GAIT VARIABILITY OF INDIVIDUALS WITH TRANSTIBIAL AMPUTATIONS WALKING IN DESTABILIZING ENVIRONMENTS

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INTRODUCTION

During walking people are exposed to many challenges to stability, including slippery surfaces and uneven terrain. These may lead to changes in walking behavior or cause falls and injuries. Walking on uneven surfaces or while exposed to perturbations increases gait variability in both, models and humans [1]. Increased gait variability may predict increased risk of falling [2]. Alternatively, increased gait variability may also result directly from the perturbations themselves and/or reflect subjects’ responses to perturbations. An improved understanding of how different types of perturbations affect gait variability, especially in patient groups that are known to be at an increased risk of falling, is needed. The purpose of this study was to determine the effect of unilateral transtibial amputation on gait variability during exposure to continuous medio-lateral perturbations of the walking surface or the visual field.

METHODS

Nine individuals with a unilateral trans-tibial amputation (TTA, 30.7±6.8yrs) and thirteen age matched able-bodied individuals (AB, 24.8±6.9yrs) walked on a 2m×3m treadmill embedded in a 4m diameter moveable platform in a Computer Assisted Rehabilitation Environment (CAREN) virtual reality system (Motek, Amsterdam, Netherlands). Participant movements were recorded using 24 motion analysis cameras (Vicon, Oxford, UK). Subjects completed five 3-min trials under each of the following conditions: no perturbation (NOP), platform (PLAT) perturbations, or visual field (VIS) perturbations. Subjects walked at the same, controlled walking speeds in all three conditions. All perturbations were applied as pseudo-random translations in the medio-lateral direction [3,4]. We calculated means and standard deviations of the following stepping parameters and trunk motions:

- **Step length**: distance between right and left heel strikes in anterior-posterior direction
- **Step width**: distance between right and left heel strikes in medial-lateral direction
- **C7 position**: mean standard deviation of the C7 vertebra position
- **C7 velocity**: mean standard deviation of the C7 vertebra velocity

For each dependent measure, 2-way mixed repeated measures ANOVAs were used to determine between-group differences across conditions. Data were compared separately for platform and visual perturbation trials because of the different nature of each type of perturbation [3,4].

RESULTS AND DISCUSSION

In the PLAT condition, subjects’ mean step width (F(1,20) = 32.3; p < 0.001), step width variability (F(1,20) = 173.1), step length variability (F(1,20) = 34.4; p < 0.001), C7 position (F(1,20) = 265.7) and C7 velocity (F(1,20) = 236.1; both p < 0.001) increased and mean step length (F(1,20) = 40.9; both p < 0.001) decreased compared to NOP for both groups (AB and TTA). Also, step width and C7 position were slightly more variable for TTA, but only C7 position reached significance (F(1,20) = 7.25; p < 0.05). Increases in mean step width and step length indicate both groups increased their base of support when walking in mechanically destabilizing environments.
Similarly, in the VIS condition, step width ($F(1,20) = 27.1$), step width variability ($F(1,20) = 50.4$), step length variability ($F(1,20) = 13.2$), C7 position ($F(1,20) = 39.4$) and C7 velocity ($F(1,20) = 49.2$; all $p < 0.001$) increased and step length ($F(1,20) = 31.3$) decreased relative to NOP in both groups. Compared to PLAT, the changes in VIS were less pronounced, indicating both groups were more affected by mechanical perturbations than by visual perturbations. This is potentially crucial for TTA patients. Despite their significantly deteriorated somatosensory input, transtibial amputees did not appear to be more sensitive to visual perturbations than healthy controls.

Although TTA patients showed slightly greater trunk movement and step width variability, only trunk movement was significantly different between our two groups. This outcome may be the result of a young, highly active and otherwise healthy patient population.

**CONCLUSIONS**

Both healthy AB and TTA patients took wider steps to increase their base of support when perturbed. Despite this accommodation, both groups still exhibited increased stepping and trunk (C7) movement variability when perturbed. Interestingly, young active patients with unilateral trans-tibial amputation did not demonstrate increased gait variability compared to healthy controls when walking in these mechanically or visually disturbing environments.

**REFERENCES**


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