

# Scientific Article

## Marginal Microleakage of Triage Sealant Under Different Moisture Contamination

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**Abstract:** ***Purpose:** Glass ionomer sealants (GISs) are promoted in pediatric dentistry for their moisture-friendly properties. This study's purpose was to investigate the marginal leakage of a glass ionomer sealant (Fuji Triage) under different moisture environments. **Methods:** Eighty extracted teeth were distributed into 4 groups: (1) control; (2) saliva contamination with 1-second air-thinning; (3) saliva contamination with 10 seconds of air-drying; and (4) saliva contamination with reconditioning. Sealants were placed after contamination. All extracted teeth underwent thermocycling followed by 1% methylene blue dye and distilled water wash. All extracted teeth were then sectioned buccolingually into 3 cross-sections and examined at 60X under a stereomicroscope. Microleakage was assessed using a dye penetration scoring system (score=0-3). Data were analyzed with Kruskal-Wallis and Mann-Whitney tests. **Results:** The control group showed significantly lower marginal leakage than the other 3 groups ( $P<.02$ ). There was no statistically significant difference among the 3 contaminated groups ( $P>.34$ ). **Conclusions:** Fuji Triage sealant had the least marginal leakage under a moisture-controlled environment. When saliva was introduced during the application of the material, microleakage significantly increased. When contamination occurred, 1-second air-thinning of the saliva, 10-second air-drying of the saliva, or reconditioning before sealant application did not show a difference in decreasing microleakage. (Pediatr Dent 2011;33:203-6) Received November 16, 2009 | Last Revision February 6, 2010 | Accepted March 19, 2010*

**KEYWORDS:** MICROLEAKAGE, GLASS IONOMER SEALANT, CONTAMINATION

The 21<sup>st</sup> century is the era of preventive dentistry, with various dental materials available for the practitioner. Fissure sealants have been shown to be an effective measure for caries prevention over pit and fissure areas of the dentition.<sup>1</sup> First permanent molars are the most caries-susceptible teeth during their first and second years of eruption. During this period, the enamel has not fully coalesced and matured, and good oral hygiene on the erupting teeth is often difficult to maintain due to lack of recognition of the newly emerging teeth.<sup>2,3</sup>

A variety of sealant materials (resin and glass ionomer) have been introduced for partially erupted molars with isolation difficulty, and several studies have been conducted to compare these sealant materials.<sup>1,4-7</sup> The low retention of the sealants or their microleakage caused by placing the sealants in a compromised condition has led to deterioration of the material and increased the possibility of caries development under the sealant.<sup>8</sup>

When comparing resin-based sealants and glass ionomer sealants (GISs), the latter possess several characteristics that

make them a better interim preventive material for occlusal surfaces of partially erupted molars. These characteristics include chemical bonding to tooth structure; fluoride release; fluoride uptake, which serves as a fluoride reservoir, promoting acid defense of the tooth; and a relatively simpler technique to use (fewer steps). Its low wear resistance, however, makes the material a better interim preventive option vs a traditional composite restoration.<sup>9,10</sup> Though the material may be dislodged at the tooth's top surface after wearing off, research has shown that the material is maintained at the bottom of the fissure and, thus, continues maintaining its preventive properties.<sup>5,9</sup>

Triage (GC America, Alsip, Ill) was recently introduced into the market as a new GIS material by Fuji. It claims to have better adhesion and retention when placed in a moist environment. Until now, few scientific studies have been conducted to evaluate Triage's microleakage potential under contamination.<sup>11,15,16</sup>

The purposes of this study were to examine the moisture-related property of a GIS under saliva contamination in vitro and to evaluate its marginal integrity.

### Methods

In this study, approved by the Institutional Review Board of Tufts University, Boston, Mass, 80 nonstained, caries-free, extracted human third molars were collected from the Oral Surgery Clinic at the School of Dental Medicine, Tufts University. All teeth were disinfected in bleach for 20 minutes

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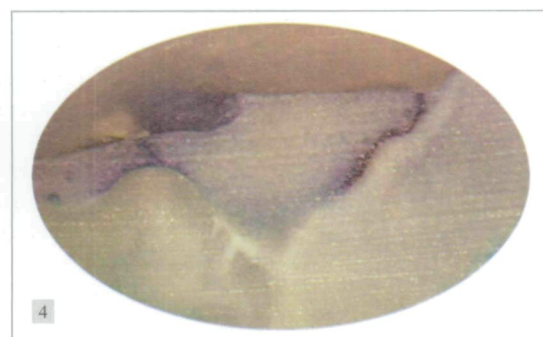
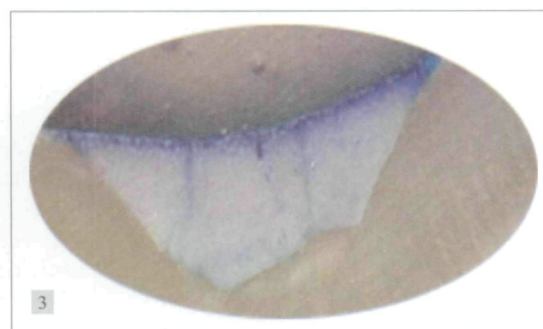
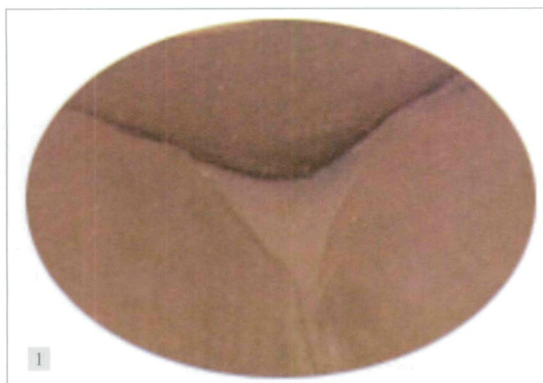


