

Effect of etching on leakage of sealants placed after air abrasion

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Abstract

Purpose: *The aim of the present study was to assess the microleakage of pit and fissure sealants in: 1) air-abraded molars with and without etching and 2) in preventive resin restorations (PRR) prepared with air abrasion or mechanically with a bur.*

Methods: *Forty molars with no or minimal occlusal caries were cleaned with pumice, washed, and assigned to four groups of 10 teeth each. In group A, the teeth were air-abraded and Helioseal® was applied directly to the fissures without previous treatment. Group B was air-abraded and etched for 20 s prior to sealant application. In group C, caries was excavated with air abrasion, etched, and restored with Scotchbond Multipurpose, Z-100® and Helioseal. Group D was similar to C except that the fissures were prepared mechanically with a carbide bur at high speed.*

Results: *Group A was significantly different in both Y1 and Y2 measurements from all the other groups. No differences were observed between all the other groups. Acid etching should be a precondition before sealant application. Air abrasion and mechanical preparation resulted in the same amount of microleakage following acid etch. (Pediatr Dent, 20:1, 25–27, 1998)*

Many efforts have been made to improve sealant success: one of them relates to the preparation and/or cleaning techniques used on the tooth surface prior to sealant application.

Prophylaxis before sealant application has been recommended in the past, but opinion on this has lately shifted.¹ Other techniques, such as using a sharp probe or scraping the pits and fissures, did not achieve the goal of sufficient debridement.^{2–4} Complete penetration of the acid etch and subsequently of the sealant rarely occurs with the mentioned conventional cleaning methods,^{3–5} so other methods have been suggested:

1. Mechanical preparation: Widening fissures with rotary instrumentation permits better diagnosis of underlying decalcifications and improves sealant re-

tion by allowing deeper sealant penetration and increasing the surface area.^{6–8}

2. Air-abrasive technology: Introduced in the 1950s,⁹ it uses a high-speed stream of purified aluminium oxide particles propelled by air pressure onto the cleaned and dried tooth surface, revealing areas of enamel decalcification.¹⁰ Stains and the organic plugs found in most pits and fissures are removed, revealing carious extensions into the subsurface areas of the enamel.¹¹ The abrasive action cleans and widens the pits and fissures while leaving all but a few microns of healthy tooth structure intact.¹⁰ Longer and repeated exposure can excavate incipient caries, preparing the tooth surface for the placement of bonded resin materials.

Dye penetration has been utilized by several investigators to assess the presence of marginal leakage around the sealant/enamel interface.^{12–14} The penetration of a dye, although not an absolute measure, can indicate the lack of a perfect seal.

The purpose of this study was two-fold:

1. To compare the microleakage of pit and fissure sealants applied to air-abraded enamel with and without etching
2. To evaluate the microleakage of sealants and preventive resin restorations (PRR) after surface preparation with air abrasion or mechanical preparation with a bur.

Methods

Sample preparation

Forty-five extracted human teeth free of restorations or other defects, and with no or minimal occlusal caries were stored in 0.1% thymol. The presence of caries was determined according to clinical parameters using a sharp explorer and visual inspection. During the caries removal procedure, the teeth with deeper carious lesions were included in the PRR restoration group, leading to an uneven number of teeth in the groups. The teeth were cleaned of all debris with an aqueous slurry of pumice using a soft polishing brush

at low speed and were rinsed with tap water. They were divided into four groups: group A, 13 teeth without caries, group B, 12 teeth without caries, group C, 10 teeth with minimal caries, and group D, 10 teeth with minimal caries. A fissure sealant or preventive resin restoration (PRR) was placed on each tooth. The sealant was Heliobond® (Vivadent, Schaan, Lichtenstein) and the composite for the PRR was Z-100® with Scotchbond Multipurpose® (3M Dental Products). All materials were used according to manufacturers' instructions. A high-velocity air microabrasion machine (Model KV-1, Kreative® Inc. Oregon) was used for surface preparation in Groups A, B, and C. The kinetic cavity preparation technique was performed, using particle size of 50 µm and nozzle tip size of 0.14/45°. Dry nitrogen was used, providing a nozzle pressure of 110 psi. The powder flow was set at 6.0°. In group D, a carbide 330 bur (SS White) was employed. All light curing was done with the Heliolux® (Vivadent) light.

Teeth in group A were air abraded and the sealant placed without additional etching. Group B teeth were air abraded and then etched for 20 s before sealant application. In group C, caries was excavated using air abrasion, and the tooth etched for 20 s. Scotchbond Multipurpose was then applied to the cavity, followed by Z-100 and Heliobond. Teeth in group D were treated by mechanical preparation using a carbide bur at high speed with water cooling. After caries excavation, the restorative procedure was identical to that of group C.

Thermocycling

All teeth were thermo-cycled between 4 ± 2°C and 60 ± 2°C for 750 cycles. The dwell time in each bath and at room temperature between baths was 1 min. After thermocycling, teeth were stored in saline before immersion in dye.

