
Blast fragment protection for the extremities

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Abstract

Explosive devices are the main threat in contemporary battlefields. Due to their fragmenting designs, penetrating trauma by blast fragments are the most common among the blast injuries, especially to the extremities. These fragments, such as casings, glass shards, or stones can penetrate the extremities at a velocity of up to 600 m/s and cause serious injuries with high infection risk, slow recovery rate, and potential amputation. However, the current personal protective equipment offers little to protect the extremities against these blast fragments. This study assessed the performance of single layers of common ballistic protective materials such as silk, Kevlar, Twaron, and shear thickening fluid solutions with the view of utilising them as potential lining materials to combat clothing. Experiments were carried out using a gas-gun system, with a 0.78-g cylindrical fragment simulating projectile (FSP) as the impactor, and ballistic gelatine as the backing material. Impact velocities at 25, 50, and 75% risk of complete material penetration, gelatine penetration, and significant wounding to soft tissue were used as metrics to rank the performance of the materials tested. The top three materials were subsequently combined and re-tested as a single lining layer against impact with 0.78-g and 1.10-g cylindrical FSPs. The resultant thin and light-weight hybrid construction could offer meaningful protection to the extremities while having minimal impact on the mobility of the users.

Keywords: lower extremity, injury, fragment, FSP, gas gun, blast, penetration

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