

PILOT STUDY ON THE EFFECTS OF UPPER-LIMB LOSS AND PROSTHESIS USE ON LOCOMOTOR STABILITY



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Introduction

- Natural arm swing as produced through passive dynamics aid locomotor stability by minimizing:
 - ◆ Body angular momentum [1] ◆ Ground reaction moments [2] ◆ Energy expenditure [3] ◆ Body center-of-mass (CoM) excursion [4] ◆
- Persons with upper-limb loss switch between walking with and without a prosthesis on a given day, or do not wear a prosthesis at all.
- No studies have investigated effects of upper-limb prosthesis use on gait stability, which is relevant to fall risk in this patient group.

Purpose: Investigate the effects of upper-limb prosthesis use and inertial properties on locomotor stability.

Methods

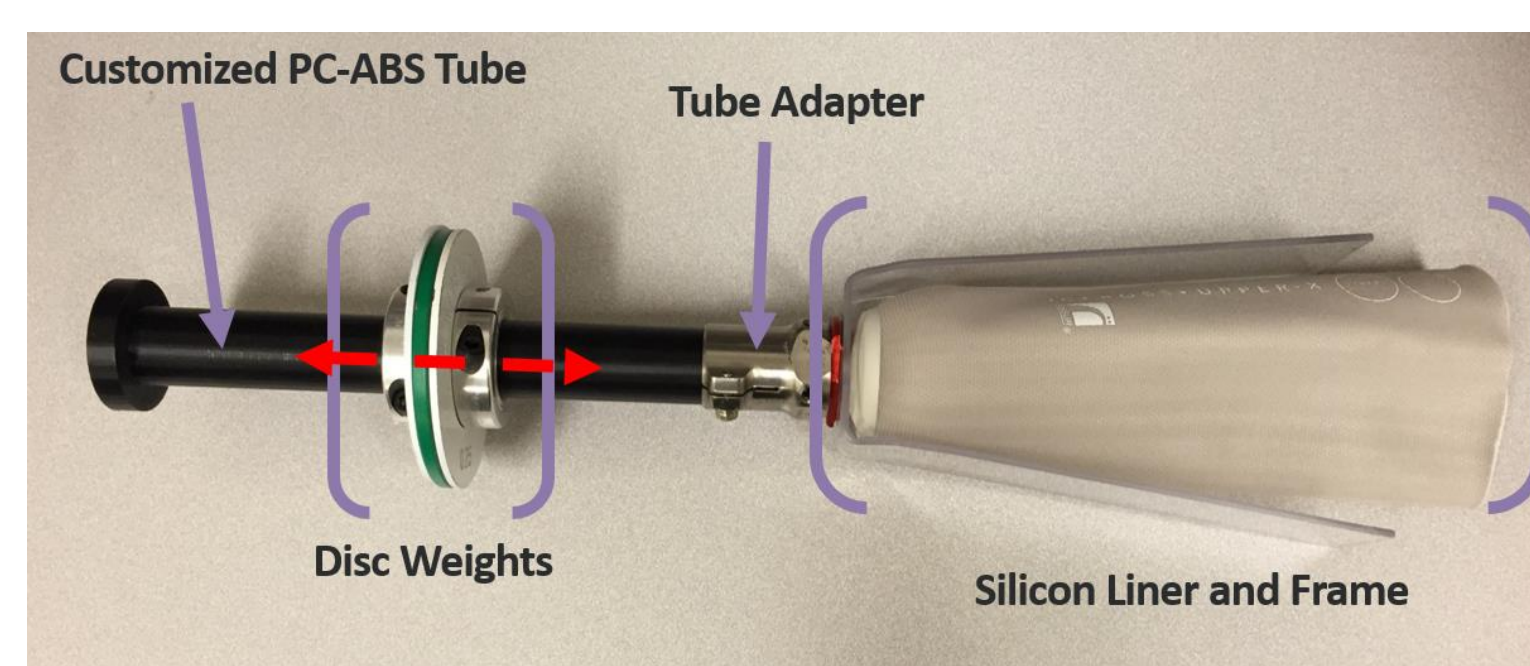
- Repeated-measures analysis on **10 subjects (7 male, 3 above / 7 below elbow amputation, 50±19 years, 75±19 kg, 1.8±0.1 m)**.

