

Battlefield Mobility: Analyzing Vertical Walking Loads on Fracture Treatments after a Lower Extremity Fracture

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05 August 2026



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Background



PROBLEM:

- » SM acquire lower extremity fractures in the field.
- » With delayed medical evacuation they need to maintain independent ambulation.

Karlberg et al., 2015; The US Army in Multi-Domain Operations 2028, 2018

POTENTIAL SOLUTION:

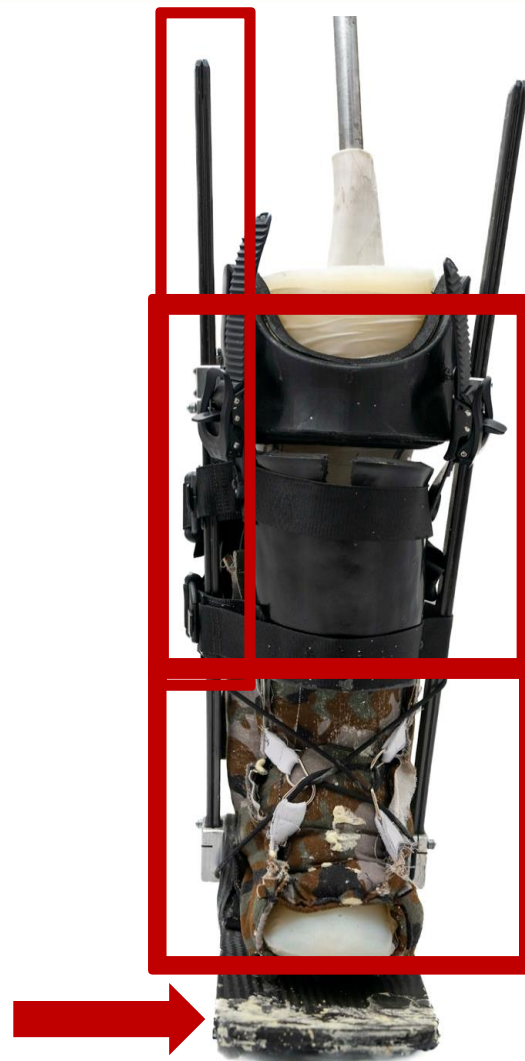
- » Triton Systems Inc. **S**prayable **U**niversal **P**oint-of-injury **O**rthosis for **R**apid **T**reatment (S.U.P.O.R.T.)

BENEFITS:

- » Stabilizes Foot/Ankle Fractures
- » Offloads fractures
- » Enables mobility on-site



- » Offloading Cuff
- » Load Support Struts
- » Footplate
- » Spray Foam Cast



Study Objective

Evaluate S.U.P.O.R.T. tibia fracture stabilization compared to standard devices for fracture stabilization.

Device Conditions

S.U.P.O.R.T.



CAM BOOT



SAM SPLINT



NO DEVICE
CONDITION



Experimental Setup

Surrogate Models: 5th% Female, 50th% Male, and 95th% Male.

Injury Simulation: Closed lower extremity fracture (20 mm tibial segment removed).

Mechanical Apparatus: Instron Materials Testing System.

Kinematic Tracking: NaturalPoint Motion Capture System.

