



# The Effect of Acid Primer or Conventional Acid Etching on Microleakage in a Photoactivated Sealant

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## Abstract

**Purpose:** The purpose of this study was to examine differences in microleakage in extracted human teeth when placing sealants using conventional acid etching or an acidic primer resin.

**Methods:** Three experimental groupings were used: group 1—conventional acid etching with placement of light-cured sealant; group 2—application of acidic primer resin (Prompt-L-Pop) and light curing, followed by sealant placement; group 3—similar to group 2, but acidic primer and sealant were photocured after placement of sealant. Teeth were thermocycled, stained, sectioned and examined for marginal microleakage.

**Results:** In group 1, 94% of the enamel-sealant interfaces were free of microleakage. For groups 2 and 3, only 28% showed no leakage, with most leakage occurring at both margin and base areas. Nonparametric data analysis indicated acid etching demonstrated significantly lower microleakage than either treatment using the acidic primer resin ( $P < .001$ ) and that leakage scores in the acidic primer groups were identical ( $P = .4011$ ).

**Conclusions:** Use of this specific acidic resin primer in lieu of conventional acid etching (whether cured prior to or subsequent to sealant placement) demonstrated greater incidence of microleakage and would not be advocated over traditional etching procedures. (*Pediatr Dent.* 2003;25:127-131)

**KEYWORDS:** SEALANTS, MICROLEAKAGE, ACID ETCHING, SELF-ETCHING PRIMER

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Dental sealants provide effective prevention of pit and fissure caries.<sup>1-3</sup> These materials are either self- or light-activated, filled or unfilled resin systems bonded to etched enamel.<sup>1,4,5</sup>

Conventional enamel etching involves application of a liquid or gel etchant for at least 15 to 60 seconds. Such application results in formation of microscopic retentive areas approximately 25 microns in depth.<sup>6</sup> The application process for conventional sealant placement involves placement of the etching material, a wait time and rinsing and drying totaling approximately 30 seconds. After this treatment, the tooth must be maintained in an isolated, dry condition so that etched enamel is not contaminated with saliva. Following drying, sealant is placed and either allowed to self-polymerize or is purposefully exposed to the curing light. Thus, there are many different, time-consuming steps involved with conventional sealant placement.

Recently, a new type of acid-priming material, the self-etching primer, has been marketed.<sup>7-9</sup> These products

utilize a combination of acidic resins that simultaneously demineralize both enamel and dentin and then are polymerized directly in the tooth. Thus, there is no rinsing or drying required, and the time to maintain a dry field is lowered compared to conventional methods. Once the acidic primer is polymerized, a sealant can be directly placed and cured. The time involved with placement of sealants using an acidic primer etching system may be less than conventional methods, saving both patient and clinician valuable chairside time.

Use of dentin bonding agents to supplement sealant retention is not new. Previous work indicated that application of single-bottle dentin bonding systems in conjunction with conventional sealants remarkably reduced the risk of occlusal sealant failure as well as sealants placed in buccal/lingual locations.<sup>10</sup> However, all of these systems utilized a separate acid-etching step prior to bonding resin placement. Previous literature on in vitro systems examining marginal microleakage of Class V composite restorations indicated

differences in patterns observed when conventional acid-etching and self-etching resins are used. In bovine teeth, the self-etching product Prompt-L-Pop produced significantly lower enamel leakage scores than did conventional acid etching and a nonacidic bonding resin.<sup>11</sup> However, in human teeth, significantly lower enamel leakage was found when conventional etching and a nonacidic bonding agent was used compared to Prompt-L-Pop.<sup>12</sup>

Although the differences between these 2 studies may arise from the substrate tested, it is important to note that, in both cases, the enamel margins were ground during the restoration process. When testing bond strength of composites in vitro to unground, human primary enamel, use of conventional, phosphoric acid and a separate nonacidic dentin bonding agent produced significantly higher values than any of the acidic bonding systems.<sup>13</sup> Use of acidic resins as bonding agents for sealant application would, in the great majority of cases, be performed on unabraded enamel.