Procedure

Walking at customary self-selected (1.2 ± 0.2 m/s) speeds with three (randomized) prosthesis conditions:

1. Without prosthesis
2. Mock prosthesis (inertia/mass matched to sound limb)
3. Customary prosthesis (or mock without mass, $n=4$)

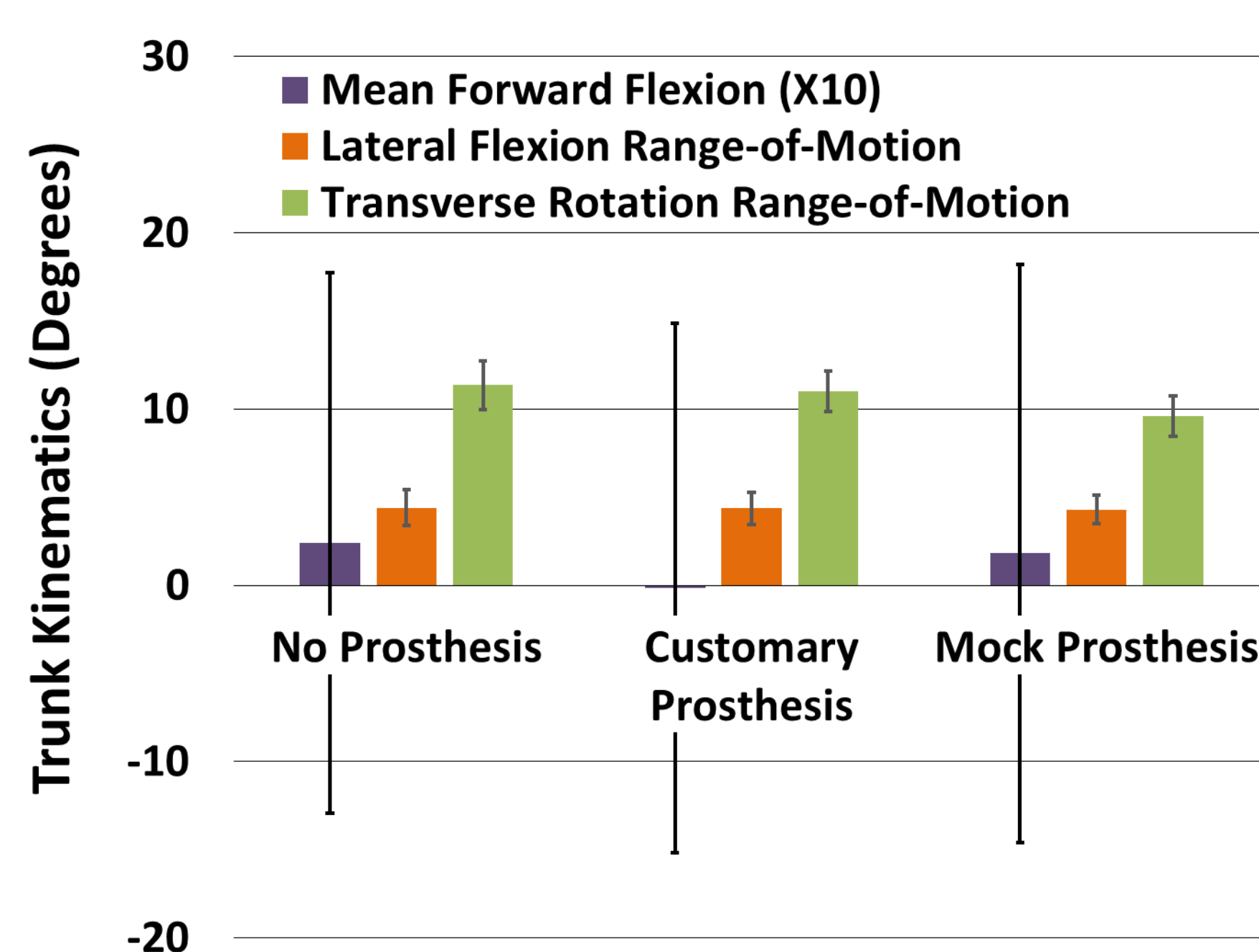
Mock Prosthesis



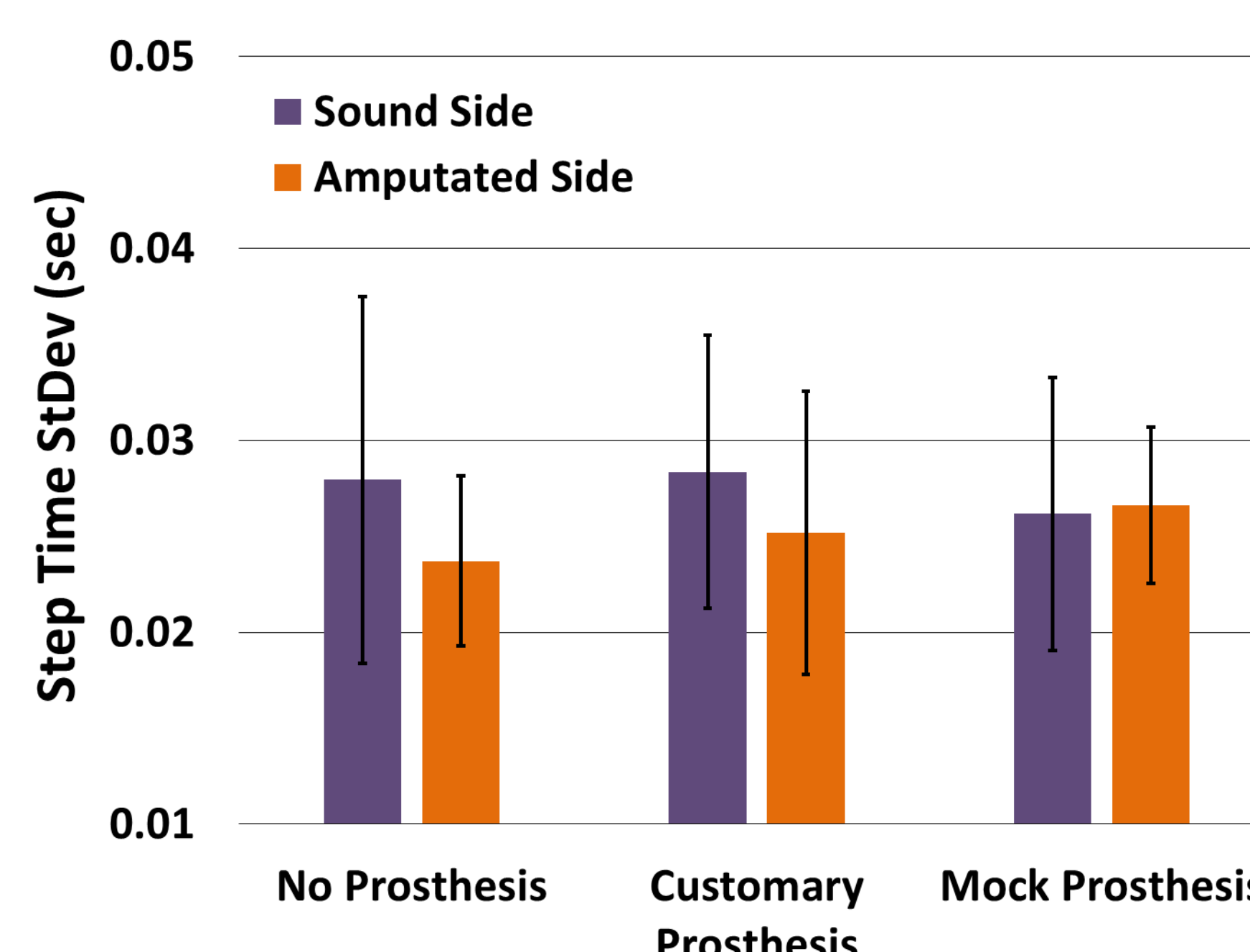
Data Collection and Analysis

- **Equipment:** Optical motion capture (Motion Analysis Corp.); six embedded force plates (AMTI).
- **Trunk kinematics:** 3-D Rotations (mean or range-of-motion).
- **Margin of Stability:** Minimum distance between 5th metatarsal head and extrapolated CoM [5].
- **Temporal-spatial measures:** Step width and standard deviation of step length and time.

