Computational Modeling Related to Blast Exposure

Modeling the Effects of Boots on Leg Injury Mitigation in Underbody Blast Events

A finite element model (FEM) of the human lower leg was developed from Computed Tomography scan data to simulate the response of the lower extremities to representative underbody blast (UBB) exposures. The model was validated against available experimental data using Post-mortem Human Surrogates. Simulations were run for both booted and unbooted conditions to assess the efficacy of boots to mitigate forces being transmitted through the floor into the lower leg, and to help quantify the associated risk of injuries to the Service member. Simulations performed at varying levels of impact mass and velocity showed reductions of 34-40 percent in peak forces transmitted to the tibia. The FEM was used to evaluate the effect of individual variations in lower extremity structure. Service members possessing more compliant plantar ligaments, higher foot arches, and thicker heel pads may be less likely to sustain injuries compared to other individuals with similar total body mass (*Hampton 2017, Hampton and Kleinberger 2016, 2017a, 2017b, 2017c*; Figure 1).

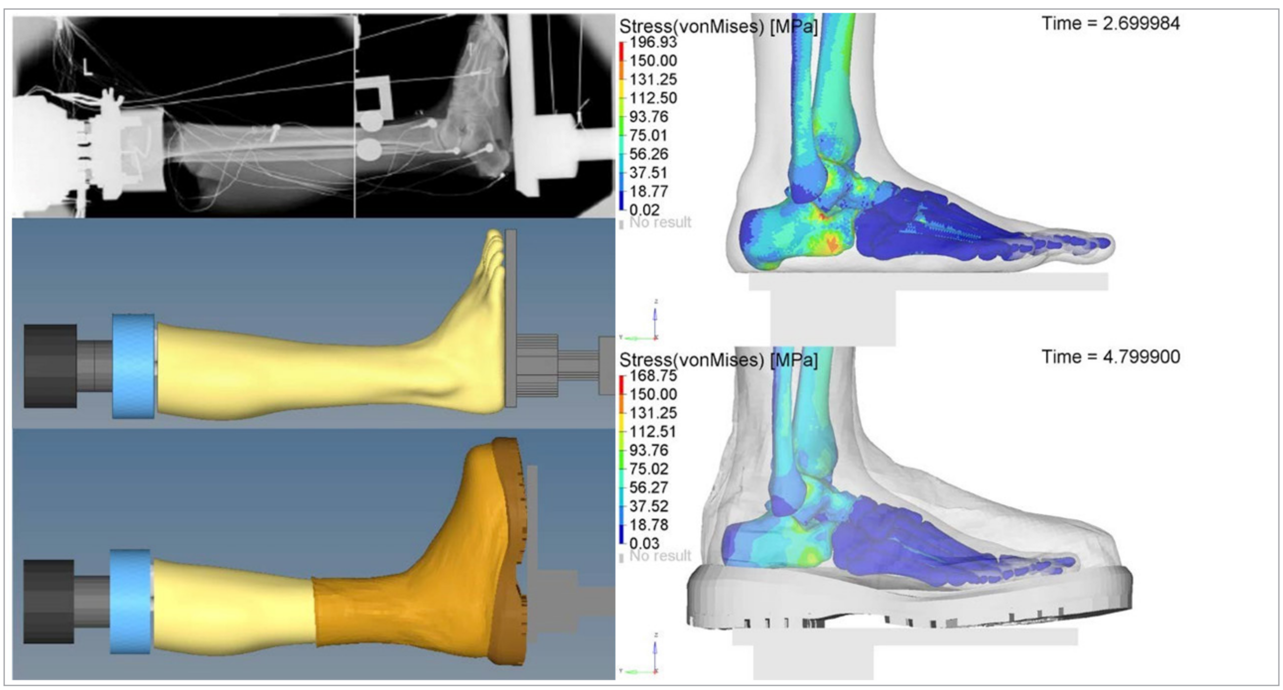

FIGURE 1: The figures above leverage the numerical lower leg to analyze select anatomic variations (plantar ligament stiffness, foot arch height, and heel pad thickness) for individual Service members. These studies provide insight into which anatomic features are most relevant in prevention of UBB injury, and reasons why injury outcomes may vary between individuals exposed to the same threat. (Figure used with permission from the authors)

A validated FEM can be used to assess Service member response to potentially harmful events, such as blast and ballistic loading. The lower leg model being described here has been used to evaluate the protective effects of boots, and is helping to design and assess the performance of future improvements to personal protective equipment and other protective technologies. This can include both Service member and vehicle-borne systems. The ability to include subtle anatomic variations will help support probabilistic methods expanding these injury risk evaluations to a population level response.

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