

A 48-month Clinical Evaluation of Fissure Sealants Placed With Different Adhesive Systems

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Clinical Relevance

Etch-and-rinse adhesive systems can be a better choice for ensuring the long-term success of fissure sealants.

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SUMMARY

Aim: To compare the retention rates of a nano-filled occlusal fissure sealant placed with the use of an etch-and-rinse or a self-etch adhesive over 48 months.

Materials and Methods: The authors enrolled 244 teeth, each with no restoration or sealant and no detectable caries, from 16 patients. The sealants were placed with Solobond M two-step etch-and-rinse adhesive or Futurabond NR one-step self-etch adhesive by four previously calibrated dentists using a table of random numbers. After completion of the adhesive application, a nanofilled sealant, Grandio Seal, was applied and light-cured. Two other calibrated examiners, who were unaware of which adhesive had been used, independently evaluated the sealants at baseline and at 12-, 24-, 36-, and 48-month recalls. Each sealant was evaluated in terms of caries formation being present or absent and retention using the following criteria: 1 = completely retained, 2 = partial loss, and 3 = total loss. The

Pearson χ^2 test was used to evaluate differences in retention rates among the sealants used with different adhesives for each evaluation period.

Results: The retention rates for sealants in the Solobond M group were significantly higher than those in the Futurabond NR group in all periods of evaluation ($p < 0.05$). No statistically significant difference between the retention rates for premolars and molars was found at each evaluation period ($p > 0.05$). There was no new caries formation throughout the 48-month recall period.

Conclusion: Fissure sealants placed with etch-and-rinse adhesive showed better retention rates than those placed with self-etch adhesive.

INTRODUCTION

Dental caries is a global public health problem that can be effectively prevented and controlled through a combination of individual, community, and professional efforts.¹ Although only 12.5 percent of all tooth surfaces are occlusal, most of the total caries experienced by children and adolescents proceeds from occlusal caries.² As a result of the morphology of the pit and fissure surfaces there are stagnation areas, where the plaque formed is anatomically protected from even a single toothbrush filament by the dimensions of the fissure.³ Because preventive approaches, such as control of bacterial plaque and topical applications of fluoride, have little effect on pits and fissures, more effective treatments are necessary.⁴ Application of pit-and-fissure sealants are one of the treatment modalities that has been shown to be very effective in preventing occlusal caries by physical obstruction of the pits and fissures.^{5,6} Therefore, the clinical effectiveness and success of sealants have been equated with their retention.⁷ If the sealant is fully retained, then recurrent caries or progression of caries beneath the restoration is negligible.⁵ To enhance the longevity of pit-and-fissure sealants, several materials and techniques have been developed, including the use of adhesive systems under sealants.^{8,9}

Bonding to enamel with the etch-and-rinse system is a reliable technique. Phosphoric acid etching removes contaminants and creates an irregular microporous enamel surface that is infiltrated by the resin-based sealant material. It has been reported that the highest bond strengths to human enamel were obtained using phosphoric acid etching

and adhesives underneath the sealants.^{10,11} However, the taste, rinsing, and suction associated with the phosphoric acid etching stage may be unpleasant for patients.¹²

Self-etch adhesive systems have been developed to simplify the bonding procedures, which significantly reduces the clinical application time and technique sensitivity because the enamel/dentin acid etching, rinsing, and drying steps are eliminated.^{13,14} Because they have fewer operative steps and a shorter chairtime, self-etch adhesives may also be advantageous for treating pediatric patients. However, previous studies^{15,16} have reported that their adhesive performance with unground enamel is challenging. The literature includes limited documentation comparing the effects of etch-and-rinse and self-etch adhesive systems on clinical performance of pit-and-fissure sealants, and the results are contradictory. Although some studies^{16–18} recommended the use of etch-and-rinse systems, one study reported that etch-and-rinse and self-etch systems cause similar results in terms of retention *in vivo*.¹²

In 2009, we reported detailed information about the clinical performance of fissure sealants placed with different adhesives for a 24-month period.¹⁸ As there is little information about the effectiveness of a self-etch adhesive application before fissure sealant placement, the aim of this clinical study was to compare the retention rates of a nanofilled occlusal fissure sealant placed with the use of an etch-and-rinse adhesive or a self-etch adhesive after a longer follow-up period.

MATERIALS AND METHODS

The protocol and consent form for this study were reviewed and approved by the Hacettepe University Human Ethics Committee. Written informed consent for involvement in the study was obtained from all patients.

