ARE STABILITY REQUIREMENTS DIFFERENT IN OVERGROUND AND TREADMILL LOCOMOTION?

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INTRODUCTION

Kinematics and kinetics of overground and treadmill locomotion only slightly differ. However, several results suggest that the two surfaces require different dynamic stability control [1, 2], and affect balance differently with age [3]. We thus compared dynamic stability during overground (OG) and treadmill locomotion in young and older adults.

METHODS

Twenty healthy persons (10 young: 21.3 (SD 0.9) yrs, 64.5 (9.4) kg, 1.76 (0.10) m; 10 older: 71.5 (4.7) yrs, 70.7 (13.3) kg, 1.66 (0.08) m), with no balance problems at clinical evaluation, participated in the study. A Bertec instrumented treadmill was used to record ground reaction forces at 600 Hz (4th-order Butterworth zero-lag filter; cut-off frequency: 10 Hz; re-sampled at 60 Hz) and to determine the global position of the centre of pressure. An NDI Certus motion analysis system was used to measure 3D body kinematics, sampling at 60 Hz, from at least 3 non-collinear infrared markers placed over each body segment. A digital probe was used on the feet contours to determine the limit of the base of support relative to foot markers. The participants were asked to walk across the ground-level stationary treadmill (OG, 5 trials for 5 steps) and on the moving treadmill (5 steps after 30 seconds of gait). Recordings were made at the preferred gait speed on each surface. In addition, recordings were made at OG preferred speed on the moving treadmill to compare balance at the same absolute velocity. Step cadence was kept identical using auditory pacing set at OG natural cadence for all trials.

To evaluate dynamic stability requirements, we used the stabilizing force, i.e. the theoretical force necessary to stop the displacements of the centre of mass at the limit of the base of support (the higher, the more unstable dynamic balance); the destabilizing force, i.e. the theoretical force necessary to bring the centre of mass to the limit of the base of support (the lower, the more unstable postural balance) and the stability index, i.e. the ratio of the two forces (the lower, the lower global stability). [4] Each was averaged, during the swing phase, between trials of the same condition. Repeated-measure ANOVAs were used to compare conditions and groups.

RESULTS

The two groups differed in terms of clinical balance (TUG: p<0.005; BBS: p=0.08) and fast gait speed (p<0.005) (Table). Treadmill preferred gait speed was lower than preferred overground gait speed in each group (p<0.001) with no interaction between group and surface (p=0.17) (Table).

There was no group difference for the destabilizing (p>0.84), stabilizing force (p=0.61) or stability index (p>0.12).

Table: Clinical scores and gait speeds (BBS: Berg Balance Scale; TUG: Timed-Up-and-Go, in seconds; POGS: Preferred OG Gait Speed, PTGS: Preferred Treadmill Gait Speed, FGS: Fast Gait Speed, in m/s)

<table>
<thead>
<tr>
<th></th>
<th>BBS</th>
<th>TUG</th>
<th>POGS</th>
<th>PTGS</th>
<th>FGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>[56]</td>
<td>6.2</td>
<td>1.47</td>
<td>1.26</td>
<td>2.07</td>
</tr>
<tr>
<td></td>
<td>(0.6)</td>
<td>(0.22)</td>
<td>(0.18)</td>
<td>(0.15)</td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>[55;56]</td>
<td>7.5</td>
<td>1.35</td>
<td>1.04</td>
<td>1.80</td>
</tr>
<tr>
<td></td>
<td>(1.0)</td>
<td>(0.16)</td>
<td>(0.21)</td>
<td>(0.22)</td>
<td></td>
</tr>
</tbody>
</table>

The stability index was lower on the treadmill at OG speed than in the two other conditions (p<0.001), which did not differ one from the other (p=0.33). The destabilizing force was smaller on the treadmill (OG and preferred speed) than OG (p<0.001), and smaller at preferred than OG speed on the treadmill (p=0.05). The stabilizing force decreased from walking on the treadmill at OG speed, to OG gait (p<0.035), to treadmill at preferred speed (p<0.005) (Figure).

DISCUSSION & CONCLUSION

Despite similar stability at preferred speed (index), instability was more postural on the treadmill (destabilizing force), and more dynamic overground (stabilizing force). At OG speed, lower stability on the treadmill is due to lower postural and dynamic stability. Further analyses are needed to determine the biomechanical variables explaining these differences.

REFERENCES


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