

Diagnosis of Injury to Axially Impacted Foot-Ankle-Leg Complexes by Use of Dermestidae

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Conflicts in the Gulf have given rise to warfighter injury by means of improvised explosive device (IED) detonation beneath armored military vehicles, commonly referred to as underbody blast (UBB). Injuries to the foot-ankle-leg, along with the pelvis, number among those most commonly sustained by warfighters in the event of a UBB. These injuries, though in many cases not directly life threatening, can cause potential issues with post-blast evacuation.

In a previous study of 38 legs tested under automotive and UBB load rates, a distribution of foot-ankle-leg injuries were produced. Techniques including high-speed x-ray video, post-test CT, and dissections were used to document injuries. The calcaneus alone contains attachments to numerous ligaments and tendons, making it a daunting task to sufficiently clean the bone to diagnose injury. Since the calcaneus is primarily composed of trabecular bone surrounded by a thin, fragile cortical shell, the act of removing the periosteum can readily induce artificial damage. The talar surface is almost entirely enveloped with articular cartilage, potentially concealing hairline and other less severe fractures. In removing this tissue, it is common to cut into the bone while dissecting with a scalpel, making it difficult to distinguish between injury and artifact.

A maceration technique that sufficiently denudes bones to allow for injury diagnosis, and preserves mechanical properties of bone for later testing, was necessary. Subcutaneous cuts to the dermis were made with a scalpel while surgical scissors were used to cut ligaments and tendons. A species of flesh eating beetles known as Dermestidae was employed to evaluate their ability to rid bones of soft tissue and cartilage, and to expose any hidden fractures.

All bones were inspected before and after Dermestidae maceration. Talus and calcaneus bones were macerated for 24 hours and then treated in India ink to aid in visual inspection. Dermestidae macerated 31 tali and 18 calcanei revealing 12 and 4 injuries, respectively, that were previously undiagnosed.

In the total study, 22 talus and 26 calcaneus injuries were diagnosed. Without Dermestidae, the amount of documented injuries would have been 10 talus and 22 calcaneus. Thorough identification of injuries is essential to ensure accuracy in statistical models such as injury risk functions. Logistic regressions were produced to quantify the significance of the findings. The pre- and post-maceration regressions predicted a 50% injury risk of 6626N and 4228N, respectively, or a 44% difference in mean. This study demonstrates that undiagnosed injuries allow such models to over-predict injury tolerance, imposing issues with automotive and military vehicle design, and subsequent injury mitigating techniques.