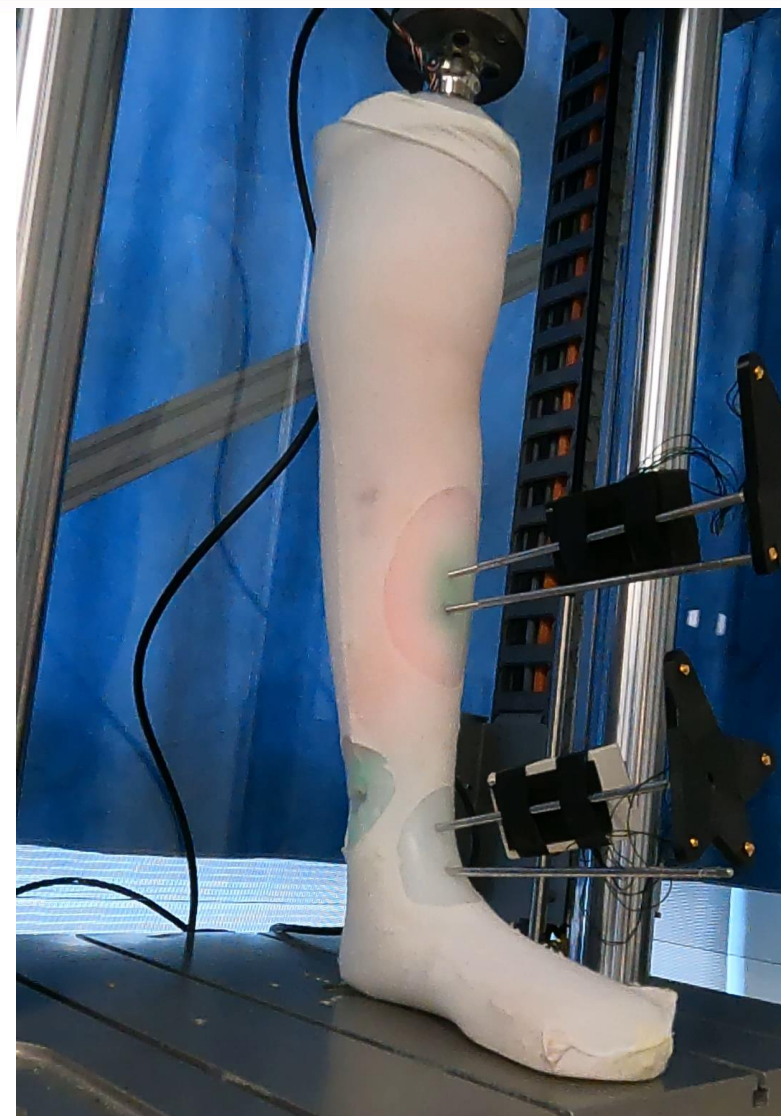
Sensor Placement: Marker arrays mounted directly to ridged bone pins.



Study Protocol

INSTRON MACHINE TESTING:

- » Cyclical Compressive Loads.
- » Loading: 40 mm downward displacement.
- » Unloading: 40 mm upward retraction (full disengagement).
- » Cycling at 0.75 Hertz.
- » Duration: 1 test of 250 cycles continuous cycling per condition.



