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Computational Modeling and Analysis of Wound Formation in Gunshot Injuries

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Abstract

This research aims to investigate the physical processes accompanying high-speed element penetration in gunshot wounds and understand the formation of wound channels, trajectory characteristics of bullets, and damaging effects on surrounding tissues. The study utilizes 3D computer modeling to simulate high-speed element penetration based on the 3D finite element method (FEM).

The paper presents a methodology of computer simulation with mathematical basics and algorithmic descriptions. The approach uses direct explicit numerical integration over time for the impact of the metallic bullet into the gelatin block specimen that analyses within the framework of its plasticity considering the nonlinear pressure dependence in a shock wave. The algorithm of simulation incorporates the process of material destruction, where elements that reach critical strain values are removed from the model. The study provides insights into the behavior of different bullet types and their impact on tissue deformation from computational experiments that simulate the penetration into ballistic gelatin of two types of bullets, the 7H6M type, and the V-max type. The simulation results reveal the distribution of equivalent stresses in the wound channel at different moments in time. Additionally, the study analyses the penetration depth and diameter of the damaged material for both bullet types. The developed 3D computer modeling method can serve as a valuable tool for further investigations, facilitating the development of advanced medical treatments.

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Keywords: gunshot injuries, soft tissue damage, wound dynamics, finite element method (FEM), penetrating impacts

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