Neurological impairments following mild blast-induced traumatic brain injury: a multidisciplinary investigation

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Mild blast-induced traumatic brain injuries (mbTBIs) have been labeled as the “signature injury” of modern warfare, accounting for the majority of combat head trauma. Many reports show compelling evidence that, even in the absence of acute noticeable symptoms, mbTBI can cause long-term brain damage leading to dire mental and neurological consequences. The social impact is reflected by the disturbing phenomena of combat veterans struggling to reintegrate into civilian life and frightening rate of suicide among soldiers that has heightened public interest and the urgency to deter this unsettling trend. However, keen research effort has been hampered by the limitations of human studies, insufficient animal models, and technical difficulties. To this end, we have established a unique and clinical relevant rat blast injury model. Further, we have obtained the first evidence in an animal mbTBI model of: 1) intracranial deformation, 2) a promising molecular diagnostic biomarker and target for treatment (acrolein) that correlates with nerve tissue deformation and mental abnormalities, 3) psychosocial deficits recapitulating human struggles with societal reintegration following mbTBI, and 4) heightened susceptibility to Parkinson’s diseases follow mbTBI. Ongoing studies, using novel neuroengineering technologies and an array of cross-disciplinary approaches, are aiming at revealing the degree of tissue deformation, resultant primary (physical-instantaneous) and secondary (biochemical-delayed) injuries in the brain region known to be critical for the psychosocial behavior and other motor (basal ganglia) and sensory (auditory) functions. It is expected that this line of investigation will facilitate the understanding of key pathological mechanisms, identification of novel treatment strategies that will prove capable of preventing, mitigating, or reversing blast-induced brain damage and, in turn, reduce the ultimate incidence and impact of post-deployment neuropsychiatric dysfunction.