A two-year clinical evaluation of pit and fissure sealants placed with and without air abrasion pretreatment in teenagers

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ABSTRACT

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Background. Long-term retention of pit and fissure sealants is essential for their success. The aim of this study was to compare the retention rates of sealants placed with acid-etching and air abrasion followed by acid etching.

Methods. Sixteen subjects aged 16 and 17 years were included in the study. Using a half-mouth design, the authors performed fissure preparation with phosphoric acid gel on randomly assigned maxillary and mandibular permanent premolars and molars from one side of the mouth (Group I) and performed air abrasion followed by acid etching on the contralateral side of the mouth (Group II). The authors applied sealant material on 162 teeth, and they evaluated the sealants as complete retention, partial loss or total loss at six, 12 and 24 months.

Results. While fissure sealant retention rates were not significantly different for the two techniques at six months ($P = .97$), the retention rates for the teeth in Group II were significantly higher at 12 ($P = .025$) and 24 months ($P = .002$). Molar retention rates were significantly less than those for premolars at each evaluation period ($P < .05$).

Conclusion. The sealant retention rates at 12 and 24 months were higher in Group II (air abrasion followed by acid etching).

Clinical Implications. As air abrasion followed by acid etching resulted in significantly higher sealant retention rates, this method could be a good choice for fissure preparation before sealant placement for long-term success.

Key Words. Acid etching; dental sealant; air abrasion.

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Pit and fissure sealants are a safe and effective preventive treatment for caries.[1,2] They help control caries by forming a physical barrier that prevents the metabolic exchange between fissure microorganisms and the oral environment.[3-5] Therefore, the clinical success of fissure sealants is related to their retention rates and integrity.[4-6]

Sealants rarely are retained completely over the tooth's lifetime and must be reapplied. Even under proper application conditions, 5 to 10 percent of sealants can be expected to fail annually.[7] Sealant longevity is related to the retentive condition of the surface and the removal of any surface debris before placement. The use of phosphoric acid is a well-accepted and standard method for roughening enamel surfaces. However, remaining debris and pellicle might not be removed by the conventional prophylaxis and the etching process.[8,9] Therefore, several methods of preparing fissures such as enameloplasty, an air-polishing system or laser treatment have been advocated by researchers for sealant retention.

Air abrasion has been suggested for preparing fissures before sealant placement.[10] Although air abrasion was introduced to dentistry in 1945, it has become more popular with the advent of minimally invasive

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dentistry. The air abrasion system uses a stream of aluminum oxide particles generated from compressed air or bottled carbon dioxide or nitrogen gas that abrade tooth structure.[11] Besides mechanically roughening enamel, an air abrasion system opens up questionable fissures and removes caries before the fissures are sealed. Several studies have reported conflicting results with this treatment, especially the need for additional pretreatment methods before sealant placement.[12-16]

We conducted a two-year clinical study to evaluate whether sealant retention increased when fissures were prepared using an air abrasion system followed by acid etching.

SUBJECTS, MATERIALS AND METHODS

We selected 16 students (14 female, two male) aged 16 and 17 years who were patients at Hacettepe University Dental School (Ankara, Turkey) for this study. Subjects who had no restorations or sealants on their fissures and no detectable caries met the inclusion criteria. All subjects had satisfactory oral hygiene.

We took bitewing radiographs of the teeth to be restored. We then cleaned the teeth with a pumice and water slurry using a slow-speed handpiece for 30 seconds. After prophylaxis, we washed the teeth with a water spray for 60 seconds.

Using a half-mouth design, one operator (A.R.Y.) acid-etched randomly assigned maxillary and mandibular permanent premolars and molars of one side of the mouth and used air abrasion followed by acid etching on premolars and molars on the contralateral side. She placed sealants on 162 teeth (46 molars, 116 premolars) and used a rubber dam to isolate the teeth.

The fissure preparation method differed by group. For Group I, the operator etched the occlusal fissures with a 35 percent phosphoric acid gel for 30 seconds using a microbrush. After rinsing the enamel with water for 30 seconds, the operator dried the enamel for 15 seconds with oil-free compressed air. For Group II, the operator air abraded the occlusal fissures with an air abrasion device (PrepStart, Danville Materials, San Ramon, Calif.) with 27-micrometer aluminum oxide particles at 120 pounds per square inch of pressure. The distance of the nozzle tip to the surface was 2 to 3 millimeters, and the operator held it perpendicular to the surface. After air abrasion, the operator rinsed the teeth thoroughly with a water spray for 30 seconds to clean residual aluminum particles from the surface. The operator then etched the prepared occlusal fissures with a 35 percent phosphoric acid gel for 30 seconds and thoroughly rinsed and dried them as she did for Group I.

