Twelve-month Sealant Retention in a School-based Program Using a Self-etching Primer/Adhesive

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Abstract

Objectives: *Very little independent research has been done on the new self-etching primer/adhesives in dentistry. A recent clinical study compared two sealant application techniques involving self-etching primer adhesives and the traditional phosphoric acid etch. The purpose of this study was to compare these two techniques in an Iowa school-based sealant program.* ***Methods:*** *Twelve-month sealant retention data on 208 students from the Des Moines, Iowa, school-based sealant program were analyzed retrospectively.* ***Results:*** *Sealant retention reported at the person level showed that 60 percent of the students who received sealants at the five schools had to be recalled at one year to have one or more surfaces resealed. A logistic regression model at the person level demonstrated that the phosphoric acid technique was six times as likely to have retention of all the sealed tooth surfaces as those sealed with Prompt-L-Pop®.* ***Conclusions:*** *In this study, many students had to be recalled to the chair 12 months after sealant application due to incomplete retention. Though sealants were retained in larger numbers with phosphoric acid, overall sealant retention at the tooth level was lower than previously published for clinical studies and school-based programs. Examining retention data at the person level, however, allows program administrators to plan resources more effectively and reevaluate sealant protocol to ensure as few children return for sealant reapplication. [J Public Health Dent 2004;64(4):191-97]*

Key Words: pit and fissure sealants, molar, dental bonding, child, program development.

During the 1990s, a sealant material advance was the inclusion of a bonding primer and adhesive layer between etched enamel and the sealant resin. To reduce the effects of salivary contamination on etched enamel, the bonding primer technique successfully improved the bonding strengths and reduced microleakage in lab studies (1-3). A clinical study of sealant retention on salivary contaminated etched enamel showed sealant retention was improved with inclusion of a bonding primer and adhesive layer between contaminated etched enamel and sealant resin (4). Another clinical study showed that on noncontaminated etched enamel the risk of failure of occlusal sealants decreased by 47 percent and the risk of failure of the buccal/lingual surfaces decreased by 65 percent when including a bonding primer and adhesive layer between etched enamel and the sealant resin (5).

Self-etching primer/adhesives are the most recent generation of enamel and dentin bonding materials to be developed (6). Very little independent research has been done on these new adhesives. In a two-year clinical study, sealant retention on occlusal and buccal/lingual surfaces of permanent molars using the self-etching primer/adhesive Prompt-L-Pop® showed equivalent retention to contralateral teeth sealed with normal etching and seal methods (7). However, no studies have been published to date examining these two sealant placement techniques in a school-based dental sealant program (SBSP). The purpose of this retrospective study was to determine what percentage of children at 12 month recall had to return for sealant reapplication. Some students had sealant placed only with Prompt-L-Pop® and others only with phosphoric acid-etch. The use of the self-etching adhesive method may have potential to minimize chair time for the patient, decrease the need for patient compliance, and minimize potential errors in sealant application (i.e., salivary contamination of etched enamel).

Methods

This retrospective study used a chart review within the Des Moines, Iowa, SBSP to compare dental sealant retention using two different sealant placement techniques. This sealant program had been using the traditional phosphoric acid etch technique (PAE) since the program began in 1997. During the first three years of this SBSP, the mean annual sealant retention rates for the four permanent first molars were 86 percent, 90 percent, and 92 percent for 26 schools from 1997 through 1999, respectively. In summer 2000, the Des Moines Health Center dental director made a decision to switch to Prompt-L-Pop (PLP), a self-etching primer/adhesive, in lieu of the traditional phosphoric acid-etch technique prior to placing the dental sealant material. This product switch was considered due to marketing advertisements advocating the use of PLP for simplifying sealant placement. The rationale was finally based on the perceived easier application along with elimination of the rinsing step after etching. In turn, there would be better patient compliance and decreased chairtime for sealant placement. Elimination of the rinsing step with water and air would also decrease possible patient gagging and contamination of the etched enamel surface prior to sealant placement. Hygienist training was "on the job," fol-

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lowing the product instructional literature for applying the PLP prior to sealant application. After using PLP at one school in August 2000, a decision was made to revert back to the traditional PAE technique. This decision was based on preliminary information the Des Moines Health Center staff heard at a conference stating concerns about retention rates of dental sealants placed with PLP. The opportunity arose to examine sealant retention data and determine whether indeed the application of dental sealants with PLP had similar retention to dental sealants placed with the traditional phosphoric acid-etch technique.

