Skull fracture prediction

Reliable computer models are needed for a better understanding of the physical mechanisms of skull fracture in accidental hits, falls, bicycle-motor vehicle & car accidents, and assaults. The performance and biofidelity of these models depend on the correct anatomical representation and material description of these structures. In literature, a strain energy criterion has been proposed to predict skull fractures. However, a broad range of values for this criterion has been reported. This study investigates if the impactor orientation, scalp thickness, and material model of the skull could provide us with insight into the influencing factors of this criterion. 18 skull fracture experiments previously performed in our research group were reproduced in finite element simulations. Subject-specific skull geometries were derived from medical images and used to create high-quality finite element meshes. Based on local Hounsfield units, a subject-specific isotropic material model was assigned. The subject-specific models were able to predict fractures that matched visually with the corresponding experimental fracture patterns and provided detailed fracture patterns. The sensitivity study showed that small variations in impactor positioning as well as variations of the local geometry (frontal-temporal-occipital) strongly influenced the skull strain energy. Subject-specific modeling leads to a more accurate prediction of the force-displacement curve. The average error of the peak fracture force for all 18 cases is 0.4190 for the subject-specific and 0.4538 for the homogeneous material model, for the displacement; 0.3368 versus 0.3844. But it should be carefully interpreted as small variations in the computational model significantly influence the outcome [1)]

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De Kegel D, Meynen A, Famaey N, Harry van Lenthe G, Depreitere B, Sloten JV. Skull fracture prediction through subject-specific finite element modelling is highly sensitive to model parameters. J Mech Behav Biomed Mater. 2019 Aug 7;100:103384. doi: 10.1016/j.jmbbm.2019.103384. [Epub ahead of print] PubMed PMID: 31419751.