The effect of a nanofilled resin-based coating on water absorption by teeth restored with glass ionomer

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ABSTRACT

Background. A nanofilled, resin-based light-cured coating (G-Coat Plus, GC America, Alsip, Ill.) may reduce water absorption by glass ionomers. The authors investigated this possibility by measuring cuspal flexure caused by swelling of glass ionomer–restored teeth.
Methods. The authors cut large mesio-occlusodistal slots (4-millimeter wide, 4-mm deep) in 12 extracted premolars and restored them with a glass ionomer cement (Fuji IX GP Extra, GC America). Six teeth were coated, and the other six were uncoated controls. The authors digitized the teeth in three dimensions by using an optical scanner after preparation and restoration and during an eight-week storage in water. They calculated cuspal flexure and analyzed the results by using an analysis of variance and Student-Newman-Keuls post hoc tests (significance level .05). They used dye penetration along the interface to verify bonding.
Results. Inward cuspal flexure indicated restoration shrinkage. Coated restorations had significantly higher flexure (mean [standard deviation], −11.9 [3.5] micrometers) than did restorations without coating (−7.3 [1.5] μm). Flexure in both groups decreased significantly ($P < .05$) during water storage and, after eight weeks, it changed to expansion for uncoated control restorations. Dye penetration along the interfaces was not significant, which ruled out debonding as the cause of cuspal relaxation.
Conclusions. Teeth restored with glass ionomer cement exhibited shrinkage, as seen by inward cuspal flexure. The effect of the protective coating on water absorption was evident in the slower shrinkage compensation.
Practical Implications. The study results show that teeth restored with glass ionomers exhibited setting shrinkage that deformed tooth cusps. Water absorption compensated for the shrinkage. Although the coating may be beneficial for reducing water absorption, it also slows the shrinkage compensation rate (that is, the rate that hygroscopic expansion compensates for cuspal flexure from shrinkage).
Key Words. Coating; cuspal flexure; glass ionomer; hygroscopic expansion; shrinkage; water absorption.

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Glass ionomer cements have gained ground in clinical practice in the last decade because of their advantages, such as fluoride release and adhesion, as well as significant improvement in their mechanical and handling properties.[1] Maintaining water balance is critical for glass ionomer materials to achieve desired physical properties. Water can dissolve the set cement, and water absorbed into the material acts as a plasticizer, reducing flexural strength and hardness.[2,3] Water absorption also causes expansion,[3-8] which may create stresses in a glass ionomer–restored tooth.[9] On the other hand, dehydration results in contraction, surface crazing, cracks and loss of translucency.[4,6,7,10,11]

Petroleum jelly, solvent-based varnish or light-cured resins have been used to maintain moisture levels in glass ionomer restorations.[12,13] A nanofilled, resin-based light-cured coating (G-Coat Plus, GC America, Alsip, Ill.) was introduced as a protective layer to improve the esthetics and physical properties of glass ionomer restorations. The manufacturer claims that the coating is self-adhesive and increases wear resistance of posterior restorations.[14] Several investigators reported that the coating reduces surface roughness and increases flexural and fracture strength.[11,15,16] Lohbauer and colleagues[11] proposed that the strength was increased because the surface coating

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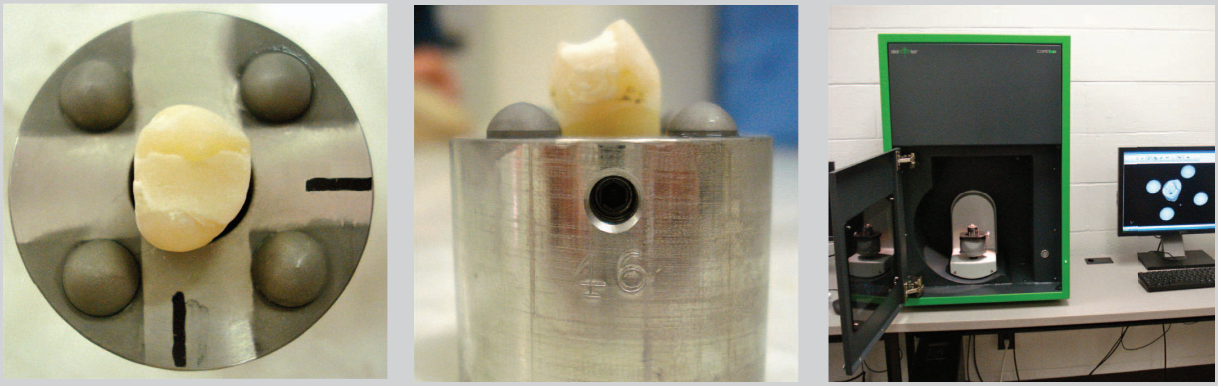

