The Relationship Between the Number of Sound, Decayed, and Filled Permanent Tooth Surfaces and the Number of Sealed Surfaces in Children and Adolescents

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Abstract

Objectives: *The purpose of this investigation was to determine the prevalence of sound, decayed, filled, and sealed permanent tooth surfaces for children and adolescents from three fluoridated communities in British Columbia and to develop a predictive model of sealant use that included the dental caries status of tooth surfaces.* ***Methods:*** *Children in grades 2 and 3 (n=2,715) and adolescents in grades 8 and 9 (3,317) were surveyed to determine the prevalence of sound, decayed, filled, and sealed permanent tooth surfaces. The DMFS index, modified to include incipient (D_1) and cavitated (D_2) lesions, was used to measure the status of all tooth surfaces. The prevalence of D_1D_2MF and sealed tooth surfaces was estimated by age group and tooth type. Logistic regression models were developed to analyze the association between a number of independent variables and sealant use.* ***Results:*** *About 60 percent of surveyed students had one or more sealants present, with a mean of 3.2 sealants per subject. Of all pit and fissure surfaces on permanent first molars, 23.4 percent and 20.1 percent were sealed for the 11 years and younger and 12 years and older age groups, respectively. For these same two age groups, the percentages of pit and fissure surfaces that were decayed and filled were 6.7 percent and 19.7 percent, respectively. For both age groups combined, 10.8 percent and 23.7 percent of all pit and fissure surfaces on second molars and premolars, respectively, were sealed. The prevalence of decayed and filled pit and fissure surfaces was 5.6 percent and 1.8 percent, respectively, for second molars and premolars. Premolars were being sealed at a rate of 13 to 1 compared to the number of decayed and filled surfaces. Logistic regression failed to identify meaningful predictors of sealant use.* ***Conclusions:*** *Results from this study found an increase in the prevalence of sealants in the three communities surveyed, yet failed to identify criteria used by dentists or auxiliaries when making decisions about sealant placement. Professional education in the appropriate use of sealants may be necessary. [J Public Health Dent 1997;57(3):171-5]*

Key Words: sealants, caries, guidelines, prevalence, criteria.

The efficacy of pit and fissure sealants has been demonstrated in numerous clinical trials (1-5). However, discussion continues about their cost effectiveness and cost benefit when used in private dental offices and public programs (6-10). Regardless of this debate, the technology justifiably has become an important part of the armamentarium in preventive dentistry.

The changing patterns of dental caries in children and adolescents, which generally favor the use of sealants (9,11-13), and the overwhelming evidence of their efficacy have generated research that investigates professional acceptance and use of sealants. This literature generally shows that use of sealants lags behind expectations (4,14-19). Cohen and co-workers (20) found that general dentists in the United States in 1984–85 provided sealants for 18.7 percent of patients under the age of 18. Rozier and co-workers (21) reported the prevalence of dental sealants in a representative sample of North Carolina schoolchildren 6–17 years of age in 1986–87 to be 12 percent. In 1988, Gillcrist and co-workers (22) surveyed a representative sample of schoolchildren aged 5 to 17 years in Tennessee. Just over 10 percent of those surveyed had sealants. Gift (23) found a similarly low level of use based on the 1989 National Health Interview Survey. One recent survey suggests a higher prevalence of sealant use. This 1992–93 statewide survey of schoolchildren in Ohio, found 26 percent of 8-year-olds and 25 percent of 14-year-old students with at least one sealant (18). However, results from a 1993–94 survey in California found only 10.4 and 12.6 percent of 8- and 15-year-olds, respectively, with at least one sealant (19). Some surveys of providers suggest that a significant proportion of practitioners use sealants, although sparingly (24,25), while others report that most practitioners routinely use sealants on their patients (26,27).

Because of concern about the limited use of sealants (14), professional and commercial efforts have focused on increasing their use (2,3,6,14,28,29). The results of these initiatives are largely unknown. Lang and co-workers (17) studied the knowledge, attitudes and use of sealants following different types of educational interventions. These results suggest that educational efforts can increase provider knowledge, but have little effect on the use of sealants.

