Evaluation of Initial Caries Score and Caries Incidence in a Public Health Sealant Program: A Retrospective Study

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Abstract

Purpose: The purpose of this study was to investigate the relationship between: (1) children's caries score (dmft, DMFT) at the time of sealant placement; and (2) "success" (measured as being caries-free) of that tooth at follow-up visits.

Methods: An existing database of over 38,000 sealants (10,038 children) placed between 1997 and 2002 by the Jefferson County Health Department's Community Based Sealant Program, Birmingham, Ala, was used in the analysis. Only children returning for follow-up visits after the initial placement of the sealants were included in this study, resulting in 6,452 sealants (2,097 children). Logistic regression analysis was performed to determine the differences in sealant success between children with a dmft score of 0 vs a dmft score of >0 at baseline, and a DMFT score of 0 vs a DMFT score of >0 at baseline.

Results: In the permanent and primary dentitions, those who had no caries at the time of sealant placement (dmft/DMFT=0) had a significantly higher success of sealants during years 1 to 5 compared to those with a caries score of greater than 0 (dmft/DMFT>0; $P<.023$, $P<.002$, respectively).

Conclusion: Children with previous caries experience may be at a higher risk for sealant "failure" (measured as caries on a tooth surface previously sealed) after 1 year and, therefore, may require more diligent sealant maintenance. (Pediatr Dent 2006;28:420-424)

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Although preventable, childhood caries remains one of the most prevalent infectious diseases.[1] Properly placed and maintained sealants, in conjunction with fluoride and good dietary and oral hygiene habits, can be highly effective against dental caries.[2]

Recognizing the importance of sealants, Healthy People 2000 set a goal that 50% of children between the ages of 8 and 14 should have at least 1 sealant placed in their permanent first molars. Despite this goal, presently only 23% of children in second and third grade and 20% of eighth and ninth graders have them, which resulted in the restatement of this goal in 2000 for Healthy People 2010.[3] Clearly, the benefits of sealants have not been fully accepted by the dental community. Among the reasons for the aforementioned are:

1. the need for maintenance;
2. possible nonreimbursement from insurance companies; and, contrary to Mertz-Fairhurst et al's findings
3. concern that sealed undetected caries may progress.[4,5]

Furthermore, sealants may not be cost-effective in all children. Those with a high risk of caries could gain the most from having sealants placed.[6] Alabama Medicaid data indicate that the proportion of underprivileged children who receive sealants is 22%.[7] In Alabama, placement of sealants reduced the cost of future restorative care in low-income minority children by $16 per child.[8]

Risk factors for caries include: (1) previous and existing dental caries; (2) diet with high exposure to sugars; (3) children from low-income families; and (4) low fluoride intake.[9,10] In 1994, the workshop on guideline for sealant use recommended that patients with teeth with morphological characteristics (ie, deep pits and fissures) should also be candidates for sealants. Data from the Third National Health and Nutrition Examination Survey, which collected data from 1988-1994, showed that 80% of all caries in children 5 to 17 years old occurred in only 25% of the population.[11] These children are considered "high risk," and the major-

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ity may not be likely to receive dental care from a private practitioner. Therefore, the need to target this particular group plays a key role in the reduction of childhood dental caries.[11] Many state and local health departments have tried to reach these high-risk children through community-based sealant programs.[11]

The Jefferson County Health Department (JCHD) in Birmingham, Ala, developed a program to place sealants in urban schoolchildren in the county. At the initial visit, oral health data were collected and sealants were placed on noncarious, sealable permanent first molars. The children were then seen for recall visits in subsequent years when the program returned to the schools. Although it is well documented that a history of dental caries is a risk factor for future caries,[12] it can be hypothesized that previous caries in primary and permanent teeth could also be a risk factor for sealant failure.

The purpose of this study was to investigate the relationship between children's caries score (dmft, DMFT) at the time of sealant placement and "success" of that tooth (success referred to as being caries-free) at follow-up visits.

Methods

Data obtained during routine dental examinations of children who had participated in the JCHD sealant program was used for this analysis. The information was available in the JCHD electronic database that included the years 1997 through 2002 and consisted of 38,798 dental examinations. The data included:

1. demographic information;
2. treatment rendered;
3. primary and permanent decayed, missing (due to caries), and filled (dmft/DMFT) teeth; and
4. other assessments relevant to the patient's condition at the time of the examination.

JCHD dentists, who are annually calibrated in caries diagnosis and sealant placement according to National Institutes of Health standards, performed all examinations.[13] The Institutional Review Board of the University of Alabama, Birmingham, Ala, and the JCHD Ethics Board approved this study.

