Research Article

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To Comparative Evaluation of Resin Adhesive Systems on Root Caries Formation In Lateral Incisors: A Research Update

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ABSTRACT

Background: To evaluate the capability of different adhesive systems to inhibit in vitro caries formation.

Method and Materials: three materials were tested: Gluma Comfort Bond, Gluma Comfort Bond + Desensitizer and I Bond. Bovine roots were ground to obtain flat mesial and distal dentin surfaces. Nail varnish was applied to the entire root surface except for two 10 mm × 2 mm windows on the flattened surfaces. The adhesives were applied to the exposed areas according to the manufacturers' instructions. The roots were incubated at 37°C for 1 week in a suspension of *Streptococcus mutans.* Control groups either received no root surface treatment or were etched with 37% phosphoric acid (without immersion in the bacterial suspension). Specimens were sectioned perpendicular to the long axis of the roots, stained for 24 hours with Rhodamine B, and analyzed with confocal laser microscopy. The data were analyzed by 1-way ANOVA and Fisher's PLSD test at 95% confidence level. **Results:** Lesions in the I B and GL+ groups were significantly shallower than those in the no treatment group. Acid etching did not produce any measurable lesions. Mean lesion depth in the GL group was similar to that in the no-treatment group. There was no significant difference between mean lesion depths in the GL+, GL, and I B groups.

Conclusion: Fluoride- and glutaraldehyde-containing adhesive systems might be an aid in root caries prevention.

Keywords: *Streptococcus mutans,* adhesive, inhibition, *Lactobacillus,* root caries.

INTRODUCTION

Human life expectancy has dramatically increased worldwide over the last century. Currently, approximately 35 million people over 65 years old live in the United States.1 Epidemiologic studies of root caries in this population consistently indicate that over half the people have experienced root caries. Even though no conclusive information linking prevalence or incidence of root caries in adult populations has been made, root caries is one of the prime causes of tooth loss inadults.2

A common clinical observation in the elderly population is root exposure as a consequence of gingival recession. Unlike the anatomic crown of teeth, root surfaces are not covered with a protective enamel layer. Without enamel, which is more resistant than cementum and dentin to low pH, root surfaces seem to be more susceptible to demineralizationandmaybecomemoreeasilycavitate difnotappropriatelyprotected.Thishigher susceptibility of exposed roots to caries is some times aggravated when other risk factors arepresent.Factorssuchasuseofmedicationsthatcaus exerostomiaandinadequate dexterity, commonly seen in the elderly, can amplify the risk ofcaries.3 To date, preventive treatments such as topical fluoride are the usual approach to prevent root caries. Although limited evidence supports its use in

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root caries prevention,4 topical fluoride seems to work by inhibiting demineralization, enhancing remineralization, and providing an antibacterial effect.5 However, these treatments are not long-lasting and must be repeated consistently to be effective. Therefore, patient compliance plays a vital role in the success of this treatment modality.

To overcome the short-term aspect of the traditional preventive methods and serve as adjunct treatment options, alternative treatments have been suggested. Adhesive systems, for instance, have been shown to be able to provide acid resistance to the dentin.6 The shield provided by the resin-dentin hybrid layer might be further improved by adding antibacterial and/or remineralization components to the adhesive systems, eg; fluoride7 and 12-methacryloyloxydodecylpyri-dinium bromide(MDPB).8,9

Glutaraldehyde is another agent included in some adhesive systems.10 Research has suggested that glutar di aldehyde might be able to minimize dentin demineralization and help in root caries prevention. In vitro and in situ studies have suggested that the inhibition of root demineralization might occur because of surface cross-linking of the dentin matrix by glutar di aldehyde, which would reduce calcium and phosphate transport out of the dentin.11,12 Also, glutaraldehyde-containing adhesive systems reportedly have antibacterial activity, which might play a role in caries prevention, aswell.13–16

The present study evaluated the capability of different dental adhesive systems to inhibit in vitro root caries formation. The null hypothesis tested was that fluoride- and glutaraldehyde-containing adhesive systems are not capable of minimizing in vitro dentin demineralization.

MATERIAL AND METHOD

36mandibular bovine lateral incisors were used in this study. Roots were separated from the crowns at the cemento enamel junction (CEJ) using an Isomet diamond saw(Buehler) under running water. Pulpal tissue was removed, and the roots were cleaned of soft tissues. The mesial and distal surfaces of the roots were ground mechanically under running water with 600-gritsilicon carbide papers to obtain flat dentin surfaces. Acid-resistant nail varnish was applied to the roots except for 2approximately 10 mm (length, cervico apical) x 2 mm (wide) windows on the mesial and distal surfaces. Adhesives were applied to the prepared “windows” according to the manufacturer s’ instructions for bonding (Table 1). Control groups either received no treatment or were etched with 37% phosphoric acid. The latter was treated with phosphoric acid only.

Table 1: Material, compositions and application sequence.