Recently, Prompt-L-Pop has been found to aggressively etch unabraded enamel almost to the extent of conventional phosphoric acid.<sup>14</sup> However, when this material is used as the bonding agent for retaining composites to the enamel, significantly lower values were seen in this group compared to those using conventional etching and a nonacidic bonding resin. Thus, there seems to be no definitive information available pertaining to the potential of self-etching bonding systems to adequately etch and adhere resin material to the convoluted occlusal surfaces of posterior teeth, compared with use of conventional acid etching and nonacidic bonding agents.

The purpose of this study was to examine differences in marginal microleakage of sealants placed in extracted, human teeth when an acidic primer resin was used compared with conventional acid etching.

## Methods

Fifteen freshly extracted, noncarious human third molars were obtained following guidelines of the academic Human Assurance Committee of The Medical College of Georgia. The teeth were randomly divided into 3 groups of equal number.

Group 1 teeth were treated using conventional acid etching methods. This protocol required application of a 35% phosphoric acid gel to the occlusal surface for 20 seconds, followed by an air-water rinse of 15 seconds. Lastly, the treated surface was air-dried until the characteristic "frosted enamel" appearance was evident. A filled sealant (lot

#20010614, Clinpro Sealant, 3M ESPE, St. Paul, Minn) was then applied to the etched surface using the syringe needle tip included with the system. The sealant was then photocured for 20 seconds with a conventional, hand-held dental light-curing unit (12 mm tip, Optilux 501, Demetron Research Corporation, Danbury, Conn).

Teeth in group 2 were subjected to the acidic primer material (lot #109831, Prompt L-Pop, ESPE, Seefeld, Germany). The primer was mixed according to the manufacturer's directions and placed over the occlusal surface using the applicator sponge to force it into the convolutions. In this group, the resin was exposed to the light unit for 10 seconds (an option, according to the instructions). The sealant was placed and cured as described above.

In group 3, specimens were treated as in group 2, with the exception that the acidic primer was not photocured prior to placement of the sealant (an option, according to the material instructions).

Immediately following placement, all teeth were thermocycled between 5°C and 55°C for 1,000 cycles. Dwell times in each bath were 3 minutes, with a 5-second transfer between baths.

After thermocycling, the teeth were stored in an aqueous dye solution (0.03g/mL; lot #746578, Basic Fuchsin, Fisher Scientific, Norcross, GA). The teeth were stored at 37°C in the solution for 24 hours, followed by retrieval and water rinsing. The occlusal surface of each tooth was then cleaned with a soft bristle brush and toothpaste to remove excess dye. The teeth were again rinsed and dried, individually embedded in epoxy and cured for 36 hours at 60°C (cat #14500, Maraglas, Electron Microscopy Sciences, Ft. Washington, Pa). The embedded teeth were then sectioned longitudinally, in a mesiodistal direction in 1-mm thick slices.

Following sectioning, each side of every slice was viewed under 1× to 2× magnification (StereoZoom 7, Bausch and Lomb, Rochester, NY). Each section was examined for the presence of dye at all interfaces with the tooth. Scoring of dye presence was made by 2 individuals and categorized as follows: presence of dye at the margin, presence of dye at the base area of the sealant and no dye presence. The total observations of each category were summed up for all teeth in each group and reported in tabular format.

Prior to examination, pilot images were reviewed by both examiners who then agreed on what image aspects constituted which microleakage classification. During the observations, the examiners were blinded as to the condition of each specimen. When scoring differences differed, a compromise was made between examiners as to the classification score. The Kruskal-Wallis test was used to compare mean rank scores among treatments, considering 0 as no leakage, 1 as leakage only at the margin, 2 as leakage only at the sealant base and 3 as leakage at both sealant base and margins. Significant differences between mean rank scores for the 3 tooth treatments were analyzed using

**Table 1. Presence of Dye Location for Each Test Group**

	Total slices	Dye at margin	Dye at base	Dye at both margin and base	No dye
<b>Group 1</b>	32	2 (6%)	0 (0%)	0 (0%)	30 (94%)
<b>Group 2</b>	28	3 (11%)	1 (4%)	16 (57%)	8 (29%)
<b>Group 3</b>	29	9 (31%)	0 (0%)	12 (41%)	8 (28%)