A total of 16 patients (15 women and 1 man) who were seeking routine dental care at the conservative dentistry clinics at the Hacettepe University, Faculty of Dentistry, were selected. Patients who participated in the current study had good general and oral health and hygiene. They also had no detectable caries, bruxism, malocclusion, previously placed restorations or sealants on the fissures, or allergies to resins. The mean age of the patients was 20 years, and the patients ranged in age from 18 to 21 years.

Bitewing radiographs were taken. The fissures of teeth were then cleaned with a slurry of pumice applied with a bristle brush in a slow-speed

Table 1: Distribution of Sealant Retention Rates

Evaluation ^a	12 Months		24 Months		36 Months		48 Months	
	Solobond M	Futurabond NR	Solobond M	Futurabond NR	Solobond M	Futurabond NR	Solobond M	Futurabond NR
1 (No. [%])	109 (89.3)	25 (20.5)	93 (81.6)	18 (15.8)	86 (75.4)	13 (11.4)	82 (71.9)	10 (8.7)
2 (No. [%])	8 (6.6)	16 (13.1)	12 (10.5)	12 (10.5)	19 (16.6)	12 (10.5)	20 (17.5)	11 (9.6)
3 (No. [%])	5 (4.1)	81 (66.4)	9 (7.9)	84 (73.7)	9 (7.8)	89 (78)	12 (10.5)	93 (81.5)
Total No.	122	122	114	114	114	114	114	114
<i>P</i> value	<0.001		<0.001		<0.001		<0.001	
^a 1, Completely retained; 2, partial loss; 3, total loss.								

handpiece to remove salivary pellicle and any remaining plaque. By using a table of random numbers, four previously calibrated dentists placed a total of 244 sealants on the permanent premolars and molars with either Solobond M (Voco, Cuxhaven, Germany), a two-step etch-and-rinse adhesive, or Futurabond NR (Voco), a one-step self-etch adhesive. After completion of the adhesive application, a nanofilled sealant, Grandio Seal (Voco), was applied and gently teased through the fissure with the tip of a periodontal probe to prevent voids and air entrapment. Then, the applied fissure sealants were polymerized using a quartz-tungsten-halogen light (Hilux, Benlioglu, Ankara, Turkey). Light output of the curing unit was found to exceed 550 mW/cm² before and after the study, as verified with a radiometer. The occlusion was checked with articulation paper. Finishing and polishing were performed using fine-grit diamond burs (Diatech, Swiss Dental, Heerbrugg, Switzerland) and rubber cups (Edenta AG, AU SG, Switzerland). All of the materials were used according to the manufacturers' instructions, and moisture control was maintained by use of adapted cotton-roll isolation procedures and a chairside assistant.

Two other calibrated examiners (ARY, MB), who were unaware of which adhesive had been used, independently evaluated the sealants with the aid of a dental explorer and an introral mirror. At the beginning of the study, Kappa values were calculated to test the intra- and interexaminer reproducibility. The Kappa values were high (0.95) and showed powerful intra- and interexaminer agreement. Each sealant was evaluated in terms of caries formation as

present or absent, and retention was evaluated using the following criteria:

- 1) Completely retained (CR)
- 2) Partial loss (PL)
- 3) Total loss (TL)

The Pearson χ^2 test was used to evaluate differences in the retention rates of the sealants used with different adhesives for each evaluation period at a 5% level of significance.

RESULTS

Sixteen patients participated in this clinical study. The distribution of sealant retention rates are displayed in Table 1. Differences between the retention rates of fissure sealants placed with Solobond M and Futurabond NR were statistically significant for all periods of evaluation ($p < 0.05$).

After 12 months, 134 fissure sealants of the 16 patients were completely retained. The retention rates of sealants placed with Solobond M and Futurabond NR were 89.3% and 20.5%, respectively.

At the 24-month recall, one patient with 16 sealants could not be evaluated because of relocation to another city. Therefore, 228 sealants of 15 patients were available for evaluation. 111 teeth were fully sealed with the fissure sealant. The retention rate of the Solobond M group was found to be 81.6%, whereas it was 15.8% for the Futurabond NR group, as previously reported.¹⁸

After 36 months, the retention rates of sealants placed with Solobond M and Futurabond NR were