Figure 1. A premolar is secured in a stainless steel ring (left and middle) and scanned with an optical scanner (Comet xS, Steinbichler Optotechnik, Neubeuern, Germany) (right).

maintains the water balance in the setting cement and, thus, improved the maturation process. If this protective coating decreases water transportation into the glass ionomer cement, the tooth-restoration complex may exhibit less dimensional change from hygroscopic expansion compared with that found for teeth restored with a resin-modified glass ionomer.[9]

The objective of this study was to evaluate whether the nanofilled resin-based coating reduced water absorption of teeth restored with a posterior glass ionomer restorative cement. Because water absorption causes swelling of the restoration, which may lead to stresses in the tooth, we investigated water absorption by measuring cuspal flexure.

METHODS

We secured 17 extracted human first and second premolars in stainless steel rings with a screw and kept them in deionized water to avoid dehydration (Figure 1). The institutional review board at the University of Tennessee Health Science Center, Memphis, approved the use of extracted teeth for this study (exempt category study number 11-01211-XM). During collection, we stored teeth in 10 percent formalin acetate. Before securing the teeth in the stainless steel rings, one of the authors (A.D.H.) cleaned them with pumice slurry. She then etched the exterior enamel surfaces with 37 percent phosphoric acid solution to achieve dull surfaces that allowed them to be scanned with an optical scanner (Comet xS, Steinbichler Optotechnik, Neubeuern, Germany) (Figure 1).

The scanner had a 60-μm lateral resolution (that is, the distance between measured points) and an accuracy of 5 μm. We scanned the tooth samples from eight directions and orientations. The three-dimensional surface geometry was reconstructed by overlaying the points of the eight surface scans.

One of the authors (R.H.H.) cut large mesio-occluso-distal slots (4-millimeter buccolingual width and 4-mm depth) in 12 of the mounted premolars by using a no. 245 carbide bur in a high-speed handpiece with copious water coolant. Another investigator (A.D.H.) divided the 12 teeth to be restored into six pairs, with each pair matched in size and shape. Restorations in six of these teeth received a coating, and the other six restorations did not receive a coating and served as controls. (The five remaining teeth served as untreated controls.) The mean (standard deviation [SD]) buccal and lingual wall thicknesses of the prepared teeth were 2.53 (0.56) mm for the group with the coated restorations and 2.50 (0.79) mm for the uncoated control group. There was no statistically significant difference in wall thickness between the two groups (*t* test, $P = .918$). One of the authors (J.H.B.) measured the wall thicknesses on the cross-sectioned specimens during the dye penetration procedure.

After preparing the premolars, the investigator (A.D.H.) digitized them with the optical scanner and used these scans as baseline scans. Another investigator (R.H.H.) applied a cavity conditioner (GC Cavity Conditioner, GC, Tokyo) to the preparations for 10 seconds, rinsed the specimens with water for 15 seconds by using a three-way syringe and blot dried them. He restored the tooth specimens with posterior glass ionomer restorative cement (Fuji IX GP Extra, lot 1011181, GC America) according to the manufacturer's recommended procedures. A capsule mixing unit (RotoMix, 3M ESPE, St. Paul, Minn.) was used to activate and mix the glass ionomer capsule for 10 seconds. The investigator applied two capsules in 2-mm increments because of the large size of the preparations. He removed excess material but did not finish or polish the restoration. The investigator prepared and restored the teeth at room temperature in ambient conditions. The glass ionomer set in 2½ minutes after the start of mixing. Five minutes after mixing, one author (A.D.H.) randomly assigned one restored tooth from each of the six restored tooth pairs to receive the nanofilled resin-based coating by means of a microtip

ABBREVIATION KEY. MSDS: Material safety data sheet.