Injury Models

Computational Modeling of Primary Blast Injury to the Eye

Researchers from the Johns Hopkins University Whiting School of Engineering are conducting research funded by a DHP grant through USAMRMC's CDMRP Vision Research Program to develop a validated computational model of the human eye globe to investigate injury mechanisms of a primary blast wave from an IED, which has accounted for 70 percent of the blast injuries in Iraq and Afghanistan. The model determines the stresses on and deformations to the eye globe and surrounding supporting structures to enable the development of more effective eye protection strategies. This application includes detailed anatomical and tissue features, and sophisticated mathematical techniques to model the movement of the blast wave and the transfer of energy when the blast wave hits the human face. The team is collaborating with scientists from the ARL to develop a geometric model of the head representing an average 21-year-old male, and models of spectacles and goggles currently approved for military applications. The model simulates the effectiveness of spectacles and goggles in reducing the blast pressure loading on the eye. The simulations reproduced the conditions of field blast in experiments performed by collaborators at the Army Test Center measuring blast pressure at the eye location of an instrumented FOCUS Head form model. Both spectacles and goggles dramatically reduced the peak pressure loading to the eye, but still allowed a small fraction of the blast wave to "under wash" through small gaps and reverberate between the surfaces of the goggles and the face. The goggles permitted a smaller amount of under wash, thus more effectively reducing the peak pressure loading compared to spectacles. The spectacles directed the flow along the lens and away from the eyes through the opening at the temples. However, the tighter fit of the goggles trapped the under wash in front of the eyes for a longer amount of time. As a result, the pressure loading on the eyes behind the goggles became higher than the pressure loading on the unprotected eyes and eyes behind the spectacles after 0.6 milliseconds post-impact from the blast wave.