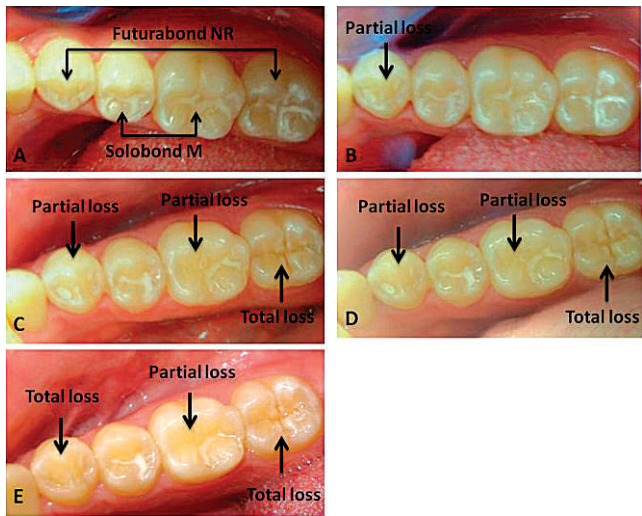


Figure 1. Fissure sealants at baseline (A), at 12 months (B), at 24 months (C), at 36 months (D), and at 48 months (E).

75.4% and 11.4%, respectively. There were nine total losses with Solobond M and 89 total losses with Futurabond NR.

At the end of 48 months, 82 sealants from Solobond M group and 10 sealants from Futurabond NR group were evaluated as completely retained; the retention rates for the groups were 71.9% and 8.7%, respectively. Twelve sealants from the Solobond M group were totally lost throughout the study; 93 were totally lost in the Futurabond NR group. Twenty sealants from the Solobond M group and 11 sealants from the Futurabond NR group were partially lost (Figure 1).

Distribution of retention rates of premolars and molars are shown in Tables 2 and 3. No statistically significant differences were found between the retention rates of premolars and molars at each evaluation period. We did not observe caries development on any of the teeth during the 48 months.

DISCUSSION

Fissure sealants can be used for caries prevention in at-risk, caries-free teeth and as therapy for carious lesions limited to enamel (incipient caries). They are also appropriate as a conservative restoration in many situations in which caries extends into the dentin. This means that not only children, on which most sealant studies have focused, but also adults with appropriate indications can benefit from their use.^{19,20} Nevertheless, clinical trials involving children are hard to perform, as sealants are very technique sensitive. Success of the follow-up is also dependent on parent cooperation and motivation to bring the child for follow-up. Therefore, we evaluated sealant retention rates in adults.

The extent and depth of the etching pattern logically should influence the bonding performance of an adhesive, as enamel bonding is primarily based on micromechanical interlocking of a low-viscosity resin into microporosities.²¹ The depth of the enamel surface removed during the etching procedure can be affected by a number of factors, such as the type and concentration of acid, the duration of etching, and the chemical composition of the surface.^{22,23} It has been demonstrated that the application of a one-step self-etch adhesive did not create a deep enamel

Table 2: <i>Distribution of Sealant Retention Rates of the Solobond M Group for Premolars and Molars</i>								
Evaluation ^a	Solobond M							
	12 Months		24 Months		36 Months		48 Months	
	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar
1 (No. [%])	54 (49)	56 (51)	47 (50.3)	46 (49.7)	40 (46.5)	46 (53.4)	37 (45.1)	45 (54.8)
2 (No. [%])	1 (12.5)	7 (87.5)	2 (16.7)	10 (83.3)	8 (42.1)	11 (57.8)	8 (4)	12 (6)
3 (No. [%])	3 (75)	1 (25)	5 (55.5)	4 (44.5)	6 (66.6)	3 (33.3)	9 (75)	3 (25)
Total no.	58	64	54	60	54	60	54	60
P value	>0.05		>0.05		>0.05		>0.05	
^a 1, completely retained; 2, partial loss; 3, total loss.								

Table 3: Distribution of Sealant Retention Rates of the Futurabond NR Group for Premolars and Molars

Evaluation ^a	Futurabond NR							
	12 Months		24 Months		36 Months		48 Months	
	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar
1 (No. [%])	14 (56)	11 (44)	10 (55.5)	8 (44.5)	5 (38.5)	8 (61.5)	4 (40.0)	6 (60.0)
2 (No. [%])	5 (31.2)	11 (68.7)	4 (33.3)	8 (66.7)	5 (41.7)	7 (58.3)	3 (27.3)	8 (72.7)
3 (No. [%])	39 (48.1)	42 (51.9)	40 (47.7)	44 (52.3)	44 (49.4)	45 (50.6)	47 (50.5)	46 (49.5)
Total No.	58	64	54	60	54	60	54	60
P value	>0.05		>0.05		>0.05		>0.05	

^a 1, completely retained; 2, partial loss; 3, total loss.