A program designed specifically for this study at the JCHD's systems information office selected children for the sample. The data were restricted to information from the JCHD sealant program. One dentist and 2 to 3 hygienists visited 1 to 2 elementary schools each week, particularly urban schools in the metropolitan Birmingham, Ala, area.

The selection of the study subjects was done according to the following criteria—children who:

1. ranged in age from 5½ to 15 years old;
2. were examined twice by the school-based sealant program between 1997 and 2002; and
3. had at least 1 occlusal sealant placed on a permanent first molar (PFM) on their first visit.

Although some children were seen more than 2 times, for the purpose of this study only the child's first and second visit were included in the analysis.

After parental consent, the dentist examined the child with a mirror, light, and no. 5 explorer. If the PFM was caries free and sealable, the hygienist was directed to place the opaque sealant. All hygienists participating in the sealant program had a bachelor's degree in dental hygiene and were assigned to the sealant program placing sealants 5 days a week during the school year. Periodic random sealant retention checks were conducted, and all sealants were checked by the supervising dentist on site after placement that day.

During the 5-year period from which the data were obtained, 15 dentists participated in the JCHD sealant program. Three of the dentists performing the exams accounted for over 50% of the initial and final examination data from the JCHD sealant program. The JCHD sealant program used portable units with air/water syringes and suction. High-speed evacuation, however, was not available in these units. Moisture control was, therefore, achieved using an air syringe and cotton rolls. The sealants were placed on the tooth without air abrasion or enameloplasty.

The records of 2,097 children (6,452 sealants placed) seen by JCHD over a period of 5 years were included in this sample. The sample of children was then separated into 4 subgroups according to the time period between the first and second examination (ie, 0.5 to >1 year, 1 to >2 years, 2 to >3 years, and ≥3 years).

At the follow-up visit, which ranged from 6 months to 5 years, PFM occlusal surfaces were classified based on the observed condition of these teeth. The sealed teeth were classified as:

1. "success" (those teeth that were sealed on the initial visit, and appear as sealed, partially sealed, or caries free on the second examination); or
2. "failure" (those teeth that were sealed on the initial visit, but appeared as carious or restored on the second examination).

If the previously sealed tooth was partially sealed or missing its sealant but sound, a new sealant was then placed on that tooth. The caries index scores at the initial visit were used to divide the children into 2 groups: (1) dmft=0 vs dmft>0; and (2) DMFT=0 vs DMFT>0. For the purposes of this paper, analyses were performed using Statistical Product and Service Solution software (SPSS Inc, version 12.0 for Windows, Chicago, Ill). Analysis of variance and logistic regression were used to determine if there was a difference between the 2 groups (dmft=0 vs dmft>0, and DMFT=0 vs DMFT>0) regarding time between follow-up visits and sealant success. Two-sided type I error was set at $P<.05$.

Results

The children in the original database were 80% African American and 52% female, with a mean age of 8.3 (±2.7 SD). The children included in the final analysis were 97% African American and 58% female, with a mean age of 8.4 (±1.6 SD), indicating minimal selection bias. Senior dental students and hygienists participated in the sealant program, but overall the hygienists placed 94% of the sealants (Table

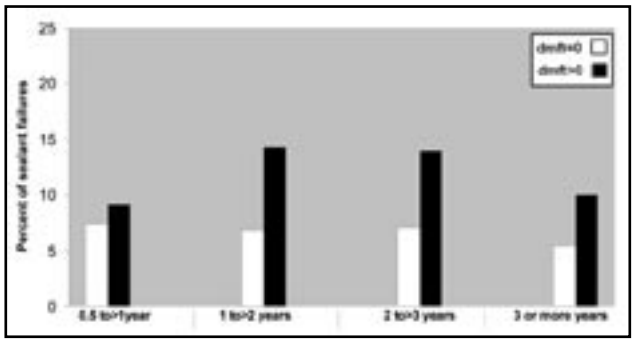

Figure 1. Caries score of primary dentition at time of sealant placement and percent of sealant failures at follow-up visits. During the follow-up periods of 1 to >2 years, 2 to >3 years, and ≥3 years, there was a significant difference between the 2 groups (P<.002).