Participants attended one of five elementary schools in the Des Moines School District where a high percentage of children participated in the free or reduced-cost lunch program. Dental sealants on first permanent first molars were placed originally on second and third grade children during September and October 2000. One-year retention checks were done on third and fourth graders in September and October 2001.

Clinical findings were verbally dictated by the one examining dentist and were recorded in each individual dental chart by the dental assistant. There were three possible maxillary sites (i.e., mesio-occlusal pit, disto-occlusal pit, and lingual groove) and two mandibular sites (i.e., occlusal and buccal pit) for each first permanent molar. After the dentist completed the screenings, dental hygienist and assistant teams applied the sealants to the appropriate children and teeth and recorded the information in the child's chart.

After the teeth had been dry brushed with a toothbrush, the hygienist placed a Driangle® for moisture control of a maxillary first permanent molar tooth or cotton rolls around a mandibular first permanent molar tooth prior to sealant application. The application for bonding the sealant material to the enamel pit and fissured surfaces of the permanent first molar teeth differed for each etching technique, the PLP® and the Dentsply Tooth Conditioner Gel™—the phosphoric acid etch (PAE).

After the tooth was isolated, rinsed with water, and dried, the PLP was continuously brushed on the enamel pit and fissured surface for 15 seconds with the application brush provided in the individual dispensing package. The number of individual packages of PLP varied for each student. The material was utilized until the package was either depleted or the PLP had evaporated. After application of PLP, a two- to three-second burst of air from the air-water syringe was done. The PLP was then light-cured for 10 seconds. Delton Opaque™ dental sealant material was placed. The sealant material was then light-cured with an Optilux 500 curing light for 30 seconds. The curing light had a built-in curing radiometer. The curing lights were checked at beginning of each day with the radiometer according the manufacturer's recommendation. The light sources were maintained to register between 380 to 420 mW/cm^2. The manufacturer recommends that the light register over 300 mW/cm^2. Both sealant teams had the same make and model of curing light. The PLP product, manufactured in March 2000, was only used at school 1.

With the PAE technique, the tooth was isolated, rinsed with water, and dried; the PAE was applied to the enamel on the pit and fissured surface for 15 to 20 seconds. The enamel surface was then rinsed with water for 10 seconds and dried with air, both from the air-water syringe. The enamel surface was checked for a frosted appearance of acid-etched enamel, and then the Delton Opaque™ sealant material was applied in the similar manner previously described for PLP. PAE was used at schools 2, 3, 4, and 5.

The Des Moines Health Center had the same two dental sealant teams, each consisting of a dental hygienist and assistant, involved at all five schools. When they applied the sealant material (with either technique) to multiple surfaces on a tooth, the sealant material was placed and cured at the same time. Since only one school received the PLP, a comparison was required with at least one other school that received the traditional PAE method. Both hygienists placed sealants in school 1 (PLP group); however, only two of the remaining four schools had both hygienists at the same schools. Thus, the investigators made an administrative decision to include all four schools (during the same season of the year) because this would provide a suitable racial mix of children. It also provided an opportunity to compare the two hygienists' retention rates, and thus potential application differences, for those schools where only the PAE was used.

Each sealant team had their own set of portable dental equipment made by the same manufacturer. The manufacturer serviced this equipment each summer, while the staff followed the daily recommended maintenance of the manufacturer. As part of the ongoing program, sealant retention was rechecked at approximately 12-month intervals.

If any sealants were partially or totally missing at the annual retention check, they were reapplied using the traditional PAE technique. In this study, retention of sealant on a tooth surface had a strict criterion. The sealant was considered either present or missing. If any sealant was partially lost on a surface (i.e., "partially missing") (8,9), it was considered missing and was resealed regardless of caries risk assessment.

The same dentist who conducted the initial screening also performed the retention check exams. The dentist was not blinded to the etchant technique done at a particular school. The dentist was, however, blinded to the hygienist who placed sealants.