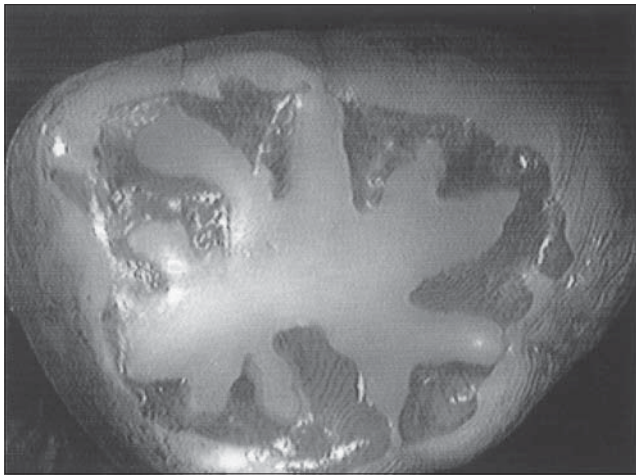


Fig 1a. Occlusal surface of specimen characteristic of group 1: conventional acid etching followed by light-cured sealant.

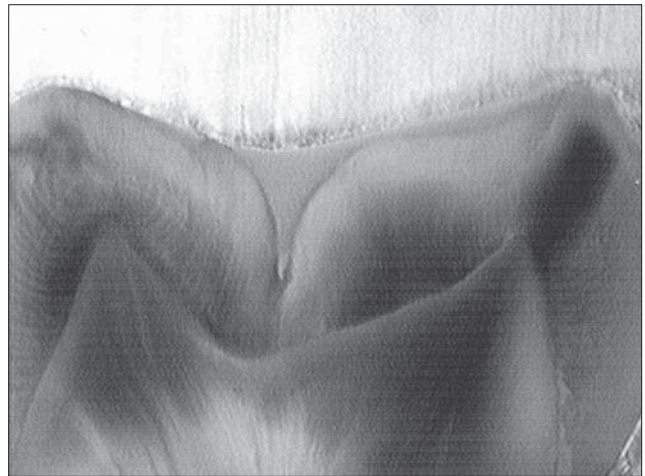


Fig 1b. Sectioned specimen characteristic of group 1: conventional acid etching followed by light-cured sealant (original magnification from 1x to 2x).

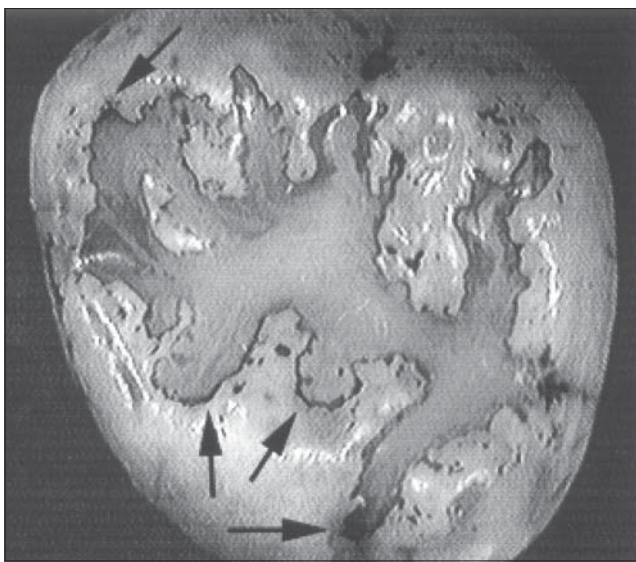


Fig 2a. Occlusal surface of specimen characteristic of group 2: acid primer resin light-cured followed by placement of sealant. Black arrows indicate locations of marginal microleakage.

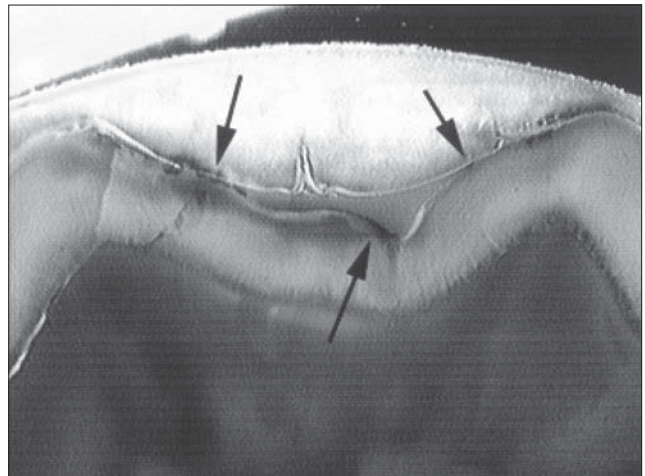


Fig 2b. Sectioned specimen characteristic of group 2: acid primer resin light-cured followed by placement of sealant. Black arrows indicate locations of marginal and base microleakage (original magnification from 1x to 2x).

the Mann-Whitney U test. Statistical significance was present at a 95% confidence level.