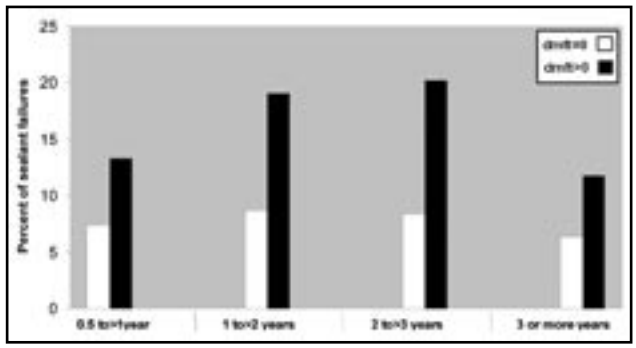

Figure 2. Caries score of permanent dentition at time of sealant placement and percent of sealant failures at follow-up visits. During the follow-up periods of 1 to >2 years, 2 to >3 years, and ≥3 years, there was a significant difference between the 2 groups (P<.023).

1). The hygienists and student had overall success rates 90% and 91% respectively at follow-up, indicating no difference in who sealed the child's tooth. A test of examiner calibration of the 3 examiners resulted in a mean interexaminer correlation of 77%±8.5%. Intraexaminer scores revealed a correlation of 80%±5.75%, and the kappa scores for the session were 0.72.[14]

Table 1. Sociodemographic Characteristics of Participants in the Jefferson County Health Department Sealant Program

Variable	Original database n=10,038	Follow-up database n=2,037
Race		
African American	80%	97%
Other	20%	3%
Gender		
Female	52%	58%
Male	48%	42%
Age in ys at initial visit±(SD)	8.3±2.7	8.4±1.6
Age in ys at second visit±(SD)	-	10.2±1.7
Mean dmft at initial visit±(SD)	1.8±2.5	2.5±1.2
Mean DMFT at initial visit±(SD)	0.75±1.5	0.76±1.2
Average time in ys between visits± (SD)	-	1.6±0.7
Sealant placement		
Hygienist	94%	-
Dental student	6%	-
Caries score		
dmft=0	57%	45%
dmft>0	43%	55%
DMFT=0	66%	64%
DMFT>0	34%	36%

Regarding the initial caries score in the primary dentition, there was a significant difference in sealant failure (caries or restoration) between the groups (dmft=0 or >0; Figure 1). For the teeth available for examination during the first year, there was no difference between the 2 groups. As the time between follow-up visits increased, however, the difference became statistically significant (*P*<.002). After 1 year, those with a dmft score of 0 were less than half as likely to experience sealant failure as those with an initial caries score of dmft >0.

Similar results were observed when sealant failure was evaluated in the permanent dentition (Figure 2). After 1 year, there was a significant difference in sealant failure between the DMFT=0 and DMFT>0 groups (*P*<.023). Children with a follow-up visit of greater than 1 year with a DMFT score of 0 were approximately half as likely to experience sealant failure compared to children with a DMFT score of >0.

Each molar was also analyzed independently to assess for any trends related to the dmft and DMFT initial caries scores (Tables 2 and 3). For all PFMs, there was a significant difference between the dmft=0 vs dmft>0 and the DMFT=0 vs DMFT>0 groups regarding sealant success when all covariates were taken into consideration, including: (1) age; (2) race; (3) gender; and (4) time between follow-up visits. Table 3 illustrates that children with a DMFT=0 were more than 4 times more likely to have success of a sealant placed on the maxillary right PFM compared to children with a DMFT>0, possibly due to right-handed hygienists placing the sealants.

The specific condition of each PFM at follow-up visits was divided into 4 different categories: (1) sealed; (2) sound; (3) restored; and (4) decayed. Those with a dmft/DMFT score of 0 had more favorable results than the dmft/DMFT score of >0 (Figures 3 and 4). For the primary dentition caries score, there was a significant difference between the dmft=0 and dmft>0 groups in the condition after 1 year (*P*<.002). After 1 to 2 or more years, 15% of the children with caries at the initial exam had decay on the sealed molars, whereas only 9% of the children with no caries had decay on the sealed molars.

Table 2. Crude Odds Ratio (OR) Comparing Children With an Initial Caries Score of dmft=0 vs dmft>0 and Sealed Permanent First Molar (PFM) Remaining Caries-free at Follow-up Visits

	Maxillary right PFM	Maxillary left PFM	Mandibular left PFM	Mandibular right PFM
Crude OR	1.83	1.89	2.75	2.57
Adj OR*	1.53	1.80	2.56	2.42
Adj 95% CI*	1.08, 2.15	1.32, 2.46	1.76, 3.75	1.62, 3.64

*Adjusted odds ratio and 95% confidence interval (CI) for the children with all covariates (eg, age, sex, race, and time between visits) taken into consideration, using logistic regression. The reference category was children with a dmft=0.