For the purpose of data collection, permission was obtained from the executive director of the Des Moines Health Center. The project received Institutional Review Board approval at the University of Iowa.

The dependent variable was sealant retention at the person level. Retention was evaluated on the following predictor variables, all of which were categorical:

- schools: schools 1 through 5,
- sex: male versus female,
- school grade: second grade versus third grade,
- prior caries history: yes or no,
- active caries present: yes or no,
- previous sealants present: yes or no,
- race: white, non-Hispanic versus other,
- sealant technique: PLP versus PAE.

At the person level, the dichotomous variable was either all sealants placed on that child (at the tooth and surface level) were all present, or sealant was missing on one or more surfaces. With this dichotomy, even the loss of one of a possible 10 surfaces

of sealant material will constituted an adverse outcome.

Data also were collected at the surface and tooth level. At the tooth level, sealant was either totally retained or not on all sealed surfaces for that particular permanent first molar tooth. At the surface level, sealant was either totally retained or not fully retained for that particular surface. If a portion of the sealed surfaces had lost sealant material, it was considered to be a failure. Descriptive data are presented at the surface and tooth level. Also, data included are the combination of both maxillary occlusal pits (i.e., mesio-occlusal and disto-occlusal) as one distinct surface. The loss of sealant material in either area meant that the sealant was not retained for that surface. Data at the tooth level show results with and without lingual or buccal pit and fissure surfaces.

SAS software was used to conduct data analysis. Descriptive statistical analysis was performed on the collected data at the surface, tooth, and person levels. However, bivariate and multivariate analyses were only performed at the person level. The hypothesis testing for the assessment of association between the dental sealant retention outcome (at the person level) and each of the predictor variables for bivariate analysis was performed by chi-square test, or Fisher's exact test if the sample sizes were too small. Only those variables that showed a significant association in bivariate analyses were included in the model building for the multivariable regression analysis. Both forward and backward stepwise logistic regression methods were used. All tests had a .05 level of significance.

Results

In autumn 2000, 272 children received sealants on at least one permanent first molar at the five schools. However, only 208 students were available for recheck exams one year later. Of these students, 92 were males (44%) and 116 were females (56%); 126 were second graders (61%) and 82 were third graders (39%). The average age of the students was 9.0 years old, with the age range being 7.4 to 10.3 years (SD=0.61 years). Dental findings included: 89 students (43%) who had previous caries experience, 70 students (34%) with active caries present, and 57 students (27%) who had sealants placed on one or more first permanent molars prior to the school-based program. One-hundred-twenty of 208 students (58%) received eight or more sealed surfaces. Forty-five students (22%) received sealants placed with PLP at school 1 and 163 (78%)

TABLE 1
Surfaces and Teeth Sealed and Retained at 12 Months for First Permanent Molars, by Tooth Number (*N*=208 Children)

Tooth #	Surface	# of Sealed Surfaces at Baseline	# and % of Retained Sealants (Surface)	# and % of Retained Sealants (Tooth)	
3	Mesial pit	158	133 (84.2)	Occlusal only	118 (65.6)
	Distal pit	172	113 (65.7)		
	Lingual pit	171	108 (63.2)	All surfaces (tooth)	114 (63.3)
14	Mesial pit	159	123 (77.4)	Occlusal only	108 (58.1)
	Distal pit	173	100 (57.8)		
	Lingual pit	174	99 (56.9)	All surfaces (tooth)	106 (57.0)
19	Occlusal surface	161	114 (70.8)	All surfaces (tooth)	115 (70.1)
	Buccal pit	12	8 (66.7)		
30	Occlusal surface	163	125 (76.7)	All surfaces (tooth)	121 (73.8)
	Buccal pit	13	6 (46.2%)		

TABLE 2
Number of Surfaces Sealed and Retained over 12 Months, Using Two Sealant Techniques

