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Can pulpal floor debonding be detected from occlusal surface displacement in composite restorations?

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Polymerization shrinkage of resin composite restorations can cause debonding at the tooth-restoration interface. Theory based on the mechanics of materials predicts that debonding at the pulpal floor would half the shrinkage displacement at the occlusal surface. The aim of this study is to test this theory and to examine the possibility of detecting subsurface composite restoration debonding by measuring the superficial shrinkage displacements. A commercial dental composite with linear shrinkage strain of 0.8% was used to restore 2 groups of 5 models class-II cavities (8 mm long, 4 mm wide and 4 mm deep) in aluminum blocks (8 mm thick, 10 mm wide and 14 mm tall). Group I had the restorations bonded to all cavity surfaces, while group II had the restorations not bonded to the cavity floor to simulate debonding. One of the proximal surfaces of each specimen was sprayed with fine carbon powder to allow surface displacement measurement by digital image correlation. Images of the speckled surface were taken before and after cure for displacement calculation. The experiment was simulated using finite element analysis (FEA) for comparison. The group I results showed a maximum occlusal displacement of 34.7 ± 6.7 μm and a center of contraction (COC) near the pulpal floor. Group II had a COC coinciding with the geometric center and showed a maximum occlusal displacement of 17.4 ± 3.8 μm . The difference between the two groups was statistically significant ($p\text{-value}=0.0007$). Very similar results were obtained by FEA. The theoretical shrinkage displacement was 44.8 and 22.4 μm for group I and II respectively. The lower experimental displacements were probably caused by slumping of the composite before cure and deformation of the adhesive layer. The results confirmed that the occlusal shrinkage displacement of composite restoration was reduced significantly by pulpal floor debonding. Thus, the occlusal displacement of a composite restoration could be used to assess its interfacial integrity.

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