A Comparison of Sealant Placement Techniques and 12-month Retention Rates

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Abstract

Objective: *This study compared time required and 12-month retention for two methods of sealant placement: traditional acid-etch technique and air-abrasion technique without acid etch.* ***Methods:*** *Sealants were placed on the permanent first molars of 84 children in grades 1–4 who were randomly assigned to treatment groups. All sealants were placed in a school setting by the same clinician. Chair time required for sealant placement was recorded, and retention rates were determined for each technique 12 months after placement.* ***Results:*** *Mean chair time for placement of sealants on four first molars using the air-abrasion technique was significantly less than for the acid-etch technique (7:36 minutes vs 10:56 minutes). Fifty-eight children were available at 12-month follow-up; an examiner not involved in sealant placement and masked as to the technique used determined retention. Rates of complete retention for occlusal surfaces were not significantly different for the two techniques, although the rate for acid etch was higher than that for air abrasion (95% vs 87%). The complete retention rates for the acid-etch technique were significantly higher than air abrasion for buccal and distolingual surfaces. These rates were 65 percent and 58 percent, respectively, for acid etch and 6 percent and 28 percent, respectively, for air abrasion.* ***Conclusion:*** *Although more research is needed to improve air-abrasion applications, it does not appear that air abrasion without acid etching offers a significant advantage over traditional sealant placement methods and, in fact, appears to be inferior to the acid-etch technique for use in public health settings. [J Public Health Dent 2000;60(1):53-56]*

Key Words: pit and fissure sealants, prevention, dental caries.

A number of studies have attempted to address the cost effectiveness of dental sealants (1-3). These studies have come to different conclusions, eliciting considerable debate as to what degree pit and fissure sealants are cost effective (1,2,4), with no clear-cut consensus. However, there appears to be some consensus that such assessments of sealants' cost effectiveness are difficult because many factors need to be considered—including caries incidence, specific teeth and surfaces sealed, sealant retention rates, and personnel costs (5-9). Furthermore, such assessments are "... sensitive to the perspective used to judge the value of the benefit being purchased, i.e., a healthy and restoration-free tooth" (7).

Mitchell and Murray (10) identified several specific factors that affect the economics of pit and fissure sealants. These included patient and tooth selection, other preventive measures used, materials and equipment used, operator technique, and durability of the sealant. Another factor that clearly can affect the economics of pit and fissure sealants is the personnel time required to place the sealants, as the less time required per child, the more children could receive them in a given period of time. This factor may be especially important in sealant clinics, including school-based sealant programs.

Sealants are most cost effective when they are placed in patients and surfaces at high risk for decay (11) and they must be adequately retained to be effective (12,13). Thus, in addition to patient and surface selection, methods that can be used to increase cost effectiveness of sealants include materials and techniques that increase retention and save time in sealant placement.

Air-abrasive technology has re-emerged in recent years, with several authors advocating the use of air abrasion (without acid etch) prior to sealant placement (14,15). Proponents of air-abrasion technology suggest that it has the potential to increase sealants' cost effectiveness because it requires no water, thereby being less technique sensitive and requiring less time for sealant placement, while maintaining retention rates similar to, or better than, traditional acid-etch methods (16,17).

Several in vitro studies have compared the bond strength and the microleakage obtained by bonding sealant or composite to acid-etched and air-abraded enamel (17-22). These studies have reported mixed results; however, at least two studies have suggested equal or greater bond strength for air abrasion compared to acid etch (17,18). This paper reports the one-year retention rates of sealants placed in vivo using air-abrasion technology compared to sealants placed using traditional methods.

