EAR OVERPRESSURE PROTECTION TESTING USING A SIMLUATED EAR CANAL

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One of the most sensitive human organs to blast overpressure is the ear. While typically not life-threatening, eardrum perforation from blast exposure affects quality of life. As such, individuals likely to be exposed to blast (e.g. bomb technicians, soldiers potentially exposed to improvised explosive devices, explosive breaching, large weapons fire training) should be provided with adequate ear protection. A simple methodology to quantify ear blast overpressure protection involves the use of simplified headforms, which could, for instance, include a single, flush-mounted hole placed at the approximate location of the ear. Tests can then be conducted with and without ear protection (integrated or not to a helmet) to obtain a reduction in overpressure measured at the simplified ear location. This represents a consistent and straightforward approach in determining the protection afforded by “earmuff” style protection. Unfortunately, the use of a flush pressure sensor is not a suitable approach to test the effectiveness of earplug style protection, which requires a more realistic ear shape to fit the earplug. Moreover, due to the complexity of the submerged ear canal, additional shock interactions are missed.

To address this gap, a 3D-printed headform comprising a realistic ear canal was developed. This headform can don both earmuff and earplug style protection for the ear. This headform was exposed to shocktube and full-scale explosive air blasts of 28 and 63 kPa overpressure, at a variety of orientations to the blast, meant to be representative of potentially injurious overpressure exposure, when no protection is employed. While the reductions in ear overpressure observed for earmuff type protection were similar when comparing the two headform types (headform with flush-mounted sensor vs. headform with realistic ear canal), the detailed ear canal allowed for the evaluation of earplug protection. Results indicate that the more invasive earplug-style protection provides the highest level of protection. Moreover, unsurprisingly, the combination of the two types of ear protection, used in concert, yields optimal protection results. This novel approach is made possible by having access to the recently developed realistic ear surrogates, with can be used to further optimize ear plug styles and designs.