Does Margin of Stability Decrease during Dual-Task Walking in Persons with Unilateral Lower Limb Loss?

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Summary

Unilateral lower limb loss challenges stability during walking and requires additional cognitive resources, particularly when performing a concurrent task. We evaluated how performing a concurrent task affects margin of stability during walking among persons with varying levels of amputation. Findings suggest level of amputation influences margin of stability more than a concurrent task.

Introduction

Falls are common among persons with unilateral lower limb loss (PLL), increasing risk for further injury and decreasing balance confidence [1]. During gait, fall risk increases when the whole-body center of mass (CoM) exceeds the base of support (BoS) [2]; PLL tend to walk using corrections that increase step width and margins of stability (MoS) to maintain dynamic balance [3]. Moreover, PLL report a heightened focus on every step, imposing additional cognitive demands that adversely affect gait mechanics [4]. Yet it remains unclear if or how additional cognitive demands (i.e., concurrent or dual tasking) influence dynamic balance control during gait. This study investigated the effects of concurrent-task walking on mediolateral MoS among PLL, hypothesizing that PLL vs. uninjured controls would exhibit larger MoS during concurrent-task walking, particularly with more proximal amputations.

Methods

Twenty PLL – 13 transtibial (TTA; age: 33±4 yr, mass: 93.9±15.3 kg, walk speed: 1.1±.2 m/s) and 7 transfemoral (TFA; 35±8 yr, 89.3±16.2 kg, walk speed: 1.0±0.2 m/s) – and 9 uninjured controls (CTR; 27±4 yr, 81.5±15.6 kg , walk speed: 1.2±0.1 m/s) walked at a self-selected speed on a treadmill (CAREN; Motekforce Link, Amsterdam, The Netherlands) in two 8-min trials: (1) no concurrent task and (2) while performing a concurrent task (shape-color matching). Full-body kinematic data (120 Hz) were collected throughout each trial; gait stability was evaluated using minimum mediolateral MoS and CoM excursion [2]. Factorial ANOVA (3 group x 2 condition) for each stance limb determined group and condition differences in MoS and CoM excursion ($p<0.05$) with Tukey's LSD correction for multiple comparisons for post-hoc analyses.

Results and Discussion

During both intact/right (PLL/CTR) and prosthetic/left stances, a main effect of group ($p<0.001$) on MoS was observed with significant post-hoc pairwise comparisons noted between all groups ($p<0.001$). Similarly, there was a main effect of group ($p<0.001$) on MoS with significant post-hoc pairwise comparisons noted between all groups ($p<0.001$) during both intact/right and prosthetic/left stances. Contradicting our hypothesis, there was no effect of dual-task condition on MoS or CoM excursion, regardless of stance limb ($p>0.1$). No differences were noted in task performance accuracy between conditions or groups.

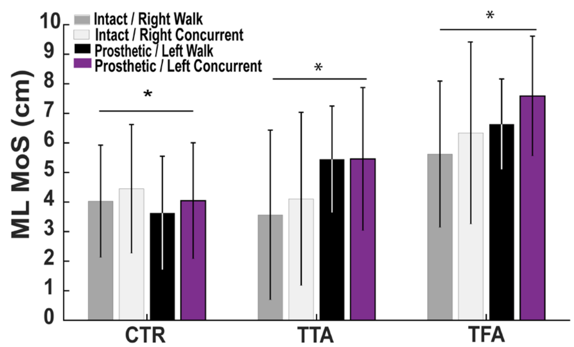

Figure 1: Mean mediolateral (M-L) margins of stability (MoS) by group (controls: CTR, transtibial (TTA) and transfemoral (TFA) amputation) and foot (intact/right; prosthetic/left), for each condition (walk only, walk + concurrent task).

Conclusions

Our findings support previous work suggesting individuals with more proximal levels of amputation (i.e., TFA vs. TTA) increase step width and MoS during walking compared to controls, regardless of a concurrent task. This strategy is likely a compensation to improve dynamic balance and reduce fall risk, particularly among persons with more proximal levels of amputation, though it may come at a cost of increasing cognitive load or demand.

Acknowledgments

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References

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