Perhaps some confusion arises from what until recently appeared to be uncertainty about when and why to use sealants. The American Dental Association (ADA) initially recommended that all children and teenagers receive sealants; however, it also suggested

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rigorous standards for sealant use and replacement strategies (30). ADA standards specified that only permanent molars be sealed, and only within specified time periods after eruption. More recently, however, the ADA recommended that preventive sealants be used on any tooth with pits and fissures that have questionable carious lesions or caries limited to the enamel (therapeutic sealant), despite the posteruptive age of the tooth, and for high-risk yet caries-free teeth (preventive sealant) (31). The American Academy of Pediatric Dentistry recommends that sealants be used on noncarious permanent and primary teeth as soon as possible after full eruption of the tooth, with the added indication that teeth with deep pits and fissures be sealed (29).

Kandelman and Lewis (3), in the 1988 edition of the Report on Preventive Dental Services in Canada, stated that "with the current caries decline, unless patients and teeth for sealant use are carefully chosen, the likelihood of wasteful, ineffective, and inefficient sealant use is greater now than it was previously" (3). They suggest that the indications for sealant use focus on individual teeth, with consideration of their morphology, eruption patterns, and dental caries susceptibility. While there appears to be increasing agreement within professional groups on the indications for sealant use, it remains difficult to identify exactly what criteria are being considered by practitioners when deciding whether or not to use them.

The purpose of this investigation was to determine the prevalence of sound, decayed, filled and sealed permanent tooth surfaces for children and adolescents from three fluoridated communities in British Columbia. A second aim was to develop a predictive model of sealant use that included the dental caries status of tooth surfaces along with a number of control variables.

Methods

This report presents some of the baseline data from a longitudinal study that will monitor the prevalence of dental caries and fluorosis in communities that have defluoridated their water supplies. The methodology is reported in a separate publication and will be summarized briefly (32). During the baseline survey in 1993–94, all children and adolescents in specified grade levels in the study communities were invited to participate in the survey. Children in grades 2 and 3 (n=2,715) and adolescents in grades 8 and 9 (n=3,317) from three communities in British Columbia were examined. Negative consent (it was possible to use passive consent in the survey) was received for only 680 children and adolescents; thus, almost 90 percent of the eligible children and adolescents from these communities were examined. Grade levels were used to focus the survey on specific age ranges; however, for analysis, wider age categories were used to maximize the number of cases. Questionnaires detailing residence history, use of fluoride therapies, and educational attainment of heads of household were received from 3,022 participants.

The status of each tooth surface was classified using a modified DMFS index, which scored incipient (D_1) and cavitated (D_2) lesions on both pit and fissure and smooth tooth surfaces where applicable (i.e., both pit and fissure and smooth surface scored on buccal surfaces of lower first molars and lingual surfaces of upper first molars) (33). The D_1 classification was scored on a pit and fissure surface when there was evidence of incipient decay—specifically, white chalky enamel or softness in a pit or fissure. This classification was assigned to smooth surfaces when a chalky white spot that did not appear glossy after drying was observed adjacent to the soft tissue margin. The D_2 classification was scored when cavitation or a loss in the normal integrity of the hard tissue was observed, either on a pit and fissure or a smooth surface. Each pit and fissure surface also was classified as either sealed and sound, sealed with recurrent decay (decay observed at the margin of an intact sealant), or sealed with primary decay (decay observed away from the margin of an intact sealant). Tooth surfaces that had lost a portion of the sealant material but had no evidence of decay were classified as sealed and sound.

Four examiners participated in the survey. The principal investigator administered two separate, one-week training exercises at each of the study sites to standardize examiners in the use of clinical measures. Replicate examinations generated reliability data presented elsewhere (32).

Data from the survey were used to generate basic descriptive statistics such as the percentage of children with sealants and the percentage with specific teeth sealed, all by age group. The outcome variables used in the regression analyses were: (1) one or more sealants, (2) two or more sealants, and (3) five or more sealants present. Predictor variables were either dichotomous or polychotomous, and included age, sex, community of residence, routine use of preventive technologies other than sealants, educational attainment of the parents or guardians, and several different components of the D_1D_2MFS index. Bivariate associations among the different dependent variables and the independent variables were tested for significance using the chi-square statistic. On the basis of these analyses, logistic regression models were developed to predict the different patterns of sealant use. Of interest was the relationship between incipient decayed surfaces, cavitated decayed surfaces, filled surfaces, community of residence, the educational status of the head of the household, and the use of sealants.

Results

Just over 60 percent of the study participants presented with at least one sealed tooth surface (Table 1). The mean number of sealed surfaces per participant was 3.2. The percentage of permanent teeth with a sealant according to specific tooth types is shown in Table 2. About 40 percent of first molars, 15 to 19 percent of second molars, and 13 to 16 percent of all premolars were sealed.