## Results

The results of the presence of dye penetration for each group are seen in Table 1. Group 1 specimens (the conventional acid-etching placement), indicated that 94% of the slices demonstrated no presence of dye at any of the categorized locations, with only 6% demonstrating marginal dye. Group 2 (use of acidic resin primer that was photocured prior to sealant placement) and group 3 (same as group 2 but without photocuring of the acidic resin) both demonstrated quite similar dye presence. In each group, approximately 28% of slices showed no dye presence. Most slices in these groups indicated dye presence both at the margin and sealant base (57% and 41%, respectively). Most of the remaining dye presence was at the marginal area only (11% and 31%, respectively).

The Kruskal-Wallis test indicated the presence of a significant difference among ranked microleakage scores ( $P < 0.001$ ): group 1=24.9; group 2=56.9; group 3=53.5. Pair-wise comparison of mean rank sums (Mann-Whitney U test), indicated that microleakage in group 1 was significantly less than either group 2 or group 3 ( $P < .001$ ), and that microleakage scores of groups 2 and 3 were equivalent ( $P = .40$ ).

Figures 1a and 1b present the unsectioned and sectioned appearance of specimens commonly seen in group 1. In Figure 1a, the periphery of the sealant is intact, with no voids or indications of dye presence. The dark periphery surrounding the sealant was determined to be dye penetration of etched enamel not covered with sealant. The intact sealant seen in Figure 1b was typical of specimens of this group. Figure 2a presents the occlusal view of a specimen common to group 2. The lack of peripheral dye from etched enamel penetration, as seen in Figure 1a, is evident. Marginal dye penetration is evident at many

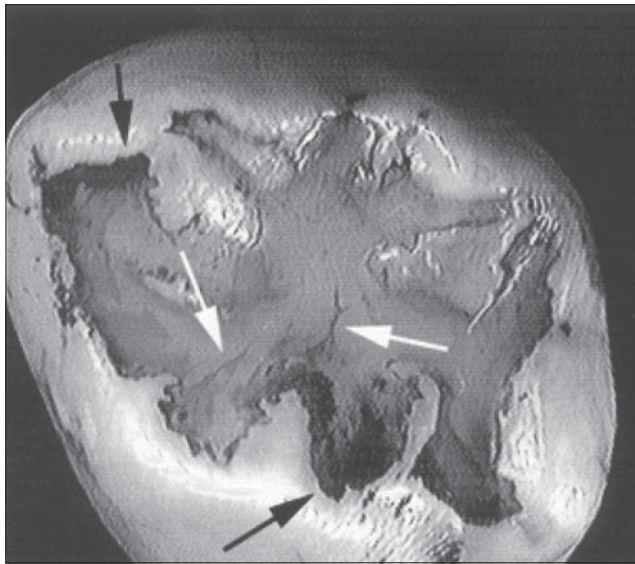


Fig 3a. Occlusal surface of specimen characteristic of group 3: acid primer resin light-cured after placement of sealant. White arrows indicate swirls where acidic primer resin and sealant have not mixed. Black arrows indicate marginal microleakage.

interfaces, as highlighted by the black arrows. Figure 2b presents the sectioned tooth of this group, indicating presence of dye penetration at the margin as well as the base (black arrows).

The lack of mixing of acidic resin primer and sealant prior to curing is obvious in the occlusal view of this specimen from group 3 (Figure 3a). Swirls of stained dye where these two materials did not mix homogeneously prior to curing (white arrows) were commonly present. Marginal microleakage in this specimen is also evident (black arrows). The sectioned view of this specimen is seen in Figure 3b, indicating the presence of marginal leakage down to the sealant base (black arrows).

