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Research Article

Dentin Demineralization Inhibition at Restoration Margins of Ionolux Resin-Modified Glass Ionomer Cement -

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ABSTRACT

Purpose: To examine the in vitro caries inhibition of a resin-modified glass ionomer cement (Ionolux-VOCO) and a non-fluoridated resin control (Z 100, 3M ESPE).

Materials and Methods: Standardized Class V preparations were placed in 20 molars, the gingival margin placed below the cementoenamel junction. Randomly, 10 Ionolux, and 10 Z 100 restorations were placed according to manufacturer's instructions. All teeth had an acid-resistant varnish placed to within 1 mm of restoration margins and they were then subjected to an artificial caries challenge (pH 4.4) for 4 days. Sections of 100 microns were obtained, photographed under polarized light microscopy, and then digitized to quantitate demineralized areas adjacent to the restoration.

Results: The mean (+/- S.D) area (μm^2) demineralization 100 microns from the dentin/gingival margin was: Ionolux 2,886 ± 3,211; Z 100 11,561 ± 2,655. A t-test indicated the Ionolux resin-modified glass ionomer cement had significantly ($p < 0.001$) less demineralization adjacent to restoration margins that the Z 100 resin-based composite control.

Clinical Significance: This study indicated that Ionolux resin-modified glass ionomer cement demonstrated caries inhibition at restoration dentin/cementum margins that was significantly greater than a non-fluoride-releasing resin-based composite control.

Keywords: Resin-modified glass Ionomer cement; Ionolux; Resin-based composite; Caries inhibition; Fluoride

INTRODUCTION

With the increasing demand for esthetic dental restorations and the concern of recurrent decay, there is great importance in choosing a restorative material that can provide both esthetics and caries inhibition properties. The physiochemical and cariostatic properties of glass ionomer cement make it an exceptional option as a restorative material.

In vitro studies have revealed that materials reinforced with glass ionomer cement have optimal antibacterial activity against S. Mutans Streptococci [1]. Glass ionomer restorative material is able to self-adhere to enamel and dentin, as well as release fluoride at the margins of the restoration. The fluoride-containing matrix has a unique property of recharging by outside exposure to other fluoride-containing substances [2,3].

Fluoride has the ability to interfere with the process of demineralization and in turn remineralize carious lesions. It has been reported that the release of fluoride from glass ionomer restorative material has the capability of preventing secondary caries lesions [4]. In contrast, traditional resin restorations have limitations. Resin restorative materials do not typically release fluoride, which allows the area to be more susceptible to secondary decay. In addition, materials containing resin properties posses the risk of polymerization shrinkage, potentially compromising restoration margins [5]. The gap formation between the wall of the preparation and the restorative material establishes a niche favorable to bacterial colonization.

The burst of fluoride release observed with resin-modified glass ionomer cement helps reduce the amount of adjacent tooth demineralization that may occur [3,6]. The effect of bioavailable fluoride release and its inhibition of demineralization are explored in this study for a more recent product that has been available in the marketplace, using an accepted in vitro caries inhibition methodology [6].

MATERIALS AND METHODS

Twenty Class V cavity preparations were made with a #330 carbide bur in a high speed hand piece on the mesial and distal surfaces of extracted human permanent molars. The gingival margin of the preparations were placed below the cementoenamel junction. The preparation extended 2 mm axially, 5mm buccolingually and 2 mm occlusogingivally.

After all 20 preparations were completed, 10 teeth were randomly selected to be restored using Z 100 resin-based composite (3M ESPE, St. Paul, MN, USA). The preparations were etched using 37% phosphoric acid on the beveled enamel margins, followed by the placement of primer and adhesive, as recommended by the manufacturer. Z 100 resin-based composite was incrementally placed and light cured. The remaining 10 teeth were restored using Ionolux resin-modified glass ionomer cement (VOCO, Indian Land, SC, USA). The Ionolux capsules were taken directly from the bag prior to activation and mixed in a triturator for 10 seconds. Ionolux material was placed into the preparation, adapted and light cured. All excess material not confined within the walls of the preparation was removed. The Z 100 and the Ionolux restorations were polished to ensure proper contour and finish.

All 20 teeth were coated with an acid resistant varnish, leaving a minimum of 1 mm of exposed enamel adjacent to the restoration margins. The teeth were then placed into an artificial caries challenge (pH 4.4) for 4 days [7]. Sections of 100 microns were cut longitudinally through the restored portion of the tooth and images were obtained under polarized light microscopy. After the images were saved, the demineralized areas adjacent to the restoration were quantified using Image- Pro Insight (Media Cybernetics, Rockville, MD, USA).

