Dynamic finite element analysis of the human maxillary incisor under impact loading in various directions

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Abstract

The aim of this study was to investigate fracture patterns occurring when a human upper central incisor is subjected to impact loadings at various angles. A two-dimensional finite element (FE) model of the maxillary incisor and surrounding tissues was established. The structural damping factor for the tooth was then calculated and assigned to the model. Dynamic FE analysis was performed to stimulate the associated impacts. Time-dependent traumatic forces at 0 degrees, 45 degrees, and 90 degrees labially to the long axis of the tooth were applied to the model. Von Mises's equivalent stress contours within the FE models were calculated. Our results indicated that tooth damping lagged behind peak stress by 0.05 ms. In addition, we found that impact direction played an important role in terms of outcome for the fractured incisor. These results can, in part, explain the mechanisms underlying the alternative outcomes when upper incisors are subjected to impact.