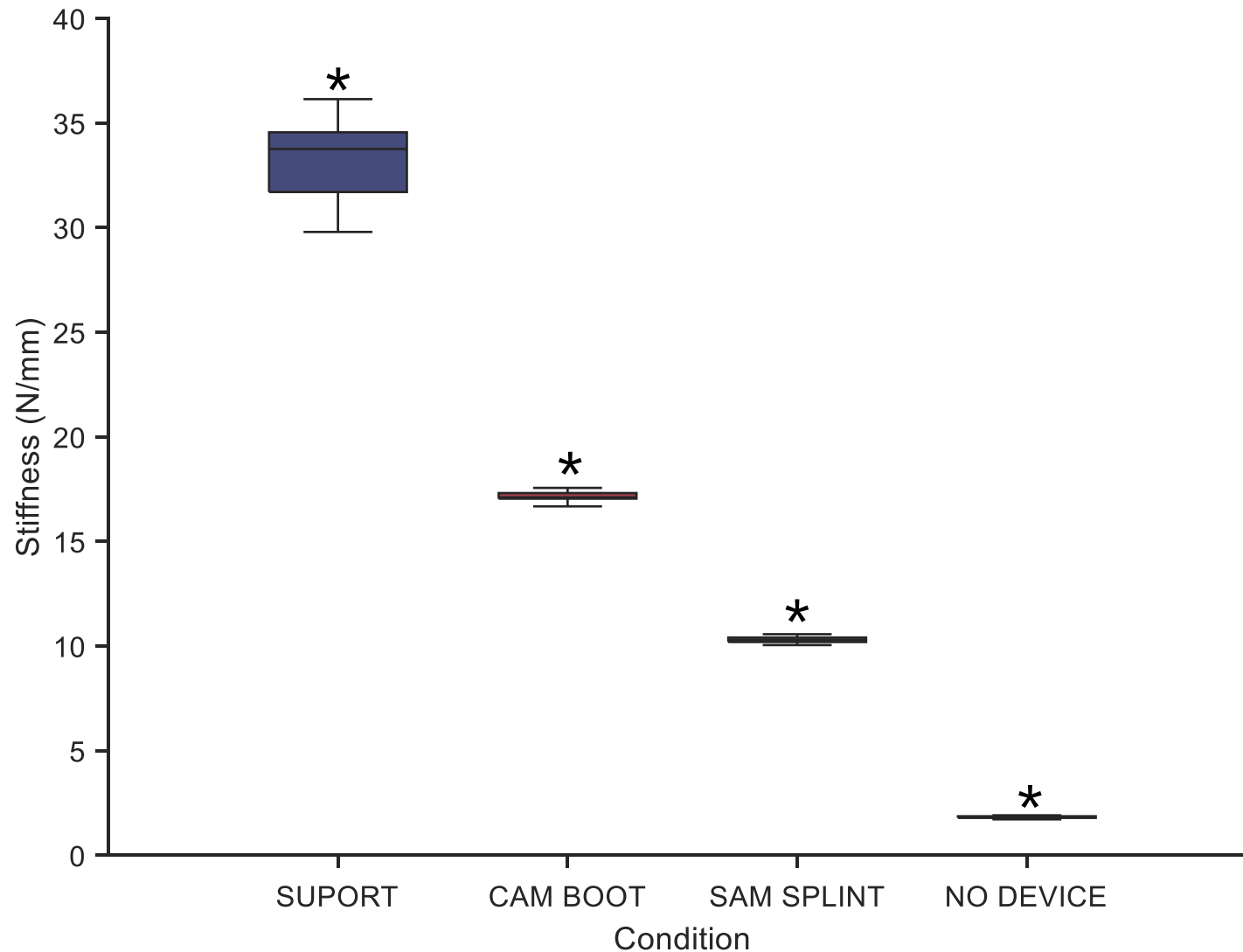
OUTCOME MEASURE:

- » Axial stiffness correlates to fracture stabilization.

STATISTICAL TESTING:

