CENTER FOR RESEARCH IN HUMAN MOVEMENT VARIABILITY

FOOT STRUCUTRES INCREASED POSITIVE MECHANICAL WORK DURING LOADED WALKING.

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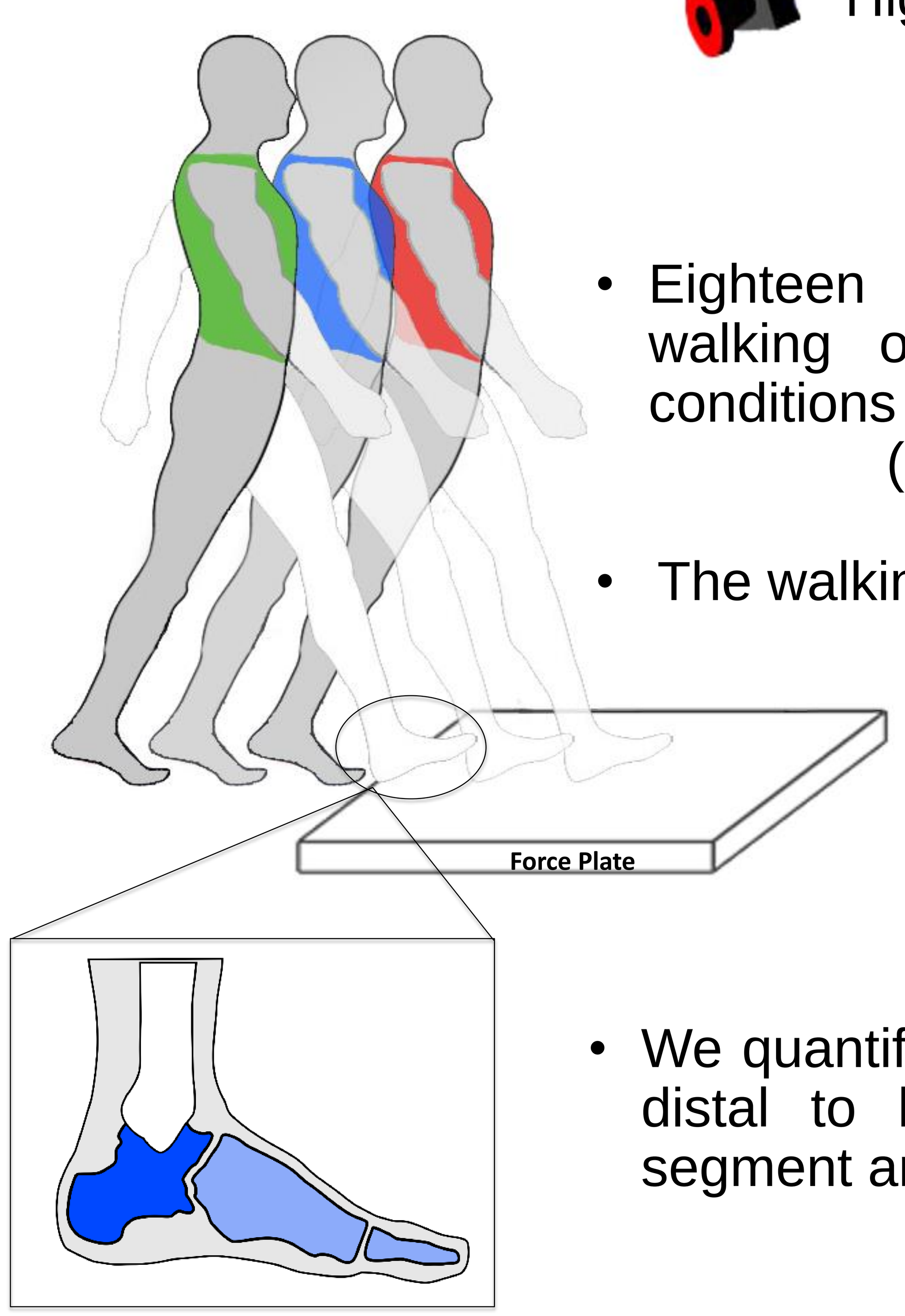
BLADE BIOMECHANICS
Biological Limbs and Assistive DEvices

INTRODUCTION

- Humans must absorb/store and generate/return energy during locomotion.
- Foot deformations are responsible for absorption and dissipation of energy during locomotion [1].
- **Purpose:** To determine how walking with varying levels of added mass affects the combined functional behavior of the foot?
- **Hypothesis:** We hypothesized that the foot structures would increase the amount of dissipated/absorbed energy when walking with added mass.