After completing the fissure preparations, the operator carefully applied Concise Light Cure White Sealant (3M ESPE, St. Paul, Minn.) to the prepared surfaces using a microbrush and an explorer and polymerized it for 40 seconds with a curing light with a power output of 400 milliwatts per square centimeter. Concise Light Cure White Sealant is an unfilled sealant, with a filler weight of 9.9 percent. After removing the rubber dam, the operator checked the occlusion, adjusted the sealants with a composite finishing bur and polished the sealants with polishing points.

CLINICAL EVALUATION

Two other calibrated examiners (G.Ö., B.D.) who were unaware of which etching method had been used before fissure sealant placement evaluated the sealants independently during clinical evaluations at six-, 12- and 24-month recall appointments. They reached a consensus if their results were not the same.

Evaluation of the sealants at each recall appointment involved visual examination with the aid of a dental explorer and intraoral mirror. The examiners evaluated each sealant according to the following scale: 1 = complete retention; 2 = partial loss; 3 = total loss.

We used the χ^2 test to evaluate differences in the retention rates between the two fissure preparation methods for each evaluation period. We used the χ^2 test or Fisher exact test to compare the retention rates of molars and premolars at each evaluation period.

RESULTS

We recalled all subjects for all evaluations. Table 1 shows the distribution of sealant retention rates at six, 12 and 24 months.

At six months, we observed a partial loss of seven sealants and the total loss of two sealants in subjects in Group I. We noted a partial loss of three sealants in subjects in Group II. We found no statistically significant difference in retention rates at six months between teeth in Group I and Group II ($P > .05$). At the 12- and 24-month recall appointments, subjects in Group II had significantly higher retention rates than did subjects in

TABLE 1

Distribution of sealant retention rates for Group I* and Group II.†

EVALUATION	SIX MONTHS		12 MONTHS		24 MONTHS	
	Group I	Group II	Group I	Group II	Group I	Group II
1 = Complete Retention (No. [%])	72 (88.9)	78 (96.3)	68 (84.0)	77 (95.1)	62 (76.5)	74 (91.4)
2 = Partial Loss (No. [%])	7 (8.6)	3 (3.7)	10 (12.3)	4 (4.9)	12 (14.8)	7 (8.6)
3 = Total Loss (No. [%])	2 (2.5)	0 (0)	3 (3.7)	0 (0)	7 (8.6)	0 (0)
Total No. of Evaluated Teeth	81	81	81	81	81	81
χ^2 Test	$P = .97$		$P = .025$		$P = .002$	

* Group I: Acid etching.
† Group II: Air abrasion followed by acid etching.

TABLE 2

Distribution of sealant retention rates for molars and premolars.

EVALUATION	ACID ETCHING						AIR ABRASION FOLLOWED BY ACID ETCHING					
	Six Months		12 Months		24 Months		Six Months		12 Months		24 Months	
	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar
1 = Complete Retention (No. [%])	56 (96.6)	16 (69.6)	55 (94.8)	13 (56.5)	50 (86.2)	12 (52.2)	58 (100.0)	20 (87.0)	57 (98.3)	20 (87.0)	57 (98.3)	17 (73.9)
2 = Partial Loss (No. [%])	1 (1.7)	6 (26.1)	2 (3.4)	8 (34.8)	3 (5.2)	9 (39.1)	0 (0)	3 (13.0)	1 (1.7)	3 (13.0)	1 (1.7)	6 (26.1)
3 = Total Loss (No. [%])	1 (1.7)	1 (4.3)	1 (1.7)	2 (8.7)	5 (8.6)	2 (8.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total No. of Evaluated Teeth	58	23	58	23	58	23	58	23	58	23	58	23
P Value	.003		.001		.001		.021		.004		.002	

Group I ($P < .05$). Subjects in Group I had a retention rate of 84 percent at 12 months and 76.5 percent at 24 months, and subjects in Group II had a retention rate of 95.1 percent at 12 months and 91.4 percent at 24 months.

While we did not observe total sealant loss in subjects in Group II at any of the recall appointments, we did note that seven sealants were lost at the 24-month recall appointment in Group I.