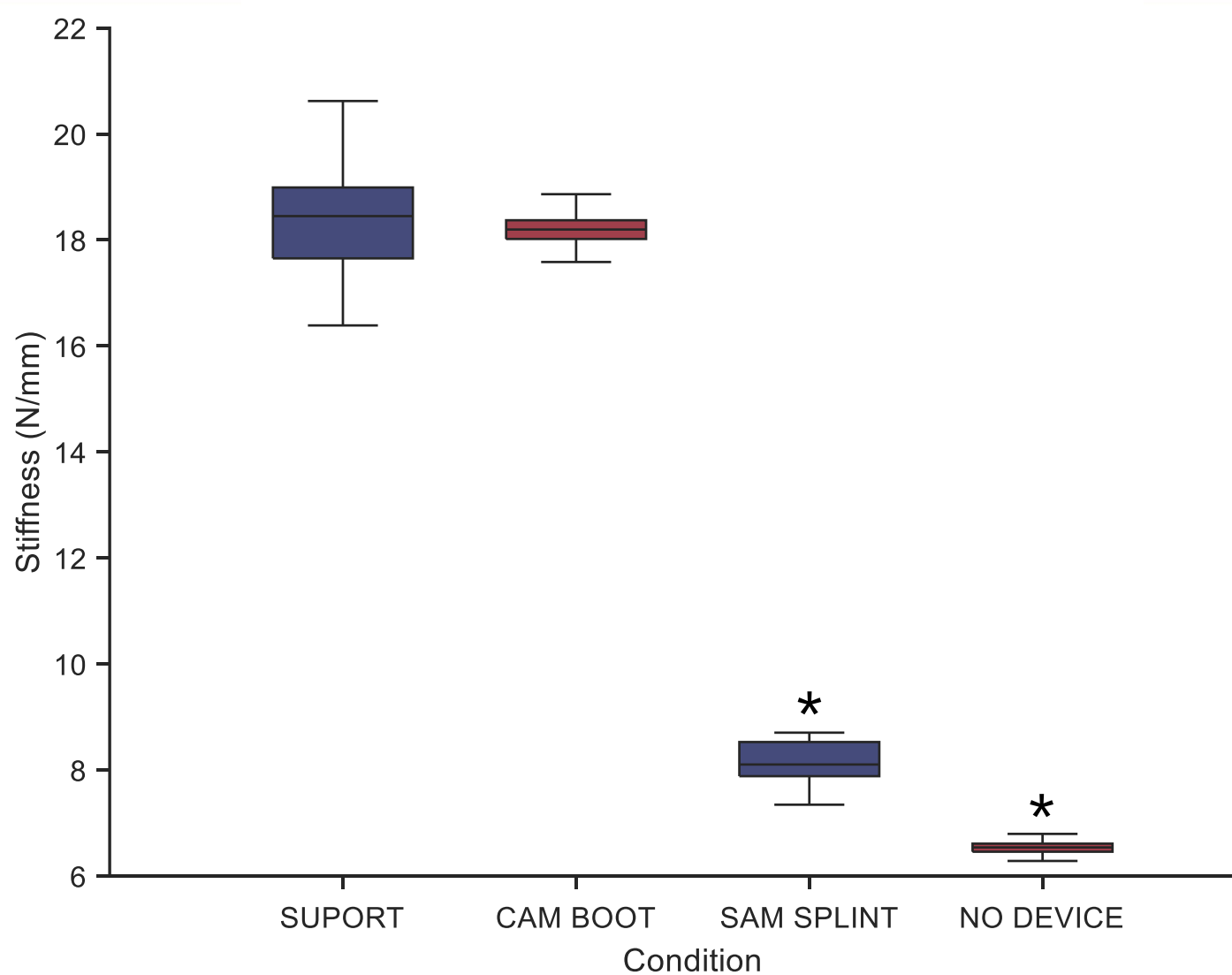
- » Two-Way ANOVA:
 - » Fixed effects of surrogate size (5th Female, 50th Male, & 95th Male).
 - » Fixed effect of device (S.U.P.O.R.T., CAM BOOT, SAM SPLINT, & NO DEVICE).
- » Post Hoc Tukey's Honestly Significant Difference test ($\alpha=0.05$).