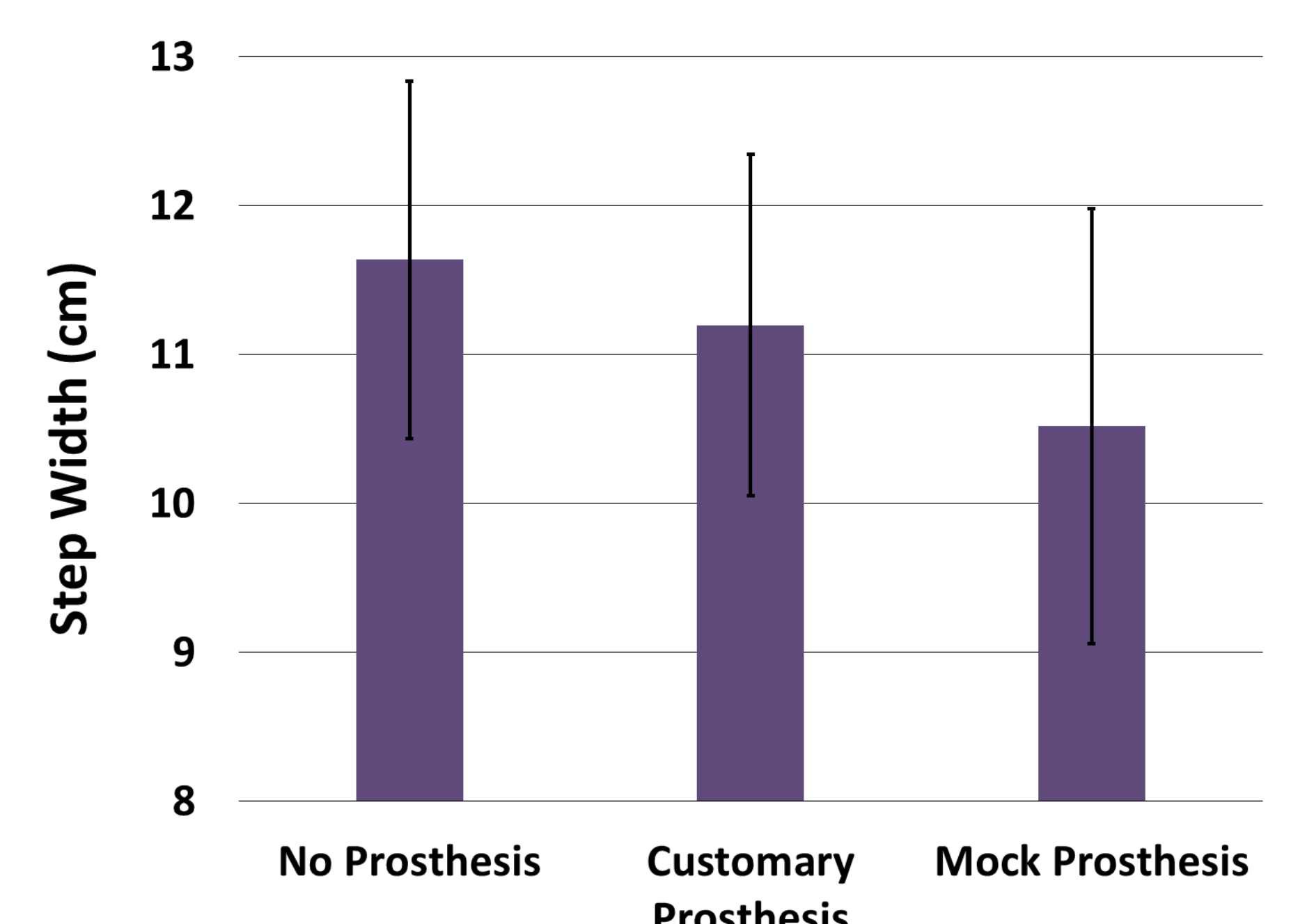
Results



Trunk Kinematics



Step Time Variability



Step Width

Discussion

- Minimal changes in trunk kinematics suggest that added mass up to that of sound limb may not affect upper body gait dynamics.
- Proxy measures of locomotor stability did not change greatly with mock prosthesis but generally became more symmetric bilaterally.
- Small but noticeable decrease in step width with use of mock prosthesis suggest increased perception of locomotor stability [6].
- Stability in persons with upper-limb loss may not be acutely affected by use of prosthesis matched to sound limb characteristics.

References

- [1] Bruijn S, et al. Gait Posture 27, 455-462, 2008. [4] Shibukawa M, et al. Eng Med Biol Conf Proc, 2001.
 [2] Collins S, et al. Proc Biol Sci 276, 3679-3688, 2009. [5] Hof A, et al. Gait Posture 25, 250-258, 2007.
 [3] Yizhar Z, et al. Int J Rehabil Res 32, 115-123, 2009. [6] Major MJ, et al. J Rehabil Res Dev 53, 839-852, 2016.

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