Effects of damping properties on the response of the maxillary central incisor subjected to a traumatic impact force

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Abstract

Maxillary central incisors are considered to be the most-frequently involved teeth when an impact occurs. The outcome of such an impact can include crown and root fracture, tooth looseness, and chronic or acute pulp necrosis. Although there have been many studies focusing on dental trauma, most investigations paid attention to the pathology, epidemiology, and clinical treatment. The relationships between the mechanical response of an injured tooth and the characteristics of the applied force are still unclear. This is due, at least in part, to most biomechanical studies of dental trauma using impact models which were simplified to a static load applied to a tooth with elastic properties. In this study, the damping ratio of the maxillary central incisor was measured by means of in vivo modal testing experiments. Then, we used the dynamic finite element method to calculate the response of a tooth impacted by a dynamic force. The effects of the damping properties on the stress distribution of the impacted incisor were evaluated by altering the damping ratio of the finite element model. Our results showed that the damping ratio of the maxillary central incisor was 14.6±3.7%. When the damping ratio of the incisor model was increased, the value of the maximum equivalent stress decreased and the response time was delayed. These results can serve as a useful reference for further advanced studies. Meanwhile, our results revealed that a static dentotraumic analysis ignoring the damping properties of the tooth would result in an overestimation of the stresses in the tissue.