Immersion in dye

After saline storage, the surfaces of the teeth, apart from the restorations and approximately 1.5 mm beyond the margins, were coated with a layer of nail varnish, melted utility wax, and a second layer of nail varnish. The coated teeth were immersed in 2% basic fuchsin solution for 24 h to allow dye penetration into possible gaps between the tooth substance and the sealant. After removal from the dye, the coatings were stripped off and the teeth embedded in self-cur-

ing resin. Three buccolingual sections were obtained by grinding off the embedded teeth buccolingually parallel to their axes.

Marginal leakage evaluation

The depth of dye penetration was evaluated by a single examiner in a blinded procedure using a binocular microscope at 25x magnification (Olympus, Model X, Tokyo, Japan). The depth of dye penetration (B + D) and of sealant/tooth interface (A + C) was measured in millimeters using a grid of 0.2 mm. The dye penetration value was evaluated as: 1) the absolute dye penetration in millimeters (Y1), defined as the sum of distance B + D, and 2) dye penetration proportional to the length of the sealant/tooth interface (Y2), defined as Y1 divided by the sum of distances A + C. The mean of the sum of the measurements of the three sections of each tooth was adopted as the representative value (Figure 1).

Results

Mean values of dye penetration in the four groups are presented in Table 1. Due to the non-normal distribution of data, Wilcoxon's rank-sum test (the Mann-Whitney U test) was used to determine the significance of the difference between treatment groups for Y1 and for Y2 measurements.

The mean value of dye penetration in group A was significantly greater in both Y1 and Y2 ($P = 0.0013$,

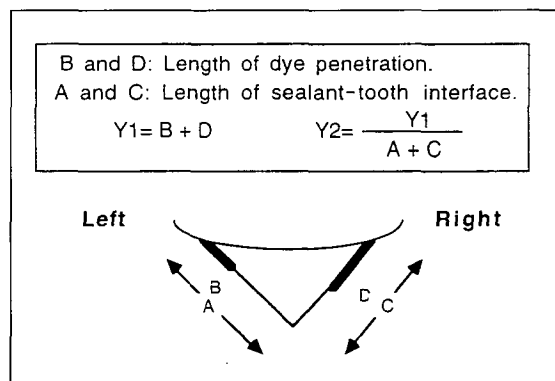


Fig 1. Scoring system employed for the evaluation

TABLE. MEAN VALUES FOR Y1 AND Y2 IN THE DIFFERENT GROUPS.

Treatment	N	Mean (Y1)	Std (Y1)	Mean (Y2)	Std (Y2)
Group A	13	0.84*	0.72	0.46*	0.39
Group B	12	0.16	0.23	0.10	0.15
Group C	10	0.07	0.08	0.03	0.03
Group D	10	0.07	0.1	0.04	0.05

Wilcoxon-Mann Whitney test. * $P < 0.05$

$P = 0.0015$) respectively. No significant difference was found between other groups (group B vs. group C vs. group D).

Discussion

The clinical significance of a microleakage test nowadays is viewed with uncertainty. Within its known limitations, it should be viewed as a theoretical level of leakage which may occur *in vivo*¹⁵ and can be accepted as an aid for developmental purposes.¹⁶ The penetration of a dye, although not an absolute measure, can indicate the lack of a perfect seal.

Only one examiner rated the teeth in a blinded procedure. Rating the amount of dye using a millimeter scale, and with high magnification and grid sensitivity, can minimize the possible error of a single-examiner approach.

The results of this investigation demonstrate that microleakage was significantly higher in the nonetch group, suggesting that the role of etching is critical and more important than the method of tooth surface preparation. This result is in agreement with the study of Roeder,¹⁷ who found that air abrasion does not eliminate the need for etching. In our study we found that air abrasion is comparable to bur preparation in achieving low microleakage when acid etch is employed. There were no statistically significant differences between groups C and D (air abrasion vs. bur preparation). A comparison between the two surface treatment techniques regarding bond strength and retention rates should follow. Another aspect to be investigated is the amount of tooth structure loss in both methods. As composite resins are known to shrink¹⁸ during curing, testing PRRs against fissure sealants with regard to microleakage seems justified (group B vs. groups C and D). In PRRs a bigger mass of resin contracts when cured, so they may behave differently than smaller, unfilled fissure sealants. However, we did not find a statistical difference in microleakage values between these groups.

Moreover, as a sealant and a PRR can differ considerably in size, it seemed important to evaluate not only the absolute dye penetration in millimeters (Y1), but also the amount of dye penetration relative to the length of the sealant/ or PRR/tooth interface (Y2) (Table). Both values (Y1 and Y2) showed comparable results.

Conclusions

1. Acid etching before sealant application, and also after air abrasion of the surface enamel, decreased leakage compared to no etching

2. Air-abrasive technology and bur preparation are equally successful in achieving low microleakage when used with etching.

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