A total of 21,402 pit and fissure surfaces were scored on permanent first molars of children in grades 2 and 3 (Table 3). For adolescents in grades 8 and 9, 26,536 pit and fissure surfaces were scored. Of all pit and fissure surfaces on permanent first molars, 23.4 percent and 20.1 percent were sealed (and sound) for the 11-and-younger and 12-and-older age groups, respectively. For these same two age groups, the prevalence of decayed and filled pit and fissure surfaces was 6.7 percent and 19.7 percent, respectively. The prevalence of proximal disease was low in both age groups; only 0.2 percent of proximal surfaces were either decayed or filled in the 11-and-younger age group and 3.7 percent in

the 12-and-older age group.

For both groups, 10.8 percent of the 36,499 pit and fissure surfaces on permanent second molars were sealed (Table 4). The prevalence of decayed and filled pit and fissure surfaces was 5.6 percent. Of the 25,808 pit and fissure surfaces scored on premolars, 23.7 percent were sealed (Table 5). The prevalence of decayed and filled pit and fissure surfaces in premolars was 1.8 percent, most of this amount being the filled component. Premolars were being sealed at a rate of 13 to 1 compared to the number of decayed and filled surfaces.

About 25 percent of the decayed score in first molars of the 11-and-under age group was cavitated. For both groups, about 2.5 percent of first molars were cavitated, about 9 percent of second molars, and less than 3 percent of premolars. These results suggest that most of the disease either is treated, is relatively new and therefore untreated, or perhaps is under observation.

Significant bivariate associations were found for study community, age, sex, educational attainment of the head of household, more than four years' use of fluoride supplements, D_1D_2MFS of one or more, and D_1D_2MFS of four or more and the prevalence of one or more, two or more, and five or more sealed surfaces (all *P*-values <.01 using unweighted, chi-square tests). Independent variables found to be significant in bivariate analyses were used in several regression models, and found to have poor predictive power. Several patterns of caries prevalence—the presence of either an incipient, cavitated, and/or a filled pit and fissure surface—failed to influence the various models to any significant extent, suggesting that previous caries activity had little influence on the use of pit

TABLE 1
Percent Distribution of Participants by Number of Sealed Permanent Tooth Surfaces and Age Group

# Sealed Surfaces	≤11 Years Old	11+ Years Old	All
0	48.7	32.4	39.8
1	4.7	6.9	5.9
2	7.8	7.8	7.8
3	9.7	6.8	8.1
4	28.9	9.8	18.4
5–9	0.1	17.4	9.5
10–12	0.0	8.4	4.6
13–16	0.0	10.6	5.8

TABLE 2
Percentage of Permanent Teeth with Sealants by Tooth Type and Age Group*

Teeth Types	≤11 Years Old	11+ Years Old	All
Upper 1st molars	31.4	48.1	39.5
Upper premolars	0.2	30.6	13.3
Upper 2nd molars	0.0	33.8	15.3
Lower 1st molars	33.8	45.0	39.6
Lower premolars	0.1	28.7	15.8
Lower 2nd molars	0.0	34.5	18.9

*Sealed teeth means that at least one pit and fissured surface on a particular tooth is sealed; it does not imply that all pit and fissured surfaces are sealed.

TABLE 3
Number and Percent Distribution of Permanent First Molar Surfaces, by Surface Status and Age Group

	≤11Years Old		11+ Years Old		All	
Surface Status	Percent	Number	Percent	Number	Percent	Number
Total pit and fissured surfaces		21,402		26,329		47,742
Sound and unsealed surfaces	69.7	14,921	59.9	15,769	64.3	30,693
Incipient lesions	2.1	440	0.9	220	1.4	668
Cavitated lesions	0.8	174	0.5	141	0.7	315
Sealed surfaces*						
Sound	23.4	5,005	20.1	5,304	21.6	10,309
Sealed with caries	0.3	56	0.2	52	0.2	108
Filled surfaces						
No caries	3.7	792	18.2	4,803	11.7	5,595
Recurrent caries	0.1	14	0.1	40	0.1	54
Number of proximal filled or decayed surfaces	0.2	45	3.8	1,010	2.2	1,055

*Counted separately from classifications of pit and fissured surfaces.

