

Abstract

Intracranial strain is considered a primary injury mechanism associated with mild traumatic brain injury (mTBI) or concussion resulting from blunt impact. Deformable physical headforms provide a promising approach for directly measuring *in situ* intracranial strain; however, their biofidelity depends on how anatomical constraints, skull–brain interface conditions, and tissue-simulant properties are represented. This seminar presents a series of studies examining how these boundary conditions influence intracranial displacement and strain during blunt impact.

A deformable three-dimensional headform (BIPED Mk2), originally developed by Defence Research and Development Canada (DRDC), was adapted to enable direct measurement of intracranial deformation. Radiopaque markers were embedded within the brain surrogate and tracked using high-speed X-ray imaging during impact. Digital image correlation was used to calculate full-field displacement and strain from the recorded X-ray image sequences. The effects of the tentorium and brainstem, the pia–arachnoid complex, and brain-simulant stiffness were investigated under controlled frontal impacts.

The studies demonstrate that changes in these boundary conditions can influence the spatial distribution, magnitude, and temporal characteristics of intracranial response. The 3D deformable headform and imaging approach introduced in this work extend previous deformable headform measurements from 2D to 3D geometry, enabling direct measurement of *in situ* intracranial displacement and strain and comparison with corresponding PMHS datasets. Quantitative evaluation of the agreement between headform and PMHS responses further identified biofidelity gaps and provided guidance for future refinement of physical headform designs.

Bio

Sheng Xu is a Ph.D. candidate and a member of the Impact Research Lab at Carleton University. His research focuses on head injury biomechanics, particularly the improvement of deformable headform design and the evaluation of helmet liner performance using high-speed X-ray imaging and digital image correlation.