Figure 1. Dye penetration score of a microleakage assessment sample. Score 0=no dye penetration.

Figure 2. Dye penetration score of a microleakage assessment sample. Score 1=dye penetration restricted to the outer half of the sealant.

Figure 3. Dye penetration score of a microleakage assessment sample. Score 2=dye penetration to the inner half of the sealant.

Figure 4. Dye penetration score of a microleakage assessment sample. Score 3=dye penetration into the underlying fissure.

and stored in saline solution at room temperature until used. The tooth crowns were cleaned with pumice in water suspension using a rubber cup and a low-speed handpiece. All teeth were rinsed thoroughly with distilled water for 10 seconds after cleaning. The teeth were randomly divided into 4 groups of 20. The teeth were randomly selected and assigned to 1 control (noncontaminated) and 3 experimental (contaminated) groups (20 per group):

1. In Group 1 (control group), a conditioner (25% polyacrylic acid) was applied to all teeth for 15 seconds according to the manufacturer's instructions with no saliva contamination. This was followed by thorough rinsing with distilled water for 10 seconds and drying with a gentle stream of oil-free air for 5 seconds. The GC Fuji Triage GIS was mixed, applied, guided into pits and fissures with a dental explorer on all teeth, and light cured for 40 seconds using a Dentsply® light-curing unit at 450 mW/cm<sup>2</sup>.
2. In Group 2, after the conditioner was applied (as in Group 1), sample teeth were completely submerged in commercial artificial saliva (Caphosol®, EUSAPharma (USA), Inc., Langhorne, PA.) for 5 seconds and air-thinned for 1 second before the sealant was applied (as in Group 1).
3. In Group 3, after conditioner application (as in Group 1), sample teeth were completely submerged in artificial saliva and then completely dried with an air stream for 5 seconds before sealant was applied (as in Group 1).
4. In Group 4, after a conditioner was applied (as in Group 1), sample teeth were completely submerged in artificial saliva, totally air-dried for 5 seconds, reconditioned for 15 seconds, rinsed with distilled water for 10 seconds, then thoroughly air-dried for 5 seconds before a sealant was applied (as in Group 1).

To prevent dye penetration, tooth surfaces were coated with a double layer of nail varnish, with a 1-mm margin between the varnish and the sealant. All teeth were thermocycled in a distilled water bath (500 cycles between water baths held at 5°C and 55°C, with 1 minute of dwell time in each bath and 30 seconds transfer time). After thermocycling, the samples were submerged in 1% methylene blue dye at room temperature for 24 hours, and then submerged in distilled water at room temperature for 24 hours.

All teeth were wrapped in gauze moistened with saline solution in a sealed environment at room temperature until the sectioning procedure was performed to prevent further dye washing-out and dehydration of the teeth. All teeth were embedded in epoxy resin and sectioned longitudinally in a buccolingual direction into 3 sections (mesial, center, and distal sections) with a double-faced diamond rotary blade at low-speed (350 rpm).

Microleakage was determined in the sections by assessing the amount of dye penetration in the sealant-enamel interface divided by the total length of enamel-sealant interface to the fissure bottom. The result was recorded according to the dye penetration score system (Figures 1-4).<sup>9</sup> Microleakage was



Table 1. MEDIAN MICROLEAKAGE AND INTERQUARTILE RANGE (IQR) OF EACH OF THE GROUPS TESTED AT 3 DIFFERENT SECTION AREAS (MESIAL, CENTER, DISTAL)

Groups	Mesial section Median±IQR	Center section Median±IQR	Distal section Median±IQR
1	2.0±0.0	2.0±0.0	2.0±0.0
2	2.0±0.0	2.0±0.3	3.0±1.0
3	2.5±1.0	2.0±0.3	3.0±1.0
4	2.0±1.0	2.5±1.0	2.5±1.0

Table 2. RESULTS OF THE MANN-WHITNEY NONPARAMETRIC TEST COMPARING MICROLEAKAGE OF THE GROUPS TESTED AT 3 DIFFERENT SECTIONS\*

