Walking Boot Design Influences Offloading
Andrew R. Hillier, Seth C. Huber, Dylan J. Parry, Amy Mitchell Hayward, Jordan K. Grover, Dustin A. Bruening

Clinical Motivation
- Nearly 14% of individuals in the U.S. suffer from diabetes
- 15-25% of these individuals will suffer from a diabetic related ulcer in their lifetime
- More than 85% of foot ulcers are diabetes related
- As ulcers worse, infection, gangrene, and amputation become more likely

Current Treatment
- Controlled Ankle Motion (CAM) boots to offload plantar pressure while ulcers heal

Clinical Problem
- CAM boots offload forefoot well, but not heel
- Recurrence is common (40% in a median of 126 days)
- CAM boots immobilize joints and change gait

Proposal
- Test offloading ability of a novel spring-loaded walker boot (SB)
- Compare offloading among the traditional CAM boot (CB) with SB and a hinged walker boot (HB)

Hypotheses
- SB would reduce plantar pressure at the hindfoot compared to the CAM boot (due to greater offloading from foot to lower leg)
- HB would increase forefoot plantar pressure compared to CB (due to a more natural forefoot push-off)

Participants
- 10 healthy male participants (age = 26.6 ± 7.5, height = 180.1 ± 5.0 cm, mass = 81.5 ± 8.8 kg)

Protocol
- Participants tested 4 conditions (Fig 1) in random order:
- Unilateral R foot tested - shoe lifts used on L foot to maintain leg length symmetry
- After acclimation, participants forces were measured while walking:
  - Instrumented insoles measured pressure distributions inside boots
  - In-ground force platforms measured total force

Data Analysis
- Metrics:
  - Peak vertical force on foot (from insoles)
  - Peak vertical force on boot (from force plate)
  - Peak pressure under forefoot
  - Peak pressure under hindfoot
- Statistics:
  - Comparisons among the four conditions
  - 1-way ANOVAs (α=0.05) with Holm post-hoc tests

Results
- Peak pressure (Figure 3):
  - Hindfoot:
    - SB 65% lower than SH
  - Forefoot:
    - SB 41% lower than SH
- Insole vertical forces (Figure 4A):
  - Similar among CB, HB, and SH
  - SB had 50% lower first peak
  - SB had 26% lower second peak
- Boot vertical forces (Figure 4B):
  - Similar among all conditions
  - Slightly delayed peaks in SB

Conclusions
- The traditional CAM boot was not statistically different from shoes in our measurements, suggesting that offloading is poor.
- The hinged boot did not change loading patterns.
- The spring boot offloaded the heel effectively, but also the forefoot, showing great promise for future diabetic ulcer treatment.

References