Methods

Children in grades 1–4 attending two low-income, public elementary schools in Muscatine, Iowa, were included in the study. Parents and guardians of children in these grades were notified that dental screening examinations would be conducted at no charge and that eligible children would be invited to participate in a study of pit and fissure sealants, also at no charge. Informed consent was

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TABLE 1
Time Required for Placement of Four Sealants Using Acid-etch and Air-abrasion Techniques

Technique	*N* Subjects	Mean Time (min)	SD (min)	Range (min)	Mean Difference	P-value
Acid etch	34	10:56	0:27	9:54–11:53	3:20	<.001
Air abrasion	29	7:36	0:41	6:35–9:12		

obtained for the screening examination and the study, following procedures outlined by the University of Iowa's human subjects' committee. Out of 181 children in grades 1–4 in the two schools, 151 received the dental screening examinations, and 109 were deemed eligible for the study based on the following criteria: presence of one or more sufficiently erupted first permanent molars that were caries- or restoration-free, sufficient cooperation of the child, and (due to the fine silica particles used in air abrasion) no history of asthma, cystic fibrosis, alpha-1 antitrypsin deficiency, or recent bronchitis. Of these, 84 children consented and were present to receive sealants.

Sealants were placed only on the first permanent molars, so that the number of teeth sealed ranged from one to four per participant, with 63 of the 84 children having four teeth sealed. For each tooth, two discrete surfaces were eligible for sealant placement: the occlusal surface and buccal pit of the mandibular first molar, and the mesio-occlusal pit and distolingual groove of the maxillary first molars. All such nonrestored, noncarious surfaces that did not already have existing sealants received sealants for the study, except for some buccal surfaces that had no detectable pit or fissure. About half of the mandibular first molars were excluded.

Using a computer-generated set of random numbers, study participants were randomly assigned to one of two sealant treatment groups: traditional acid-etch application and application using the KCP-1000 air-abrasion system. In total, 275 surfaces in 43 children were sealed using the acid-etch technique, and 264 surfaces in 41 children were sealed using the air-abrasion technique. All sealants were placed in the elementary school that the individual child attended using portable equipment. The same opaque sealant material (Helioseal® by Vivadent) was used for both techniques, and an experienced pediatric dentist (MJK) placed all sealants.

The protocols for both sealant placement techniques have been described previously (23). For sealant placement using the acid-etch technique, children were asked to "dry brush" their teeth while waiting for sealant placement. Teeth were then etched for 30 seconds with 37 percent phosphoric acid, rinsed for 15 seconds and thoroughly air dried. A dry field was maintained using cotton rolls and Dri-aids® (Young Dental, St. Louis, MO). Sealant material was applied using a small disposable brush (Benda-brush®, Centrix, Shelton, CT). All sealants were light cured for 20 seconds with a Demetron 401 light curing unit. The power density of the light curing unit exceeded 400 mW/cm^2 before and after placement of all sealants, as measured by a Demetron Model 100 Curing Radiometer (Kerr, Orange, CA).

For sealant placement using air abrasion, children were asked to dry brush and then the teeth to be sealed were air abraded for 15 seconds using the KCP-1000 (50μ particles of alpha alumina at 160 psi). As with the acid-etch group, cotton rolls and Dri-aids® were used to maintain a dry field. The sealant was applied and light cured for 20 seconds. Etching liquid and water were not used with the air-abrasion group.

For both groups, the amount of actual chair time required for sealant placement was recorded using a stopwatch. The specific teeth and surfaces sealed for each child also were recorded.

About 12 months following sealant placement, an experienced public health dentist (JJW), who had no knowledge of which technique was used for placement, conducted examinations to determine sealant retention. Retention was classified as complete, partial, or completely lost using established criteria (13). The follow-up examinations were conducted at the participating schools, using a portable chair, headlamp, mirror, and explorer.

Data were entered and verified using SPSS for Windows (24). Analysis focused on comparison of sealant retention and time required for sealant placement. *P*-values of .05 or less were considered statistically significant.

Results

Data regarding the amount of time required for sealant placement were available for all 84 participants; however, to facilitate meaningful comparisons of equal numbers of teeth per child, only those 63 children who received sealants on all four first permanent molars were included in the analysis of time required for sealant placement. Time comparisons of children receiving 1, 2, or 3 sealants were not done due to the small number in each group. The results of this comparison are presented in Table 1. The air-abrasion technique consistently required less time for sealant placement and, on average, required less than 70 percent of the time required for the acid-etch technique.

Of the 84 original participants, 58 (69%) were available for the 12-month follow-up evaluation of sealant retention. The 12-month sealant retention rates for the acid-etch and air-abrasion techniques by surface are presented in Table 2. Retention rates for the sealants placed using the acid-etch technique were higher than the retention rates for sealants placed using air abrasion for all surfaces. Differences in retention rates by technique were not statistically significant ($P=.17$) for occlusal surfaces. However, statistically significant ($P<.01$) differences in retention for buccal and distolingual surfaces were observed.