Table 3. Crude Odds Ratio (OR) Comparing Children With an Initial Caries Score of DMFT=0 vs DMFT>0 and Sealed Permanent First Molar (PFM) Remaining Caries-free at Follow-up Visits

	Maxillary right PFM	Maxillary left PFM	Mandibular left PFM	Mandibular right PFM
Crude OR	4.58	1.88	2.26	1.79
Adj OR*	4.38	1.76	2.04	1.60
Adj 95% CI*	3.16, 6.07	1.25, 2.46	1.42, 2.93	1.08, 2.39

*Adjusted odds ratio and 95% confidence interval (CI) for the children with all covariates (eg, age, sex, race, and time between visits) taken into consideration, using logistic regression. The reference category was children with DMFT=0.

For the permanent dentition caries scores, the difference between condition and initial caries score was statistically significant with every follow-up group ($P<.001$). For the children with an initial DMFT score of 0, decay was found in 10% of previously sealed molars at follow-up visits between 1 to 2 or more years. In those with initial DMFT scores >0, decay was found in approximately 20% of previously sealed teeth.

Discussion

Several factors can affect sealant retention, such as: (1) individual tooth morphology; (2) caries risk; (3) dietary and oral hygiene habits; and (4) placement technique.[9,10,12] The overall results showed that, after the first year, the child's caries score at the time of sealant placement was associated with sealant success and condition. Bravo et al have reported that the early loss of sealants is mainly due to difficulties in isolation and placement technique.[15] In this study, there was not a significant difference between the child's caries score and sealant retention for the first year. Table 3 illustrated that children with a DMFT score of 0 were more than 4 times more likely to have caries-free teeth on the right maxillary PFM than children with a DMFT score >0. This could be due to ease of isolation of that tooth or the fact that children are more likely to brush the right side of their mouth.

Most community-based sealant programs try to reach children who will benefit the most, specifically those with the highest caries experience. The National Preventive Dentistry Demonstration Program found that:

1. caries prevalence is higher in communities with a low socioeconomic status; and
2. this population may also be less likely to receive treatment.[16]

High-risk children include those with: (1) deep pits and fissures; (2) a family history of caries; (3) early childhood caries; (4) irregular dental visits; and (5) low fluoride exposure.[17] These factors should be taken into consideration when placing sealants.

One reason for the differences in sealant success and initial caries score is that children with a history of caries could already have undetected demineralization of the enamel around the sealants. This can affect the margins of sealants, leading to sealant loss and caries in the pits and fissures.[10] Sealants placed on teeth with small enamel lesions, however, have been shown to inhibit the progression of the caries if they are well sealed and maintained at follow-up.[4,18] This supports the importance of maintenance, especially during the first year after sealant placement.

Once sealants have been placed, the role of recall visits becomes critical. The sealed surfaces should be evaluated within 1 year of application since most failures occur within that time, mainly due to lack of moisture control.[16] At that time, if the sealant is partially or fully lost, another sealant can be reapplied. According to Feigal,[17] sealants have an average failure rate of 5% to 10% per year. If no follow-up is provided, the benefit of sealants is questionable since the lack of maintenance could allow loss of protection against caries. If subsequent follow-up visits are performed, however, the success rate of a sealant increases to 80% to 90% after more than 10 years.[16] Community-based sealant programs are a necessity to help decrease the epidemic of childhood caries because they serve high-risk children and often provide follow-up visits to determine if reapplication of sealants is needed. Therefore, children at higher risk due to caries history who receive sealant maintenance will benefit the most from sealant placement. This may lead to

optimal cost-effectiveness of this procedure and the public health sealant programs, thereby helping to prevent this most prevalent infectious disease of childhood.

The strengths of this study included a large sample size and the ability to perform follow-up evaluations for up to 5 years. This high number of follow-up visits allowed for accurate determination of sealant effectiveness. No high-speed evacuation was used during sealant placement, however, possibly hindering adequate tooth isolation. Possible "hidden caries" prior to sealant placement could have altered the results. Although multiple persons placed the sealants, they were periodically checked for retention and all sealants were checked prior to the child's release. Calibration data were available for 3 of the 12 examiners (providing 50% of all examinations), although information on the other examiners was not available. The differences in management strategies in the children who returned for follow-up visits with restorations could not be adjusted for when conducting the analyses.

Conclusions

Based on this study's results, the following conclusions can be made:

1. Children with existing caries are more likely to have sealants that turn into caries lesions after the first year of placement. Therefore, they need to be monitored more closely by dental professionals.
2. Although the ability of sealed teeth to remain caries free depends on various factors such as oral hygiene and diet, the patient's caries index remains a determinant of the sealant's overall success.

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