TABLE 4
Number and Percent Distribution of Permanent Second Molar Surfaces by Surface Status, All Ages

Surface Status	# of Surfaces	Percent
Total pit and fissured surfaces	36,499	
Sound and unsealed surfaces	30,533	83.7
Incipient lesions	377	0.1
Cavitated lesions	177	0.5
Sealed surfaces		
Sound	3,854	10.6
Sealed with caries	60	0.2
Filled surfaces		
No caries	1,484	4.1
Recurrent caries	12	<0.1

TABLE 5
Number and Percent Distribution of Premolar Surfaces by Surface Status, All Ages

Surface Status	# of Surfaces	Percent
Total pit and fissured surfaces	25,808	
Sound and unsealed surfaces	19,189	74.4
Incipient lesions	38	0.1
Cavitated lesions	12	<0.1
Pit and fissure sealants		
Sound	6,124	23.7
Sealed with caries	5	<0.1
Filled surfaces		
No caries	438	1.7
Recurrent caries	2	<0.1

and fissure sealants.

Discussion

The US Public Health Service national objective for dental sealants calls for an "increase to at least 50 percent [in] the proportion of children who have received protective sealants on the occlusal (chewing) surfaces of permanent molar teeth" (29). The report noted that the 1986–87 level of sealant prevalence was 11 percent of children aged 8 and 8 percent of adolescents aged 14. The problem of low sealant use has been identified and discussed by others. Cohen (4) suggested that coverage under third party plans and the delegation of the task to auxiliaries would encourage greater use. Frazier (16) concluded that third party carriers were reluctant to cover the cost of sealants; however, she contended that the social, professional, economic, and cultural milieus within the profession influences practitioners' knowledge, attitudes, and behavior. In British Columbia, dental hygienists can apply sealants. However, no provincial dental public health programs provide sealants; therefore, the high prevalence found in this study cannot be explained by services provided in public programs. Information about third party coverage for sealants was not available.

The results of this study suggest that in the communities studied, the objective of the US Public Health Service has been met. Further, these results, while not representing dentists outside the study communities, reflect what the pattern of sealant use might be, given their wider use. Specifically, the findings fail to provide a clear picture about what criteria dental professionals are using when deciding to seal a particular surface. There is at least some suggestion in these results that the existing caries prevalence on specific surfaces does not influence greatly the decision, as evidenced by the high prevalence of sealants and the low prevalence of decayed and filled surfaces on premolars. While this assumption is not supported conclusively by these results, the picture presented raises some important questions about decision making and sealant use. It seems likely that different practitioners are using different criteria to make these decisions. The effect of therapeutic sealants on our observations is impossible to detect. However, whatever effect might exist would diminish the discrepancy noted in these results.

Kandelman and Lewis (3) noted that sealant use can be ineffective and inefficient. As a result, they recommended selection criteria for individual teeth to be sealed. Similar tooth-oriented criteria for individuals have been suggested by others (2,31). Recommendations concerning the use of sealants in community programs point to more liberal criteria for sealant use on sound and questionable teeth (30). Other investigations have studied the patterns of sealant use under different reimbursement plans (7). Their findings show a significant difference in the average number of sealants per child according to the type of insurance coverage. In one plan, premolars were not covered, resulting in lower use. The authors concluded, however, that dentists generally provided sealants in an appropriate fashion regardless of the extent of coverage. Burt (15), in looking at clinical and economic factors related to sealant use, also raised the issue of sealing all molars and premolars. He pointed out that guidelines for sealant use apparently have not been adopted by the profession in North America, despite their publication. Eklund (8) suggested that the cost of sealing premolars, particularly with a continued decline in pit and fissure caries for molars, could produce a higher premium for sealant coverage. His analysis points out the importance of the caries level when assessing the value of sealants. He suggested that if there is little or no disease to prevent, then there is little justification for the cost of the procedure.

The data presented in this study

support some of the concerns raised by other investigators and suggest that sealants can be used inappropriately. Clearly, there is evidence to suggest that the use of sealants is on the increase; however, it is important to stress that it is the appropriate use of the technology that will benefit the public. If the technology is overused, insurance companies may eliminate or reduce coverage for the procedure. Results of this study point to the continued need to investigate considerations being used by providers to determine the need for preventive and therapeutic sealants. Such information will help insurance companies design cost-effective benefit packages and will assist educators in designing appropriate educational and promotional activities for the use of sealants.

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