We also compared sealant retention rates for the two techniques on a per-child basis, and found that 12-month complete retention rates were significantly different for the two techniques (chi-square, $P=.041$). Complete retention of all sealant surfaces occurred in nine of 31 children (29%) who received

TABLE 2
Percent Distribution of Sealants by Retention at 12 Months and Surface Type

	Occlusal		Buccal Pit*		Distolingual Groove*		All Surfaces*	
	Acid Etch (*n*=119)	Air Abrasion (*n*=92)	Acid Etch (*n*=34)	Air Abrasion (*n*=31)	Acid Etch (*n*=62)	Air Abrasion (*n*=46)	Acid Etch (*n*=215)	Air Abrasion (*n*=169)
Totally retained	97.5	89.1	64.7	6.5	58.1	28.3	80.9	57.4
Partially retained	0.8	7.6	20.6	3.2	32.3	60.9	13.0	21.3
Completely missing	1.7	3.3	14.7	90.3	9.7	10.9	6.0	21.3

*Significantly ($P<.01$) different rates of complete retention between acid etch and air abrasion.

sealants placed using the acid-etch technique, while complete retention of all sealant surfaces occurred in two of 26 children (8%) who received sealants placed using air abrasion.

Discussion

As discussed previously, many factors must be considered in assessing the cost effectiveness of pit and fissure sealant, including time needed for sealant placement and rates of retention. Our study found that the use of air-abrasion technology did significantly reduce chair time in placement of pit and fissure sealants, and the technique required fewer steps than traditional methods. The time required to place four sealants using the traditional acid-etch technique in this study was 10 minutes 56 seconds, which is very close to the time of 9 minutes 25 seconds reported by Calderone and Mueller (25). Our air-abrasion group, however, required only 7 minutes 36 seconds to place four sealants, which is a time savings of approximately one-third. However, sealant retention—the issue that is paramount in any assessment of sealant cost effectiveness—was lower for the air-abrasion technique than for the acid-etch technique, particularly for nonocclusal surfaces. Thus, while reduced initial chair time may be an advantage to air-abrasion technology for sealant placement, the need for reapplication of sealants as a result of lower rates of retention likely would outweigh any time savings.

In addition to issues regarding time and retention, the use of air-abrasion technology for placement of sealants in a public health setting may have additional limitations. First, the equipment required for air abrasion adds additional costs, requires some degree of maintenance, and may not be as portable as desired for school-based programs. Second, because the air-abrasion technology removes tooth structure, state practice acts may restrict its use to dentists. Personnel costs may be higher because dental hygienists or other auxiliaries could not be used under these limitations.

Despite these limitations, it should be remembered that while air-abrasion technology was first introduced in the 1950s, it only recently has been "rediscovered" and applied to contemporary dentistry. As with the acid-etch technique, air abrasion achieves its retention through mechanical retention via alteration of the surface enamel. For air abrasion, this alteration of surface enamel is done through physical abrasion, rather than chemical acid etching. Thus, the alteration in the enamel achieved by air abrasion, microscopically, is not the same as for acid etch, and may not have optimal mechanical retention properties (26). However, air abrasion does have certain advantages, such as its ability to more thoroughly remove stain and organic materials in pits and fissures (16). It should also be remembered that investigations to develop and improve air-abrasion techniques are in their infancy, and some newer techniques may hold greater promise. One such approach is to use air abrasion in combination with acid etching for sealant placement. While this approach does not produce higher bond strengths in vitro than either technique alone (18), the use of air abrasion prior to acid etching in vivo may result in increased sealant retention. This result would appear to be theoretically plausible due to removal of organic plug material from deep pits and fissures, thereby allowing deeper penetration of both etchant and sealant material.

In summary, although more research is needed to improve air-abrasion applications, it does not appear that air-abrasion technology without acid etch offers a significant advantage over traditional sealant placement methods and, in fact, appears to be inferior to the acid-etch technique for use in public health settings.