Leg Stiffness Across Devices: 5th Percentile Female



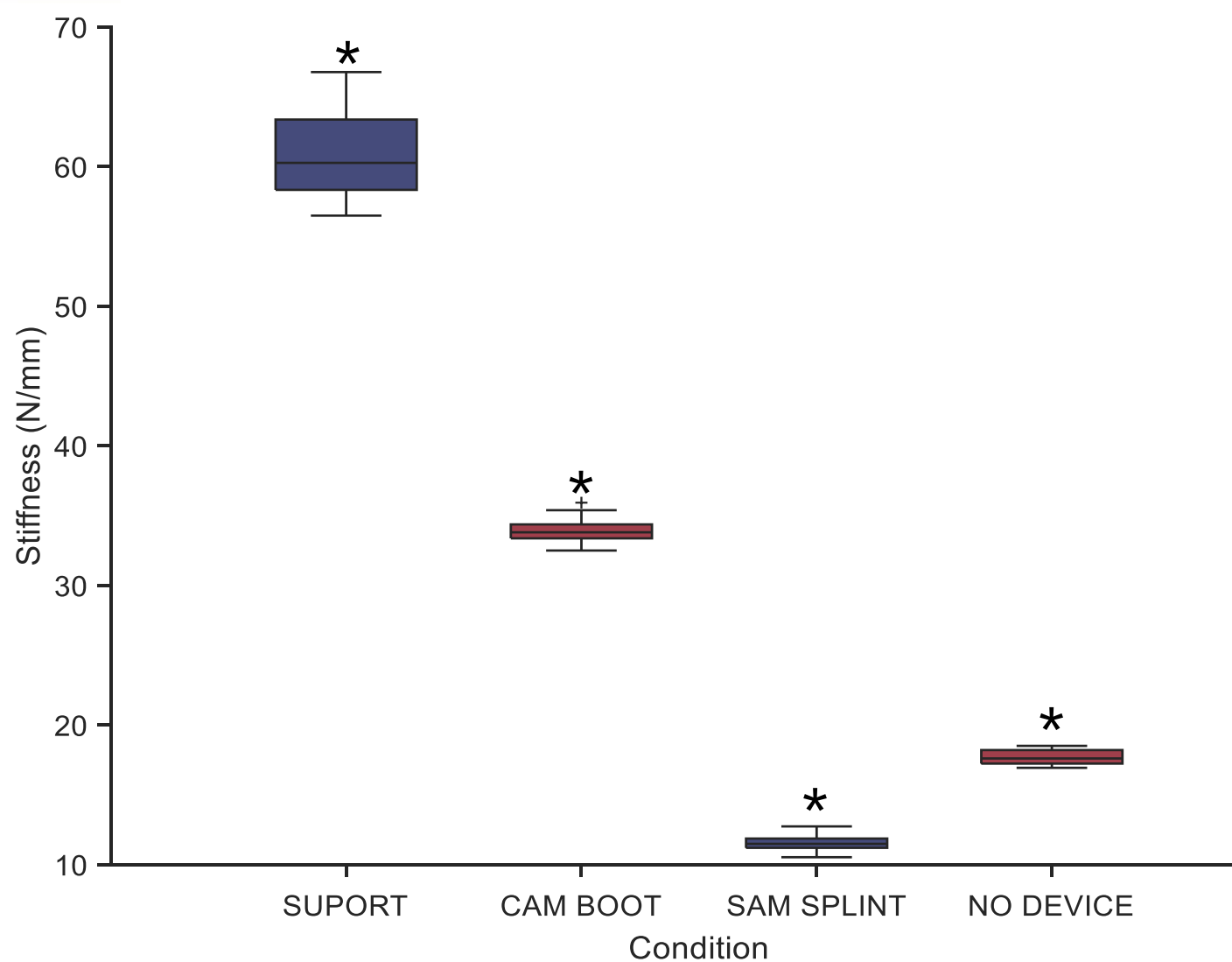
* represents $p < 0.05$ for all comparisons

