Effects of a concurrent task on walking on an unpredictable foam surface in people with lower limb loss: a pilot study

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INTRODUCTION

Lower limb loss (LLL) profoundly alters the sensory afferents and motor efferents critical to walking. These impairments may manifest as postural instability, particularly in challenging situations like walking over irregular surfaces (Lamoth, 2010). In situations where the ground is unstable or moving unpredictably, persons with LLL may compensate for limited sensory feedback from the prosthesis by relying on cognitive control to maintain postural stability. Such interactions between cognition and walking can be examined with a dual-task paradigm, where walking is assessed both with (dual-task) and without (single-task) a concurrent task.

Prosthesis users report the need to concentrate on walking (Miller, 2001), but previous studies do not consistently demonstrate walking dual-task walking deficits. A reason for this discrepancy between self-report and measured outcomes may be that experimental walking conditions are not as challenging as the complex environments people with LLL encounter in their daily lives (Morgan, 2014). Assessment of walking on challenging terrains is needed to better understand the effects of concurrent cognitive tasks on walking in people with LLL.

METHOD

Subjects: A 50 year-old male with transtibial amputation (TTA) and comorbid diabetes, a 66 year-old male with transfemoral amputation (TFA), and a 19 year-old female with no amputation.

Procedures: Participants walked at a self-selected pace over two level surfaces, one predictable (firm) and one unpredictable (foam with variable compliance). On each surface, walking was measured under single-task and dual-task conditions, with the auditory Stroop test used as the cognitive task.

Data Analysis: Walking was quantified using speed, step width, and step time asymmetry. Cognitive task response accuracy was also measured.

RESULTS

All participants walked more slowly and with wider steps on the unpredictable surface compared to the predictable surface. Adding a concurrent cognitive task did not affect walking speed for individuals with LLL on either surface. However, on the foam surface, both participants with LLL demonstrated increased step width and step time asymmetry in dual-task compared to single-task condition.

On the cognitive task, participants with LLL increased accuracy over time, while the control participant's accuracy was 100% for all conditions.

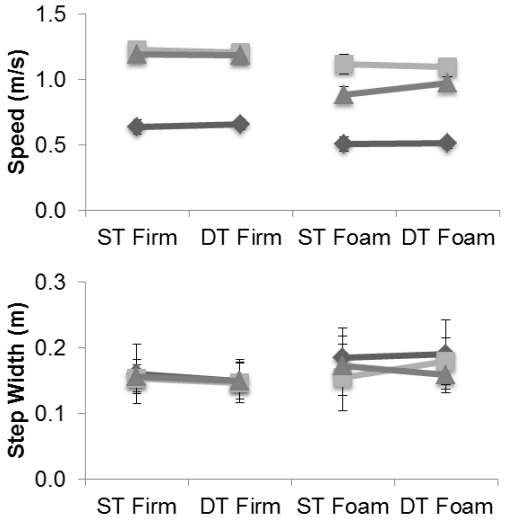

Figure 1. Changes in speed and step width across single- and dual-task conditions. ◆ = TTA, ■ = TFA, ▲ = Control

DISCUSSION

Overall, addition of a cognitive task similarly affected walking performance for all participants on the firm surface. In contrast to the control participant, participants with LLL demonstrated increased step width, an indication of postural instability, during dual-task walking on the foam surface. Results also suggest that the cognitive task chosen may be too challenging for some participants, particularly those with cognitive impairment.

CONCLUSION

These preliminary findings suggest that people with LLL may rely on cognitive resources to maintain postural stability on unpredictable surfaces, where the absence of sensory afferents and motor efferents reduces the ability to regulate postural stability automatically.

CLINICAL APPLICATIONS

We developed a novel protocol to assess cognitive contributions to walking over an unpredictable foam surface. This protocol may be used to enhance our understanding of the mobility challenges faced by people with LLL and to investigate their potential use of compensatory cognitive control during walking.

REFERENCES

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