

Thermal and Mechanical Analyses of Dental Composites for Class II Cavity Restoration in a Molar Tooth: A Finite Element Study

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Flowable dental resin composites have substituted mercury-based amalgam as dental restorations over the past decade due to amalgam's biological adverse effect. The flowable dental resin composites are more preferred due to their material properties, aesthetics, and minimal invasiveness. Therefore, the effect of thermal and mechanical stimuli on resin dental composites is an area of active research. This study describes the construction of three-dimensional finite element models of a posterior molar tooth based on data obtained from micro-CT. The scanned tooth consisted of 872 slices that were segmented and meshed in Mimics Innovation Suite software to obtain separate geometric models of enamel, dentine, and pulp. The segmentation process involved mask creation through threshold sets, followed by manual inputs through multiple slice editing. Geometric models were imported to a commercial finite element analysis (FEA) software and conditions such as an intact, cavitated, and filled tooth were simulated for Class II dental cavity restoration. The material properties of each model were assumed to be homogenous and isotropic with elastic behaviour. Transient thermal analysis was conducted to determine the temperature change within each model. The ambient tooth temperature was assumed to be 37°C with extremities in thermal stimuli to be 2°C and 50°C. Moreover, the models were subjected to loading of 400N on the occlusal surface to imitate a bite force at ambient tooth temperature. The strain and stress distributions in the tooth, and tooth restoration, due to thermal and mechanical loading, were studied to optimise the Class II dental cavity restoration. The finite element simulations showed that restorative filling materials with higher Young's modulus and larger coefficient of thermal expansion independently results in higher stress levels. The regions of higher stress on the tooth model were detected and the effects of temperature and mechanical load variations on restoration microleakage were discussed. This study investigated the potential application of three-dimensional finite element modelling for optimizing restorative materials.

Keywords: Dental composite; Thermal stress; Temperature distribution; Strain analysis; Finite element method; amalgam; Flowable

Speakers Gender

Male

Level of Expertise

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Do you wish to take part in the poster slam

Yes

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