Leg Stiffness Across Devices: 50th Percentile Male



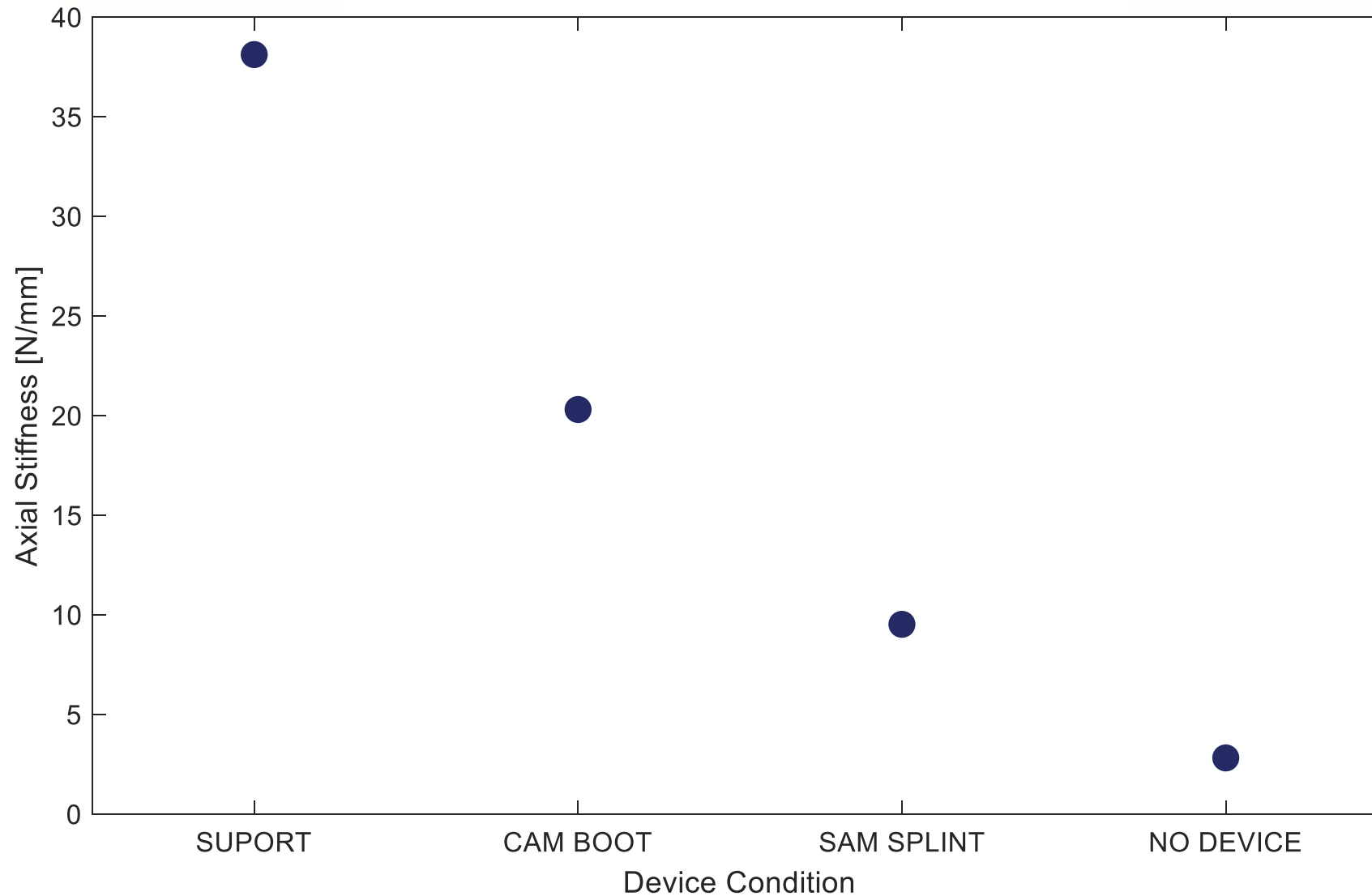
* represents $p < 0.05$ for all comparisons

