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Modeling Blast-Related Traumatic Brain Injury

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ABSTRACT

Traumatic brain injury (TBI) has been recognized as a significant cause of death and disability that imposes enormous costs on society. Most studies of TBI thus far have focused on TBI caused by blunt impact, such as occurs during traffic accidents, sports collisions, and falls. A number of studies have used finite element models of the human head to simulate blunt impact leading to TBI and to develop injury criteria [1,2,3]. Recently, though, the conflicts in Iraq and Afghanistan have highlighted the importance of military TBI, which may be caused by blasts in addition to (or rather than) blunt impacts. Little is currently known about the effects of blasts on the central nervous system; injury thresholds have not been established, and even direct transmission of the shock wave into the brain is disputed. Here, we simulate a blast wave traveling through a human head using coupled fluid-solid solvers and a comprehensive finite element model of the human head consisting of differentiated tissues and structures. We demonstrate that during a blast event, the brain is subjected to conditions well in excess of the threshold values of the accepted brain injury criteria for impact conditions, suggesting that the primary effects of a blast constitute a plausible cause for TBI.

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