METHODS

High Speed Motion Capture Cameras

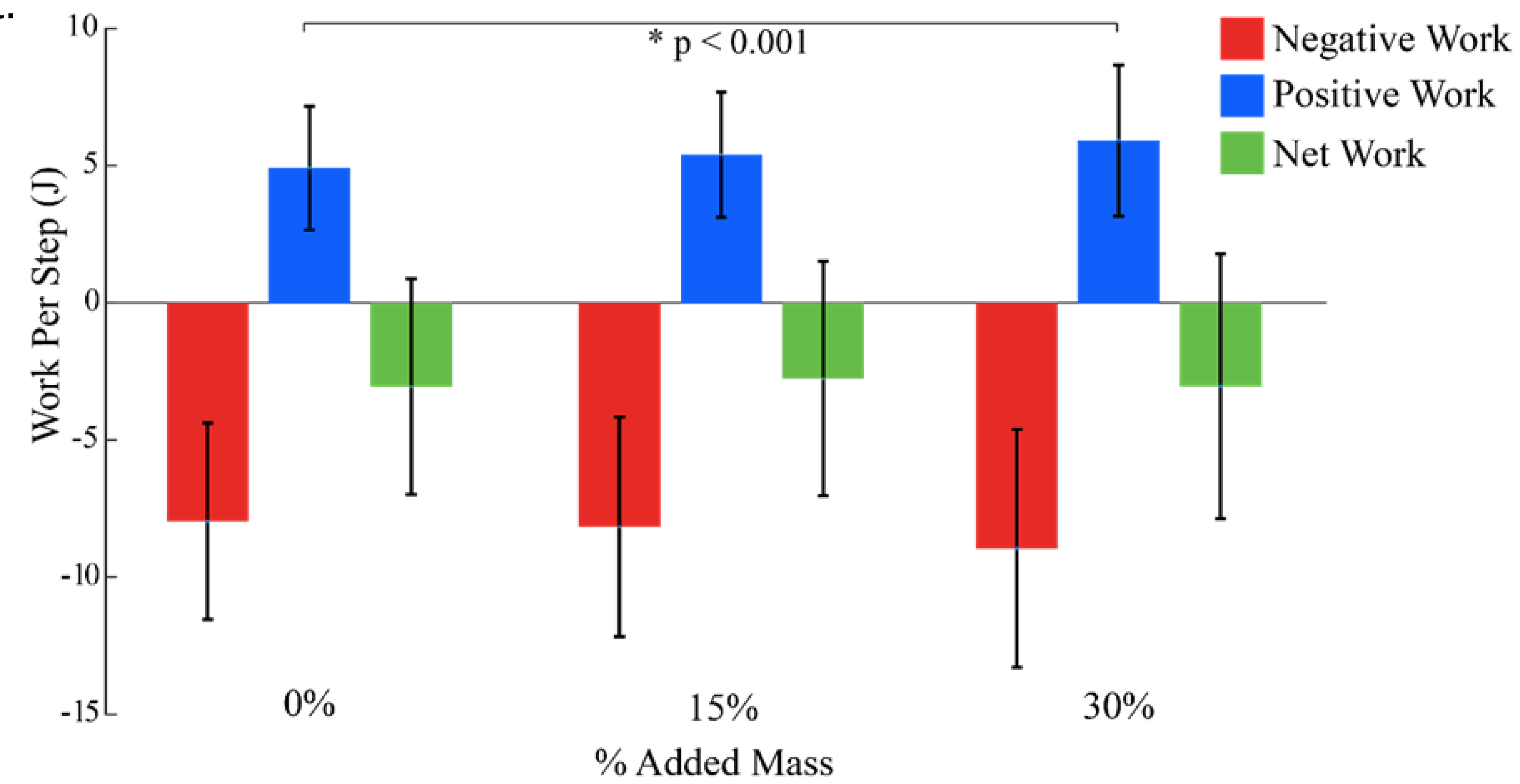


- Eighteen healthy, young participants completed barefoot walking over force plates in three randomized loading conditions (0, +15, and +30% of added body mass).
- The walking speed was targeted at 1.25 m/s (2.8 mph).
- We quantified power & work contribution of the foot structures distal to hindfoot (Figure 1.) using a unified deformable segment analysis [2].

Figure1. Ankle-foot structures distal to hindfoot (i.e., heel pad, arch, mtp joint).

RESULTS & CONCLUCIONS

Figure 2: Negative, positive and net work produced by the structures distal to the hindfoot.



- Walking with added mass caused a significant increase in the magnitude of positive work production (20% increase per 30% increase in added mass).
- Walking with added mass had no significant effect on negative (p = 0.055), and on net work (p = 0.402).
- Experimental results **failed to support our initial hypothesis**, as the **foot** increased the magnitude of positive work, and **preserved similar amounts of net negative work** (i.e., energy dissipated/absorbed) across varying levels of added mass conditions.
- Overall, the foot appears to have similar characteristics of a shock absorber-spring complex.

FUTURE APPLICATIONS

- Robotics.
- Prosthetic devices.
- Foot Pathology
- Rehabilitation & assistive devices.
- Shoes.

Figure3. Flexible foot prototype performing adaptation to different surface to manually applied force. Adopted from [3].

ACKNOWLEDGEMENDS

This work was supported by the NIH (P20GM109090 and R15HD086828 and the Center for Research in Human Movement Variability.

REFERENCES

1. Kelly, LA, et al. J R Soc Interface 102, 20141076, 2015
2. Takahashi KZ, et al. J Biomech 45, 2662-2667, 2012.
3. Eckert & Ijspeert. Dynamic Walking 2016, Holly, Michigan, USA, 2016.

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