Material	Composition	Application sequence
Gluma Comfort Bond Desensitizer	4-META, HEMA, UDMA, maleic acid, polycarboxylic acid ester, ethanol, water, CQ	ABCD
Gluma Comfort Bond	4-META, HEMA, UDMA, maleic acid, polycarboxylic acid ester, water, CQ	ABCD
iBond	4-META, UDMA, glutaraldehyde, water, CQ	CDF

After application of the adhesive resins, the roots were washed with tap water and incubated in a bacterial suspension. The roots from the phosphoric acid control group were not incubated but were kept wet until being prepared for microscopy. Phosporic acid specimens were used to evaluate the depth of demineralization by the acid alone. Two species of bacteria were used in this suspension, *Streptococcus mutans* strain ATCC 10449 (serotype c) and *Lactobacillus acidophilus* strain ATCC 4356. A stock culture of each bacteria was transferred to trypticase soy broth (TSB, Difco Laboratories) and incubated. After 48 hours, this suspension was transferred to another TSB tube, the bacteria mixed to equal amounts, and the suspension adjusted to 0.1 OD (optical density). The sus- pension was then supplemented with 2.5% sucrose and the roots immersed in 200 µL of it. The roots were incubated at 37°C for 1 week. The medium was replenished every48 hours.

After incubation, specimensapproximately0.5 mm thick were sectioned perpendicularly to the long axis of the roots using an Iso met diamond saw under running water. These specimens were oval (bovine root) shaped and had 2 areas to be analyzed (mesial and distal surfaces). Two cuts 2 mm from each other were made in each root, with the fir stone approximately2 mm below the CEJ. Specimens were left to dry overnight at room temperature and then stained for 24 hours with Rhodamine B (Allied Chemical),pH7.0.

Confocal laser microscopy was used to analyze the stained surfaces and determine the extent of the lesions. Excitation was with the 543-nm line of a green helium-neon laser. The pinhole setting was at 1 Airy unit scanning a 515 × 512 pixel raster at a zoom setting of1.

Image analysis was performed using ImageJ 1.36b (National Institutes of Health).The deepest point of the lesion was recorded as the lesion depth. In cavitated lesions, an imaginary line connecting the edges of the lesion was drawn and used as the reference.

The data were analyzed by 1-way analysis of variance (ANOVA) and Fisher's PLSD (protected least significant difference) test at the 95% confidence level.

RESULTS

The difference in sample size is due to loss of specimens during the preparation procedure. Acid etching did not produce any measurable lesion. Mean lesion depths in the Gluma Comfort Bond + Desensitizer (GL+) and iBond (iB) groups were significantly less than the mean of the no-treatment group. *P* values for those groups when compared to the no-treatment control group were <.0001, .0009, and .0232, respectively. Gluma Comfort Bond (GL) was not significantly different from the no-treatment group (*P*=.2711). Mean lesion depths of the GL, GL+, and iB groups were not significantly different.

DISCUSSION

This study investigated the potential antibacterial effect that different adhesive systems might have against root caries–related bacteria. Gluma Comfort Bond, Gluma Comfort Bond + Desensitizer, iBond, and One-up Bond F were applied to bovine root surfaces and tested in vitro against *L acidophilus* and *S mutans.*

The null hypothesis—that fluoride-and glutaraldehyde-containing adhesive systems are not capable of minimizing in vitro dentin demineralization—was rejected. Although the fluoride- and glutaraldehyde-containing adhesive systems were not able to fully prevent root surface demineralization in the study design applied, shallower lesion depths were present in these groups than in the positive control group (no treatment).

Although no clinical study is available to confirm the efficacy of the dental adhesives in root caries prevention, these materials have been suggested to be a potential aid in this matter. An in vitro study done by Swift and col- leagues17 showed that the All-Bond 2 system (Bisco) is able to minimize root demineralization. Root surface lesions could not be fully prevented, but their severity was lowered by using that adhesive system.17 Another in vitro study corroborated that finding, reporting that both Syntac (Ivoclar Vivadent) and Prime &Bond 2.0 (Dentsply Caulk) were able to fully prevent root demineralization when used with- out air thinning of the adhesive. A possible explanation for the positive effect of Syntac is the presence of glutaraldehyde in its composition.18

Even though different materials were tested in the present study, the data support these previous reports. Three of 4 adhesives used in this study were able to minimize demineralization to some extent. iBond and One-up Bond F are self-etching adhesive systems that contain glutaraldehyde and fluoride, respectively. Gluma Comfort Bond + Desensitizer is a 1- bottle, total-etch adhesive system that differs from Gluma Comfort Bond only by the presence of glutaraldehyde in its composition. Along with MDPB, glutaraldehyde and fluoride have been shown to inhibit bacterial growth.7–9,13–16The only material that was not effective and had lesions comparable to the ones in the control group was Gluma Comfort Bond. This material does not have any known antibacterial agent in its composition.

Overall, the process of root caries formation is similar to the process that occurs in coronal surfaces. Bacteria present in the oral cavity metabolize carbohydrates, which results in reduction of pH. This drop in pH causes demineralization of the root structure, initiating the caries process. The critical pH for root surface demineralization is approximately 6.7.19 So far, different experimental caries models have been developed trying to copy this process.9,18,20 Although the bacteria used in this study seem to be directly associated with root caries initiation or progression, 21 a flawless in vitro reproduction of the caries process might be impossible. The caries process is an accumulation of competing demineralization and remineralization events and not a unidirectional process as performed in the present and most other invitro investigations. Thus, the results of this study must be carefully analyzed and might not be directly translated to a clinical situation. The methodologies employed to analyze the results of experimental caries studies vary, as well.9,18,22 In the present study, confocal laser microscopy was used to evaluate the lesions. Lately, several studies, have used confocal microscopy to analyze caries formation, and it seems to be a valuable mean for this purpose.23–26

CONCLUSION

Based on the findings of this study, fluoride- and glutaraldehyde-containing adhesive systems might be a potential aid in root caries prevention. Researchers of in situ and clinical studies are urged to verify whether fluoride- and glutaraldehyde-containing adhesive systems are clinically effective in root caries prevention.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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