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References

1. Weintraub JA, Stearns SC, Burt BA, Beltran E, Eklund SA. A retrospective analysis of the cost effectiveness of dental sealants in a children's health center. Soc Sci Med 1993;36:1483-93.
2. Weintraub JA. The effectiveness of pit and fissure sealants. J Public Health Dent 1989;49:317-30.
3. Klein SP, Bohannan HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. Am J Public Health 1985;75: 382-90.
4. Results of the workshop. J Public Health Dent 1989;49:331-7.
5. Feigal RJ. Sealants and preventive restorations: review of effectiveness and clinical changes for improvement. Pediatr Dent 1998;20:85-92.
6. Soderholm KJM. Reaction paper. The impact of recent changes in the epidemiology of dental caries on guidelines for the use of sealants: clinical perspectives. J Public Health Dent 1995;55:302-11.
7. Rozier RG. Reaction paper. The impact of recent changes in the epidemiology of dental caries on guidelines for the use of sealants: epidemiologic perspectives. J Public Health Dent 1995;55:292-301.
8. Brown LJ, Selwitz RH. The impact of re-

cent changes in the epidemiology of dental caries on guidelines for the use of sealants. J Public Health Dent 1995;55: 274-91.
9. Burt BA. Fissure sealants: clinical and economic factors. J Dent Educ 1984;48:96-102.
10. Mitchell L, Murray JJ. Fissure sealants: a critique of their cost effectiveness. Community Dent Oral Epidemiol 1989;17:19-23.
11. Leverett DH, Handelman SL, Brenner CM, Iker HP. Use of sealants in the prevention and early treatment of carious lesions: cost analysis. J Am Dent Assoc 1983;106:39-42.
12. Mertz-Fairhurst EJ, Fairhurst CW, Williams JE, Della-Giustina VE, Brooks JD. A comparative clinical study of two pit and fissure sealants: 7-year results in Augusta, GA. J Am Dent Assoc 1984;109: 252-76.
13. Simonsen RJ. Retention and effectiveness of dental sealant after 15 years. J Am Dent Assoc 1991;122:34-42.
14. Kotlow LA. New technology in pediatric dentistry. NY State Dent J 1996;62:26-30.
15. Goldstein RE, Parkins FM. Using air-abrasive technology to diagnose and restore pit and fissure caries. J Am Dent Assoc 1995;126:761-6.
16. Goldstein RE, Parkins FM. Air-abrasive technology: its new role in restorative dentistry. J Am Dent Assoc 1994;125:552-7.
17. Keen DS, von Fraunhofer JA, Parkins FM. Air-abrasive etching: composite bond strengths [Abstract]. J Dent Res 1994;73(Spec Iss):131.
18. Laurell KA, Lord W, Beck M. Kinetic cavity preparation effects on bonding to enamel and dentin [Abstract]. J Dent Res 1993;72(Spec Iss):383.
19. Horgesheimer JJ, Haws SM, Kanellis MJ, Vargas MA. Composite shear bond strength to air-abraded enamel [Abstract]. J Dent Res 1994;74(Spec Iss):324.
20. Eakle WS, Wong J, Huang H. Microleakage with microabrasion versus acid etched enamel and dentin [Abstract]. J Dent Res 1995;74(Spec Iss):31.
21. Berry III EA, Ward M. Bond strength of resin composite to air-abraded enamel. Quintessence Int 1995;26:559-62.
22. Haws SM, Oliveira MI, Vargas MA, Kanellis MJ. Air abrasion and microleakage of pit and fissure sealants [Abstract]. J Dent Res 1996;75(Spec Iss):180.
23. Kanellis MJ, Warren JJ, Levy SM. School-based sealant placement: six-month comparison of air abrasion vs acid etch techniques. Pediatr Dent 1997;19:258-61.
24. SPSS for Windows base system user's guide. Release 6.0. Chicago: SPSS, Inc., 1993.
25. Calderone JJ, Mueller LA. The cost of sealant application in a state dental disease prevention program. J Public Health Dent 1983;43:249-54.
26. Laurell KA, Hess JA. Scanning electron micrographic effects of air-abrasion cavity preparation on human enamel and dentin. Quintessence Int 1995;26:139-44.