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A Finite Element Model of the Head and Neck for Automotive Impact Applications

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A finite element (FE) model of the head and neck was developed to improve understanding of mechanisms of traumatic brain injuries (TBI) during vehicle collisions and to aid in the design of injury countermeasures. The FE model was developed based on the reconstructed geometry of a volunteer close to the anthropometry of a 50th percentile male. The model has more than 293,000 nodes and 1,173,000 linear tetrahedral elements included in 47 distinct components (parts). The material and structural properties were selected based on a synthesis of current knowledge of the constitutive models for each tissue. The cerebrospinal fluid (CSF) was simulated explicitly as a hydrostatic fluid by using a surface-based fluid modeling method, which allows fluid and structure interaction. The model was validated in the loading condition observed in frontal impact vehicle collision. These validations include the intracranial pressure (ICP), impact force and intracranial acceleration response. In addition to very good predictions in terms of biomechanical response and injuries, the model showed stability at severe loading conditions. Overall results obtained in the validation indicated improved biofidelity relative to previous FE models. The model may be used for improving the current injury criteria of the brain and anthropometric test devices. Furthermore, the present head and neck can be coupled together with other body region FE models into the state-of-art human FE model to be used in the field of automotive safety.

Keywords: **Head and neck, Finite element, Model validation, Biomechanical response, Vehicle collision**