Groups	1			2			3		
Sections	M	C	D	M	C	D	M	C	D
2	.24	<.04	.002						
3	>.05	<.11	.002	>.22	.78	<.85			
4	>.01	.001	.008	>.07	>.08	.53	>.84	>.06	>.43

\*M=mesial; C=center; D=distal (*P*-values).

observed in a stereo binocular microscope (Bausch and Lomb, Rochester, NY) at 60X magnification. The sample size of 80 (20 per group) will provide more than 95% power to detect an effect size difference among the 4 groups of 0.25, assuming  $\alpha=0.05$  (nQuery Advisor 7.0, Statistical Solutions, Saugus, Mass). All samples were evaluated by a single examiner according to the dye penetration score system (Figure 1). All data were analyzed with the Kruskal-Wallis and Mann-Whitney tests using the SPSS software (SPSS Inc, Chicago, Ill). A *P*-value of  $\leq 0.05$  was considered statistically significant.

## Results

All 80 sealants were present at the time of the examination. Table 1 shows the microleakage values obtained in each group at 3 different sections (mesial, center, distal). The highest degree of microleakage was observed in Groups 2 and 3. The best seal was obtained by the control group (Group 1) with no saliva contamination.

A Kruskal-Wallis analysis found statistically significant differences among the 4 groups in all 3 sections ( $P=.005$  at mesial;  $P<.01$  at center;  $P=.003$  at distal). The Mann-Whitney test found Group 1 to be significantly different from the other 3 groups. There was no statistically significant difference between Groups 2, 3, and 4 (Table 2). Although it was not statistically significant, there were some trends toward differences between Group 2 and 4 and between Groups 3 and 4, where Group 4 showed higher scores, especially at center sections ( $P>.08$  and  $P>.06$ , respectively; Table 2).

## Discussion

Microleakage at the tooth-restoration interface is an important key in predicting the clinical retention of a restorative material. Polymerization shrinkage, which leads to microleakage of resin material, has been significantly decreased with the development of the etch-bond system. Glass ionomers adhere to the teeth chemically and illustrate no polymerization shrinkage.<sup>11,12</sup> Twenty-five percent polyacrylic acid solution is used as the conditioner for glass ionomer materials to remove the smear layer and create clean and slightly etched surfaces on the tooth for optimum bonding.<sup>13,17</sup> A high concentration of fluoride ions in the glass is released during the chemical reaction at the enamel interface and promotes remineralization of the tooth structure.<sup>7,9</sup> Research has found that glass ionomer materials, however, are not ideal for permanent restorations, as they have low wear resistance and are more difficult to handle than resin material.<sup>14</sup>

Both resin and glass ionomer materials were introduced as sealant materials by many manufacturers. Ashwin et al., found that there is no difference in microleakage between resin-based sealants and GISs in a moisture controlled environment,<sup>11</sup> although long-term studies showed low retention of GIS.<sup>7,9,10</sup> When sealants are placed under salivary contamination, GISs show better results in marginal microleakage.<sup>3,8,16</sup>

This research was designed to examine the margin integrity of a GIS placed under 3 different clinical approaches when saliva contamination can occur. Microleakage of the material was tested by dye penetration, which is the simplest and most widely used approach to assess microleakage. In this study, the control group showed the least microleakage under the sealant. When saliva was introduced during the application of sealant material, the microleakage significantly increased. In their research examining microleakage of resin and glass ionomer materials with 20 seconds of saliva contamination, Borsatto et al., drew a similar conclusion.<sup>3</sup> Intergroup analysis showed no difference between 1-second air-thinning or 10-second air-drying of the tooth surface after saliva contamination. Therefore, when contamination occurs clinically, 1-second air-thinning of the saliva may be adequate before sealant application.

Although it was not statistically significant, there were some trends toward differences between 1-second air-thinning and reconditioning and between 10-second air-drying and reconditioning of the tooth surface after saliva contamination, especially at center sections. Reconditioning showed higher scores in both comparisons. Double conditioning the tooth surface in Group 4 showed more microleakage between sealant-tooth interfaces. This may explain the critical importance of avoiding overetching of the tooth structure when using glass ionomer materials. Overetching may further dissolve the mineral content in the crystal prism, which is not favorable in the adhesion of glass ionomer materials.<sup>17</sup> Therefore, when contamination occurs, it may be preferable to avoid reconditioning the tooth surface to prevent an increase in microleakage.

This study had 2 limitations: the anatomic differences between the first and third molars; and the differences in viscosity and constituents between artificial and human saliva.

As the results obtained from this *in vitro* study cannot necessarily be extrapolated to the clinical situation because of the complex oral environment, future research *in vivo* is needed.

## Conclusions

Based on this study's results, the following conclusions can be made:

1. Fuji Triage sealant has the least marginal leakage under a moisture-controlled environment.
2. Air-thinning contaminants before sealant application produced less microleakage than air-drying.
3. Reconditioning—before sealant application and following salivary contamination—showed the most leakage.

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