Abstract

Title: Simulation and experimental evaluation of the effects of small ammunition bullets entering a bulletproof vest

Objectives: The main objectives of the study were: parameterization of the wounding effects of bulletson artificial materials, quantification of bullet impacts using international and experimental gunshot wounding criteria, parameterization of the mechanical characteristics of polymer fibers used in bulletproof vests, objectification of the deformation effects of missiles on soft biological tissues and creating a simplified analysis of ballistic missile interaction.

Methods: In this study, experiments were performed on two artificial materials: food gelatine and glycerine soap. Calculated values and individual parameters are reported for 9 mm weapon systems. The experiments were performed in a ballistic test laboratory under standardized conditions. Data processing and parameterization of shape changes were performed using computed tomography (CT), micro-CT,ultrasound elastography and 3D scanning. Other devices used were infrared vibration spectroscopy and high-speed camera. We used the collected datato create analytical relations describing the mechanical effects ofthe material under a bulletproof vest..

Results: The area of greatest impact for the ammunition was 1.48 - 1.6 times the diameter of the projectile used. During propagation of the deformation waves through the artificial material convective waves were diminished and a sudden jump deformation occurred with a large dissipation of mechanical energy at a distance of 64.35 ± 21.45 mm under bulletproof vest. Using the maximum acceleration of the plane wave (82.3 m^2/s) and the axial symmetric waves (10.1 m^2/s) we are able to predict traumatic damage to soft tissues in the body.

Keywords: Wound Ballistics; Substitute Materials; Gunshot Wound Criteria, Bulletproof Vest, Missile Interactions, Deformation Wave, Traumatic Injuries