		Prompt-L-Pop		Phosphoric Acid		
Tooth #	Surface	# of Sealed Surfaces at Baseline	# of Retained Sealants After 12 Months	# of Sealed Surfaces at Baseline	# of Retained Sealants After 12 Months	*P*-value*
3	Mesial pit	33	25 (75.8)	125	108 (86.4)	.1362
	Distal pit	37	21 (56.8)	135	92 (68.2)	.1960
	Lingual pit	37	17 (46.0)	134	91 (67.9)	.0142
14	Mesial pit	37	23 (62.2)	122	100 (82.0)	.0117
	Distal pit	38	16 (42.1)	135	84 (62.2)	.0265
	Lingual pit	38	16 (42.1)	136	83 (61.0)	.0373
19	Occlusal surface	34	21 (61.8)	127	93 (73.2)	.1916
	Buccal pit	3	1 (33.3)	9	7 (77.8)	.2364
30	Occlusal surface	33	18 (54.6)	130	107 (82.3)	.0008
	Buccal pit	3	1 (33.3)	10	5 (50.0)	.9999

*Chi-square statistic or Fisher's exact test.

received PAE at the other four schools. There were no statistically significant differences between grade and sex (P=.7169) or between sex and school (P=.1312). Similarly, there were no statistically significant differences for grade and sex within each school. There was no statistically significant difference between the age of the child and whether or not the child retained all of the sealants placed (P=.6831).

At the surface level, 708 surfaces (72%) retained sealant after 12 months. At the tooth level, 465 (67%) of 690 permanent first molar teeth retained sealant. The mesio-occlusal pit of the maxillary molars had the highest sealant retention rate (Table 1). This table not only presents surface level data, but tooth level retention data with and without the respective lingual or buccal surfaces. For example, the retention rate for tooth #3 is 65.6 percent and 63.3 percent when considering the occlusal only and all sealed pit and fissure surfaces, respectively. Tooth level rates are presented both ways because most previous clinical trials and SBSPs include only occlusal surfaces. At the person level, 84 (40%) of the 208 students retained all sealed surfaces after 12 months. The buccal and lingual surfaces were included in the person level analysis because it was this program's policy to reseal any sound surface that had been sealed previously.

Of the 212 surfaces sealed with prior PLP application, 124 (58%) retained sealant, whereas 584 (75%) of the 774 surfaces with prior PAE application retained sealant. Of the 145 teeth sealed with prior PLP application, 74 (51%) retained sealant, whereas 391 (72%) of the 545 teeth sealed with prior PAE application retained sealant. Six (13%) of 45 students retained sealant on all surfaces sealed with prior PLP application, whereas 78 (48%) of 163 students retained sealant on surfaces/teeth sealed with prior PAE application.

Surface-specific retention rates for the two sealant techniques are reported in Table 2. The retention rates for all surfaces were higher when the traditional PAE was used. Statistically significant differences between the two placement techniques occurred in five of the 10 surfaces, with all three surfaces of tooth #14 demonstrating a difference. The retention rates for both techniques were lower for tooth #14 compared to its contralateral molar (i.e, tooth #3).

TABLE 3
Bivariate Analysis Summary of Sealant Retention at Person Level and Predictor Variables (N=208)

Predictor Variables	Sealant Retention at Person Level: Yes	No	$\chi 2$	df	P-value
School					.0001
1	6	39	23.37	4	
2	14	27			
3	15	9			
4	23	20			
5	26	29			
Sex					
Male	34	58	0.81	1	.37
Female	50	66			
Race					
White, non/Hispanic	34	33	4.41	1	.04
Other	50	91			
Grade					
2nd	49	77	0.30	1	.50
3rd	35	47			
Hygienist					
1	41	56	0.27	1	.60
2	43	68			
Previous caries history					
Yes	34	55	0.31	1	.58
No	50	69			
Active caries present					
Yes	22	48	3.52	1	.06
No	62	76			
Previous sealants present					
Yes	26	31	0.89	1	.35
No	58	93			
Sealant technique					
PLP	6	39	17.45	1	<.0001
PAE	78	85			

Bivariate analysis that summarizes the findings for retention rates at the person level are displayed in Table 3. At the P<.05 level, there were statistically significant differences for 12-month retention rates for the variables of school, race, and sealant techniques. However, the variables of school and sealant technique were highly correlated because only school 1 children received PLP. Although there was a statistically significant difference by race, a small number of white, non-Hispanic children attended school 1 (6 of 45). Reexamination of the bivariate analysis by dropping school 1 showed that there was no statistical significant difference in retention rates by race (P=.22). The only other marginal statistically significant difference at the person level was active dental caries (P=.06). However, there was no statistically significant difference in active dental caries among of the schools (P=.1398).