RESULTS

The mean (+/- S.D) area (μm^2) of demineralization seen under polarized light microscopy on the sections obtained at 100 microns from the dentin/gingival margin was: Ionolux 2,886 ± 3,211; Z 100 11,561 ± 2,655. A t-test indicated the Ionolux resin-modified glass ionomer cement had significantly ($p < 0.001$) less demineralization adjacent to restoration margins that the Z 100 resin-based composite control.

DISCUSSION

The results of this study indicated Ionolux resin-modified glass ionomer cement inhibits caries at the dentin/cementum restorative margins (Figure1) significantly better than the non-fluoride-releasing resin-based composite (Figure2). The inhibition of demineralization seen with resin-modified glass ionomer cements is usually associated with a continuous fluoride release from the restorative material [8]. This fluoride release is through surface dissolution of the glass ionomer cement and passive diffusion of the resin component of

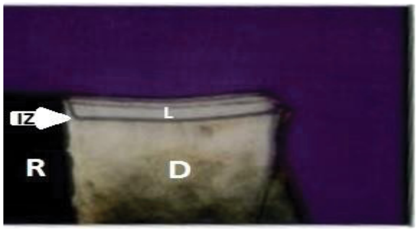

Figure 1: A Lesion (L) in Dentin (D) adjacent to the Ionolux resin-modified glass ionomer cement restoration (R). Note the Inhibition Zone (IZ).

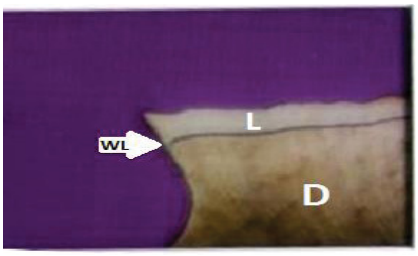

Figure 2: A Lesion (L) in Dentin (D) which was adjacent to a Z 100 resin-based composite restoration. Note the Wall Lesion (WL).

resin-modified glass ionomer cements [9-10]. During an acidic attack the presence of fluoride in low sustained concentrations allows absorption by the surface of apatite crystals. This absorption inhibits demineralization. Preceding the acid attack, when the pH returns to normal, the remnants of fluoride will be incorporated into the tooth structure. The results of fluoride uptake by the dentin in this experiment suggest a possible increase in the process of remineralization, thus rendering the dentin more resistant to future acidic challenges. Previous studies have eluded to the uptake of fluoride into dentin adjacent to resin-modified glass ionomer cement restorations [6,10].

A favorable characteristic of fluoride-releasing materials is their ability to be “recharged.” This allows for extended fluoride release long after the extrinsic source of fluoride has been removed from the oral environment by salivary flow [9]. The capability of a resin-modified glass ionomer cement to act as a fluoride reservoir is a distinct advantage in caries resistance and has been well-established in the dental literature [8,9,11].

The fluoride releasing capability of glass ionomer cement makes it the material of choice for Class V restorations. Its poor mechanical strength limits its use in posterior restorations. However it has been shown that through incorporation of nanoparticles, the materials exhibited higher compressive, diametral tensile, and biaxial flexural strength [12]. This increase in mechanical properties allows the potential for placement as posterior restorations.

Although fluoride release is a great chemical property, experimental studies have shown that, similar to composites, the greatest reason for the breakdown of resin-modified glass ionomer cement is recurrent decay, [13] thus implying fluoride release is not substantial enough to completely arrest bacteria replication and its detrimental results [11].

In recent years, learning institutions have emphasized a more conservative approach to cavity preparations [14]. This methodology increases the probability of leaving behind affected dentin. In conservative restorations such as these it would be beneficial to use materials that halt the progression of demineralization in hopes to increase longevity.

Through this study, numerical values recorded with the use of Image- Pro Insight, show a significantly smaller area of demineralization in the groups that received fluoride-releasing glass ionomer cement restorations when compared with the group that received conventional nonfluoride-containing resin-based composite restorations. These results support the notion that dentin near the fluoride-releasing material has an increased resistance to caries.

CONCLUSION

It can be concluded, within the limitations of this in vitro study, that Ionolux resin-modified glass ionomer cement effectively inhibits adjacent dentin demineralization when compared to a resin control.

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