Thermo-debonding mechanisms in dentin bonding systems using finite element analysis.

Le SY, Chiang HC, Huang HM, Shih YH, Chen HC, Dong DR, Lin CT

Abstract

The finite element method (FEM) has been extensively used in evaluating the interfacial status of biomaterials. We used FEM to explore the microscopic debonding mechanism of the dentin/hybrid layer/resin adhesive interface. The stress status of the local material was used as an index to judge whether the adhesive interface would develop a debonding mechanism. To generate the local stress concentration, the thermal boundary condition was applied to the model which has the phenomenon of the coefficient of thermal expansion (CTE) mismatch. The thermal boundary condition was used to emulute a previous study conducted with a laser thermoacoustic technique (LTAT). The materials, Scotchbond MP, Optibond, and Tenure bonding systems, used in the previous experiment were also tested in this study. The results show that interfacial debonding in the finite element model occurred through the hybrid layer for both the Scotchbond MP and Tenure systems, as well as within the adhesive layer itself for the Optibond system. These findings are compatible with observations by SEM obtained by LTAT. Another transformed model was created to test the "elastic cavity wall" concept. The result also confirms the importance of the elastic cavity wall concept. These compatible results between FEM and LTAT indicate that FEM can be a very useful supplement to thermoacoustic testing.