The resulting logistic regression models show that sealant technique was the only statistically significant predictor of dental sealant retention at the person level. Students who received the traditional PAE technique had a significantly higher rate of dental sealant retention (OR=5.97) (Table 4).

Dental hygienists were included in a competing logistic regression model

TABLE 4
Logistic Regression Model for Reporting Dental Sealant Retention at Person Level (*N*=208)

Parameter: Sealant Technique	Odds Ratio Estimate (95% Wald Confidence Limits)	*P*-value
Phosphoric acid-etch vs Prompt-L-Pop®(47.9% vs 13.3%)	5.97 (2.39, 14.86)	.0001

TABLE 5
Multivariable Logistic Regression Model for Reporting Sealant Retention at Person Level, Including Dental Hygienist (*N*=208)

Parameter:	Odds Ratio Estimate (95% Wald Confidence Limits)	*P*-value
Sealant technique: phosphoric acid-etch vsPrompt-L-Pop® (47.9% vs 13.3%)	6.40 (2.54, 16.12)	<.0001
Hygienist (I) vs (II) (42.3% vs 38.7%)	1.42 (0.79, 2.56)	.2445

against dental sealant retention at the person level even though bivariate chi-square statistical analysis did not demonstrate an impact on the sealant retention (*P*-value=.2445) (Table 5). Rationale for this inclusion is that the literature is replete with documentation about the sensitive nature of dental sealant placement. With the inclusion of the hygienists in the regression model, the odds ratio was approximately the same (OR=6.40). No evidence of statistical interaction was found between the hygienist and sealant retention variables.

Discussion

This study has several limitations. First, this was a retrospective chart review. A randomized trial utilizing a contralateral, split-mouth design to compare sealant retention using both techniques would have been a more ideal study design, but it is not practical for SBSPs. Second, the data reflect treatment that had already occurred, was recorded, and was charted by other people. Moreover, the original intent was not for research purposes. Third, one dentist examiner (DJV) did all the sealant screenings and one-year retention checks. Since the examiner was not blinded to the technique used at each school, there was potential for bias. However, the examiner was blinded to the hygienist who placed the sealant. Fourth, this program used one of the first formulations of PLP. Although the hygienists did apply the PLP according to the manufacturer's instructions, the hygienists did not receive any formal training in the use of the PLP in sealant application (i.e., practicing on extracted teeth prior to the school program). The PLP product instructions indicated that it could be used with a light-cured sealant or restorative material. Thus, the Delton™ light-cured sealant material, which this program has used since its inception, was the sealant product for both groups. The question of whether there are product compatibility issues warrants further research.

Many studies examine sealant retention at the surface and tooth level. However, a decision was made to emphasize sealant retention at the person level because of program planning issues. If a child has to be recalled to the chair for resealing one or more surfaces of a tooth or teeth, there is a significant amount of time spent retrieving the child from the classroom, setting up and disinfecting the equipment, preparing the child for resealing, and returning the child to the classroom. If the child retains sealant on all surfaces sealed, he or she does not have to be recalled and use chair time that can potentially be used for another child. Previous studies concerning retention, including SBSPs, have generally looked at surface or tooth rates (10-12). However, surface and tooth level findings frequently are identical because often only occlusal surfaces are sealed. Moreover, most research is silent about reapplication of sealant material at revisits. SBSPs, however, must take into consideration whether or not a child, rather than a tooth, needs to be reseen. Using sealant materials with the best retention properties is therefore important to prevent large numbers of children from returning to the chair for resealing.

The percentages of children available for the 12-month follow-up were similar for each of the five schools in the study. That is, the return rates varied from 37.6 percent (school 2) to 48.2 percent (school 5), there was no statistically significant difference between schools and dropout rates (*P*=.5575). Lower socioeconomic status (SES) families often are highly transient, switching schools frequently. Conversely, this is precisely why schools in lower SES areas have been targeted for many health-related activities, including preventive dental services such as sealants.