Table 2 demonstrates the difference between the retention rates for premolars and molars at the six-, 12- and 24-month recall appointments. The complete and partial retention rates of premolars were statistically higher than those for molars ($P < .05$).

We did not observe caries development on any of the sealed surfaces throughout the 24-month recall period.

DISCUSSION

Adequate isolation is the most critical aspect of the sealant application process. Therefore, we placed all sealants under rubber dam isolation, as rubber dams provide the best, most controllable isolation.[17] In addition, it is impracticable to use air abrasion without using a rubber dam, as using air abrasion systems creates dust in the working area.

In this study, we evaluated sealant retention rates in teenagers. Although most sealant retention studies involve teeth at childhood, clinical trials with children are difficult to perform since the success of follow-up depends on the parents' motivation to bring their children to scheduled appointments.[18] In 2002, Feigal[19] reported that caries risk on surfaces with pits and fissures might continue into adulthood; therefore, posteruptive age alone no longer should be used as a major criterion for making a decision about whether to place sealants. He also pointed out that any tooth at any age could benefit from sealants. More recently, Yıldız and colleagues[20] found that applying sealants on fissures was highly effective in preventing caries in a popula-

tion aged 18 to 20 years.

Researchers have investigated a variety of fissure preparation methods in an attempt to improve sealant retention. There are contradictory results about whether air abrading surfaces should be followed by acid etching. While one study reported that air abrasion has the potential to prepare enamel surfaces in a comparable way to that attained by acid etching,[16] other studies have found that a combination of air abrasion and phosphoric acid etching yielded better results in decreasing microleakage[13,21] and increasing bond strength than acid etching without air abrasion.[22,23] They concluded that air abrasion could not be used as a sole surface treatment before bonding resin-based composite to enamel and dentin.[24-27] Hatibovic-Kofman and colleagues[28] reported that the rough surface created by air abrasion without acid etching lacks the seal obtained with acid etching alone. Therefore, we chose not to test the retention rates of sealants on teeth that were air abraded only.

In our study, the 12- and 24-month retention rates for Group II were higher than those for Group I. While seven sealants were lost in Group I at the end of the 24-month recall period, no sealants were lost in Group II. Air abrasion may induce a more retentive etching pattern and enhance etchant penetration to deep fissures, as this system widens and deepens the pits and fissures, eliminates organic material and exposes a more reactive tooth enamel.

The presence of a prismless layer of enamel at the fissure entrance and fissure walls reduces the etching pattern.[29] The air abrasion technique removes the prismless enamel layer and enhances the development of resin tags to obtain better bonding results. Moreover, contamination at the fissure walls and bases that cannot be reached by routine etching procedures might inhibit the dispersion of the sealant and its ability to come into close contact with enamel.[8,30]

Contrary to our findings, Duangthip and Lussi[31] found that the use of air abrasion in combination with acid etching did not decrease sealant microleakage significantly or improve the penetration ability compared with the traditional pumice prophylaxis with acid etching. However, most studies evaluating the effects of air abrasion on microleakage or bond strength are based on in vitro results. Only a couple of clinical studies have compared the retention rates of sealants after air abrasion only.[31,32] In a study comparing sealant retention rates after traditional acid etching and after the use of air abrasion without acid etching, researchers observed no significant difference in retention rates between the two techniques at one year for occlusal surfaces.[33] However, the air abrasion preparation technique had significantly higher failure rates on other surfaces than did the acid etching preparation technique.

Our data reveal that the sealant retention rate at 12 and 24 months was higher for Group II. Our study supports findings from earlier in vitro studies that air abrasion is more effective for bonding when used with acid etching.[12,24-26] Besides conditioning the enamel surfaces, treating questionable occlusal incipient lesions is another benefit of using air abrasion.

Studies on sealant retention by tooth type report that premolars have the highest sealant retention rates and second molars have the lowest sealant retention rates.[34,35] In our study, we found that retention rates for molars were significantly lower than those for premolars. The retention rates for fissure sealants (91.4 percent for Group II and 76.5 percent for Group I) that we obtained from our two-year study are in accordance with other studies that reported rates of 75 to 84 percent for two years.[36-39]

CONCLUSIONS

There was a difference in success at 12 and 24 months between sealants placed with acid etching and those placed with air abrasion followed by acid etching. As clinical trials are the best method to predict the retention rates of fissure sealants, more long-term in vivo research studies should be conducted. ■

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