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Stress wave propagation and cavitation in gelatin due to ballistic impact

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Gelatin is commonly used as a surrogate for characterizing soft tissues response including injury mechanisms in humans. However, characterization of high rate response of such soft material using conventional techniques is difficult due to large difference in shear and pressure wave speeds and inertia effects. Limited high pressure data exists for this material. We carried out plane-strain and ballistic experiments on ballistic gel and a synthetic gel made from thermoplastic elastomers as surrogate system to investigate stress wave propagation and cavitation as a potential injury mechanism for behind helmet blunt trauma. The stress wave generated from ballistic impact was recorded with piezoelectric pressure gages. In addition to monolithic gel blocks, experiments were also conducted with gel blocks where air bubbles was preplaced to investigate negative pressure regime that may lead to cavitation. High speed camera recorded the wave motion and bubble dynamics utilizing the transparency contrast and densification of the gel. The bubble dynamics was correlated with measured pressure. The cavitation threshold correlated well with theoretical estimates of cavitation threshold of these materials. We utilized both numerical simulations to obtain insight into the nature of stress wave propagation. The experimental measurements and simulations provide significant insight into potential injury mechanism arising out of stress wave and consequent large deformation of the soft material.

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