Leg Stiffness Across Devices: 95th Percentile Male

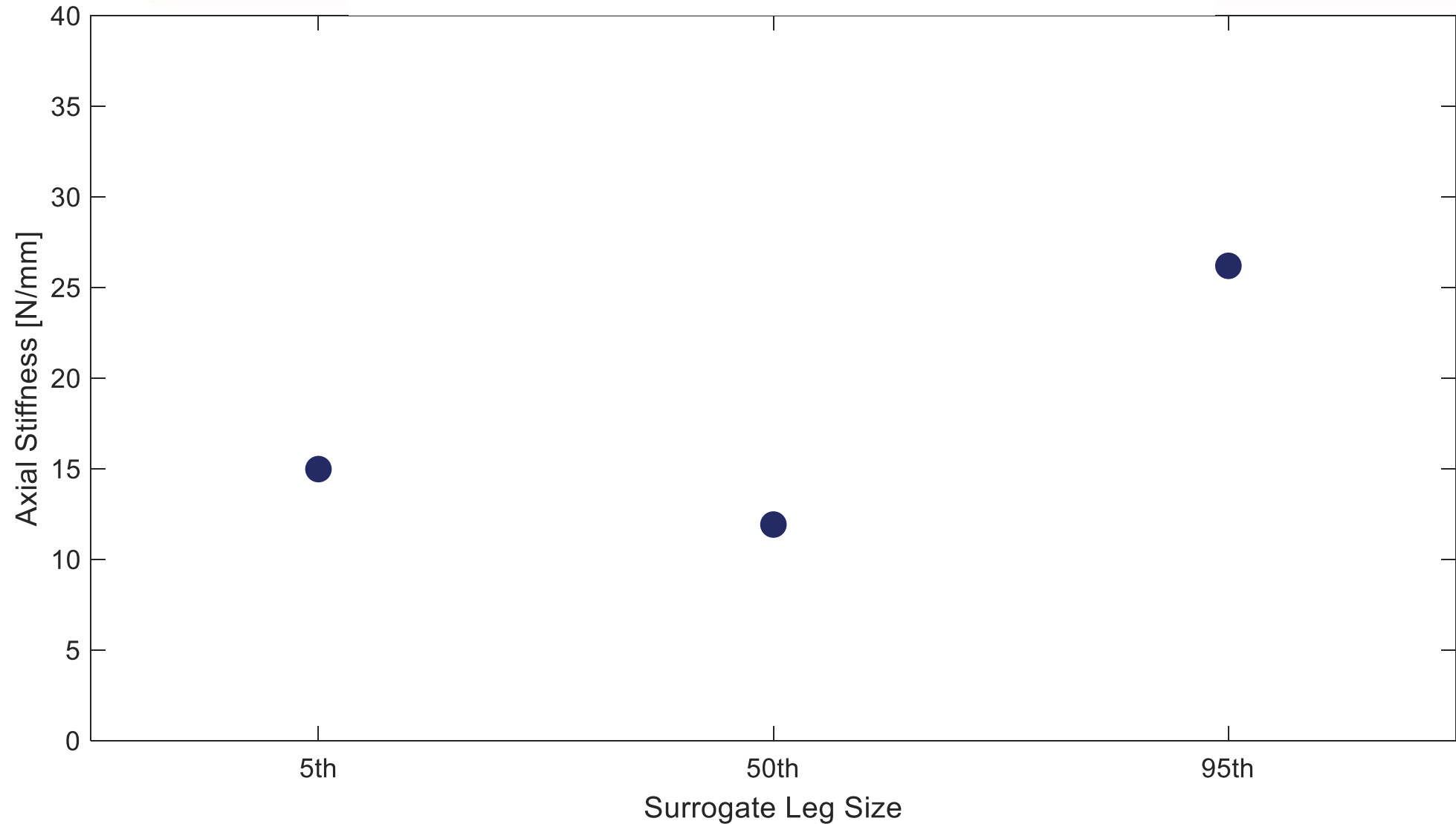


* represents $p < 0.05$ for all comparisons

Comparison of Surrogate Size Across Devices



Comparison of Device Across Surrogate Sizes



- » Overall, we see regardless of surrogate size, SUPPORT has the highest stiffness.
- » S.U.P.O.R.T. isolates the fracture site by suspending on the upper calf and transferring loads around the fracture, increasing weight-bearing potential.
- » Non-linear correlation of surrogate size warrants further investigation.

Conclusion

Primary Outcome: The S.U.P.O.R.T. system exhibited the highest axial stiffness (an indirect measure of fracture stability).

Significance: Both the medical device type and bone surrogate size significantly impact fracture stability ($p < 0.05$), highlighting that an optimal fit to the leg is essential for ensuring optimal fracture stability.

Questions



QUESTIONS?

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“Military medicine is not just about treating injuries; it’s about ensuring the health and readiness of those who serve, so they can accomplish their mission and return home safely.”

- MG Paula C. Lodi, Commanding General, USAMRDC

External Fixator

- » Goal: Restore bone length, alignment, and rotation
- » Protection: Safeguard surrounding skin and soft tissue
- » Not intended to sustain walking loads