## Discussion

Adhesive resins have been used successfully in combination with or as sealants alone.<sup>15,16</sup> However, these studies used adhesive resins that were placed following conventional acid etching, and the products themselves were not acidic resins. In the present study, it was anticipated that use of an acidic resin primer would provide equivalent protection against marginal microleakage as that seen with conventional acid-etching techniques. However, the results did not prove this assumption true. The classification of no dye penetration in the acidic resin primer-treated teeth was observed very infrequently as opposed to almost all specimens undergoing conventional treatment showing no evidence of microleakage. These results indicate the extent of enamel demineralization afforded by the acidic resin primer may not be as extensive as that provided by conventional treatment. Pashley and Tay<sup>14</sup> demonstrated that the aggressiveness of Prompt-L-Pop (the acidic-resin adhesive used in the present study) was almost equivalent to that of conventional phosphoric acid treatment. However,

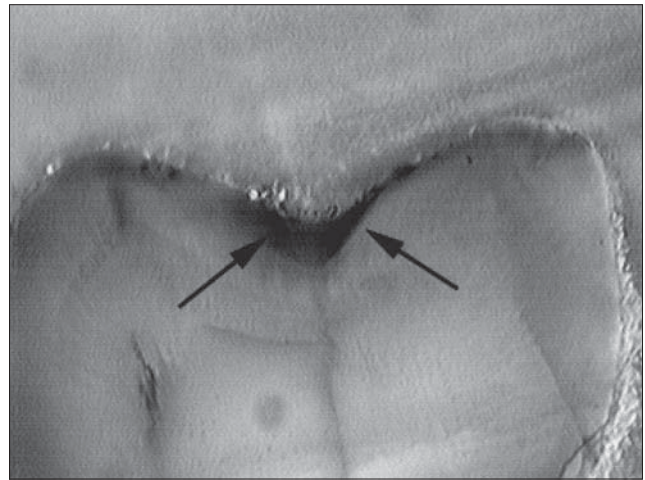


Fig 3b. Sectioned specimen characteristic of group 3: acid primer resin light-cured after placement of sealant. Black arrows indicate locations of marginal and base microleakage (original magnification from 1× to 2×).

subsequent bond testing indicated that the strength obtained with Prompt-L-Pop could be attributed to the polymerized network, and not to the extent of etching alone.

In this study's findings, the microleakage patterns observed when Prompt-L-Pop was used are more likely the result of inability to seal the margin with a well-cured resin than by supplying an adequately etched enamel surface. Lack of marginal seal with Prompt-L-Pop use on extracted human teeth was also noted by Pradelle-Plasse et al.<sup>12</sup> However, in that study, leakage of Class V restorations was evaluated on an abraded enamel surface, unlike the present work where untreated occlusal surfaces were tested. Also, in the present study when the acidic primer was not polymerized prior to placement of the sealant, obvious differences were noted in the solubility of the 2 fluids, indicating a non-uniform and perhaps phase-separated materials.

The experimental condition group 3, where the acidic bonding adhesive was placed and not light-cured and the sealant was directly placed over top, produced conditions somewhat like those presented in previous research.<sup>17</sup> In that work, acidic resin adhesive was intentionally applied to a tooth surface, but not polymerized for various time intervals after a light-cured composite was placed. An ever-decreasing bond strength value was found with delay of light activation.

In the present study, the uncured Prompt-L-Pop could be interacting with the overlying sealant to reduce adhesion between the 2 materials. If this was the result, higher microleakage values would have been found for this experimental group when compared to Prompt-L-Pop applied and immediately light cured (group 2). However, no such difference between experimental groups was found. Thus, it may be assumed that, within the time frame of application and light curing of the 2 materials simultaneously, there was no further degradation of bonding to the enamel sur-

face. The only evident problem with exposing both the acidic adhesive and sealant together was the great lack of miscibility of the 2 resins.

The clinical implications of these results indicate that one should not use this combination of acidic resin monomer and sealant. Only 1 sealant and 1 acidic resin primer were tested in this study, both from the same manufacturer. Hence, global statements regarding the effectiveness of all such acid resin primers and sealants cannot be made.

### Conclusions

1. Conventional acid etching of enamel demonstrated lower incidence of marginal microleakage in sealants in vitro than did use of an acidic primer resin.
2. The incidence of microleakage for sealants placed with acidic primer resin was similar for either pre-curing the primer prior to sealant placement or curing both primer and sealant in one step.

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