>
<td>Stepping accuracy</td>
<td>0.105</td>
<td>0.067</td>
<td>0.221</td>
<td>0.344</td>
<td>-0.221</td>
</tr>
<tr>
<td>20%</td>
<td>0.052</td>
<td>0.070</td>
<td>0.127</td>
<td>0.265</td>
<td>-0.147</td>
</tr>
<tr>
<td>30%</td>
<td>-0.180</td>
<td>-0.093</td>
<td>-0.079</td>
<td>0.076</td>
<td>-0.056</td>
</tr>
</tbody>
</table>

Significant correlations are printed in bold.

> No difference was found in anticipatory and reactive obstacle-avoidance success rates and in stepping accuracy between subgroups stratified for fall history and fear of falling (all p>0.05).

Conclusion

Gait adaptability can be validly assessed using an instrumented treadmill with visual context, as evidenced by significant between-group differences. Moderate correlations with clinical tests imply that this assessment provides unique, objective information about walking ability in people with lower-limb amputation. We therefore promote that a gait adaptability assessment should be considered as an integral part of a walking ability evaluation.

This study has led to the development of a commercially available treadmill with visual context (C-Mill).

Acknowledgements

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