Retention of sealants at the surface and tooth level in this study did vary from previous studies on sealant retention. Statistically significant differences between the two placement techniques occurred in five of the 10 surfaces, with all three surfaces of tooth #14 demonstrating a difference. The retention rates for both techniques were lower for tooth #14 when compared to its contralateral molar, indicating that there may be difficulty in access to these surfaces by right-handed dental hygienists. This access problem may be exacerbated with the bonding procedure. This study showed a tooth level retention rate of 67 percent for the four first permanent molars 12 months after placement for the two techniques combined. On the contrary, Feigal's clinical trials review (13) estimated sealant failure rates at 5 percent to 10 percent each year. While PAE sealant retention was better than PLP in this study, PAE still had a 28 percent failure at the tooth level after 12 months. This study may be illustrative of some of the differences between an SBSP and a clinical trial, where application techniques are standardized and monitored more closely. Even so, retention of sealant at the tooth and surface level after 12 months for both

techniques individually and combined were less than what has been seen in previous SBSP studies (10-12). The criterion for success in this study was quite restrictive. If the surface had partial loss of the material, it was considered a failure. However, if retention criterion also included the "partially missing" designation (8,9), then retention at all levels (surface, tooth, and person) would have increased substantially. Another possible explanation for a lower retention rate than found in clinical trials may be the use of portable rather than fixed dental equipment. Portable dental equipment maintains a single supine position without the capability to alter head angle for application to the mandibular or maxillary posterior teeth. Regardless, the lower retention in the Des Moines school-based program warrants an examination of the program to determine why retention is less than previously has been published.

Tooth morphology and location may play a role in sealant retention. Distal pit retention on the maxillary molars was lower than the mesial pit in this study. Difficulty in isolating the distal pit surface may be a reason for poor retention, especially in younger patients; thus, there is a lower retention rate at the tooth and person level. Distal opercula may also impede sealant placement on the distal pit. Also, the portable dental equipment may exacerbate this situation.

The large number of children being recalled, even for the PAE technique, may indicate that there may be a problem or problems in sealant placement technique within the SBSP. Sealant retention is technique sensitive and is highly correlated to the skills of the operator placing the sealant (8,9,14-16). However, this study did not find any significant statistical differences in the two hygienists who placed sealants in the SBSP. Possible explanations for no significant statistical differences may be that both hygienists have been placing dental sealants for over 15 years and have comparable clinical skills. Both hygienists place dental sealants on a routine basis, either in the SBSP or in a private practice setting. Also, both hygienists place sealants with the same brand of portable dental equipment. In addition, both use sealant materials from the same dental supply order. Retention rates at the tooth level for this study were less than the previous three years of the program. These findings will be useful to thoroughly review and reinforce all of the required steps in sealant placement.

This study found only a marginal statistically significant difference in sealant retention (at the person level) when assessing active caries status. The literature does support a significant statistical difference in sealant retention at the tooth and surface level when looking at active caries status (17). It can only be speculated on why active caries status may affect sealant retention. It may be due to higher level of *S. mutans* and acidity levels in the oral cavity that may have an impact acid etching tooth enamel, thereby decreasing sealant retention. However, no significant statistical difference was found in sealant retention with previous caries status or previous sealant placement. Though Poulson et al.'s study (17) also examined previous caries history with regard to sealant retention, there are no studies found in the literature that examined sealant retention with sealant placement prior to a SBSP.

One other study, a randomized clinical trial of sealant retention, compared retention rates between the original PLP formulation and PAE (7). Findings showed comparable sealant retention at the tooth and surface levels between the PLP and PAE techniques. The reader is reminded that the data under study here are not from a clinical study. Although the present study only tested for statistical significance at the person level, these somewhat contradictory findings beg for further research in the area of school-based programs using self-etching primer/ bonding agents.

Sealant placement with this particular formulation of PLP was found to have poor sealant retention when compared to the traditional phosphoric acid-etch. Only the sealant placement technique (i.e., product) was found to be predictive in sealant retention at the person level using the multivariate logistic regression. School-based programs need to have good sealant retention to be cost effective. Recalling students unnecessarily, for even one surface of a tooth, is a waste of resources. Even though the technique of using PLP in sealant placement is perceived to be simpler and more convenient than phosphoric acid-etch, further studies still need to be done to determine its comparability with the more traditional method. This issue is now complicated by the reformulation of PLP, which recommends two or more applications of PLP before placing sealant or restorative materials.

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