etching pattern compared to those of phosphoric acid.^{24,25} Dos Santos and others²⁶ evaluated the penetration of adhesive materials into enamel before the application of a pit-and-fissure sealant and reported that etching with phosphoric acid exhibited significantly greater penetration than enamel treated with a self-etch adhesive. Beloica and others²⁷ have reported that the microshear and microtensile bond strength to intact enamel of the recently introduced all-in-one adhesives was inferior to that of an etch-and-rinse system. Various studies have also indicated the potential benefit of additional phosphoric acid etching of enamel before application of a self-etch adhesive.^{28,29} Luhrs and others³⁰ showed significantly increased shear bond strength values to enamel with the addition of phosphoric acid etching to self-etch adhesives. Another study also reported that pre-etching the intact enamel with 37% phosphoric acid resulted in the formation of longer resin tags and a higher depth of penetration of the resin tags of the self-etch adhesive (Clearfil SE bond); it also attained a higher bond strength to intact enamel.³¹

Consistent with our 24-month results, the sealant retention rates were higher for the Solobond M group at the 36- and 48-month recalls. In accordance with these findings, Venker and others³² reported that at the end of their 12-month clinical study, sealants placed with self-etch adhesives had lower retention rates compared with sealants placed with phosphoric acid etching. In another clinical study, the effects of a self-etch adhesive system and a conventional acid etching on retention of a fissure

sealant were compared.¹⁷ It has been found that at the end of a 12-month period, the retention of the acid-etch group was significantly superior to that of the self-etch group. They concluded that the best practice for placement of sealants remains enamel preparation with acid etch and use of an intermediate bonding layer.¹⁷

Contrary to the findings of the current study, Feigal and Quelhas¹² reported similar sealant retention rates using Prompt-L-Pop adhesive and conventional phosphoric acid etching without the use of any bonding agent *in vivo*. However, the results cannot be directly compared with our results, as no adhesive system was used in conjunction with the phosphoric acid. Moreover, it has been reported that the pH of Prompt-L-Pop was approximately one and was almost as aggressive as conventional phosphoric acid etching.²⁴ Moura and others³³ demonstrated a correlation between the pH of the adhesive systems and the level of morphological alterations of the enamel surface. Recently, it has been demonstrated that self-etch systems with higher pH values (AdheSE and Clearfil SE Bond) can have increased bond strength values when the application time is doubled.³⁴ They found a significant correlation between pH and mean bond strengths. The low retention rates observed with Futurabond NR at each evaluation period of the current study may be related to the pH of the adhesive (pH=1.4), which is considered to be a mild self-etch primer. This may have caused insufficient etching and deficient resin penetration of the self-etching priming agents into the fissure enamel.

Nevertheless, achieving a sufficient etching pattern on unground enamel remains a problem for self-etching adhesives.¹⁵ The intact enamel surface is prismless, is hypermineralized, and contains more inorganic material than the inner enamel layer.³⁵ By using etch-and-rinse adhesive systems, the prismless enamel surface layer is removed because of the phosphoric acid etching and subsequent water rinsing of the etched enamel. Therefore, sufficient microretentive bonding of the fissure sealant can be provided by the exposure of the prismatic structured enamel. In contrast, treatment with self-etching priming agents does not remove a significant amount of the prismless enamel surface layer, as no rinsing takes place after application of the primer.^{15,21} It is possible that the prismless enamel surface layer prevents the permeation of self-etching primers, thus leaving some areas partially unetched.¹⁵ It has recently been shown that self-etching primers produce high-tensile bond strengths when enamel is roughened but lower tensile bond strengths when enamel is left unprepared.^{15,16}

Before acid etching and sealant application, it is important to make sure that the fissures are free from plaque and debris, which may influence the etching and sealing pattern.³⁶ In the current study, prophylaxis was performed with pumice before the sealant placement. The remaining pumice and debris in the fissures could be another reason for the lower retention rates of the Futurabond NR group, as its etching capacity is not high enough to remove remnants from the fissures. However, the etching capacity of phosphoric acid has been reported to be high enough to remove those remnants.³⁶

Studies on sealant retention by tooth type report that premolars have the highest sealant retention rates and second molars have the lowest.³⁷⁻³⁹ However, no statistically significant difference was found between the retention rates for premolars and molars in the current study.

CONCLUSION

This clinical study has demonstrated that, over a 48-month period, fissure sealants placed with an etch-and-rinse adhesive showed significantly higher retention rates than those placed with a self-etch adhesive. Further clinical studies are needed to confirm the reproducibility of these findings.

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Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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