Population- vs. Risk-Based Applications of Fissure Sealants in First Permanent Molars: a 13-Year Follow-up

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Purpose: To evaluate and compare the long-term outcome of a population-based and a risk-based strategy of applying fissure sealants in newly erupted first permanent molars.

Design and Setting: Retrospective cohort study in primary dental care.

Materials and Methods: Four hundred and ninety-six subjects from two cohorts were included. In group P (n = 236), routine applications of fissure sealants were conducted while sealants were placed on the basis of subjective criteria in Group R (n = 260). Data of applications, maintenance, decay, restorations, extractions, and cumulative time of applications from six to 19 years were extracted from the dental records and bite-wing radiographs by two of the authors simultaneously. The main outcome measures were the total caries prevalence at the age of 19 years as well as the fate of each sealed and non-sealed occlusal surface.

Results: In group P, 87.7% of all first permanent molars were sealed compared with 20.2% in group R. There was no statistically significant difference concerning the total DFT at 19 years of age between the groups (mean 3.5 ± 3.8 vs. 3.7 ± 3.4). Considering the occlusal surfaces of the first permanent molars only, a statistically significant treatment effect was demonstrated in group P with an odds ratio of 4.6 (95% CI: 3.0 – 6.7; $p < 0.05$). The absolute risk reduction was 36.3% and the number needed to treat was 2.8. In Group R, no statistically significant treatment effect was disclosed (OR = 1.3; 95% CI: 0.9 – 1.7; risk reduction 5.5%).

Conclusion: This 13-year follow-up showed that population-based applications of fissure sealants in first permanent molars shortly after eruption showed a statistically significant treatment effect on the occlusal surfaces at the age of 19 years, which was in contrast to findings from a cohort in which sealants were applied on the basis of an individual risk-based strategy. There were, however, no significant differences concerning the total caries experience between the two cohorts.

Key words: caries prevention, first permanent molars, fissure sealants, preventive strategies

Oral Health Prev Dent 2006; 4: 151–156. *Submitted for publication: 30.08.05; accepted for publication: 07.12.05.*

Fissure sealants are frequently used in childhood for the prevention of fissure caries and the evidence for its efficacy and effectiveness has been examined and evaluated in recent tutorials and systematic reviews (Simonsen, 2002; Locker et al, 2003; Mejàre et al, 2003; Ahovuo-Saloranta et al, 2004). The reviews have clearly demonstrated that sealants are an effective preventive technology and with proper application techniques and maintenance, long-term retention rates can be achieved. Their efficacy may, however, be related to the background caries prevalence both of the individual and in the population and the cost-effectiveness must be considered locally (Ahovuo-Saloranta et al, 2004). In this context, the efficacy of sealants applied in molars on a population-based versus a risk-based strategy has been investigated. Heidmann et al (1990) conducted a study in two municipalities in Copenhagen, one with a policy of sealing all occlusal fissures of the first permanent molar and the other with a non-sealing policy. The effectiveness in caries reduction on the target surfaces after six to seven years was 25–32%. Virtanen and co-workers

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(2003) found that although fissure sealants were effective in preventing caries in molars with both strategies, the use of selective criteria for targeting the treatment could yield savings in costs and efforts in a low caries population. Similarly, Leskinen et al (2005) reported that routine sealing of first permanent molars did not prevent the need for restorative treatment in a significant way compared with sealing of risk subjects only.

In Sweden, tradition and local guidelines for clinicians within the Public Dental Service have resulted in different approaches for utilising fissure sealants, but generally the application has, to a large extent, been delegated to dental hygienists and dental assistants. Although there are some long-term follow-ups of fissure sealants available in the literature (Wendt and Koch, 1988; Simonsen, 1991; Vehkalahti et al, 1991; Wendt et al, 2001a, 2001b; Parnell et al, 2003), it was thought of interest to investigate the effects and possible benefits of contrasting fissure-sealing programmes on dental health in young adults and to calculate the risk reduction and number needed to treat. The aim of this study was to retrospectively evaluate and compare the long-term outcome of a population-based and a risk-based strategy of applying fissure sealants in newly erupted first permanent molars.

MATERIALS AND METHODS

Study groups

The study comprised 496 subjects from two cohorts of children born in 1982 with similar demographic and socioeconomic characteristics living in the County of Halland, Sweden. The groups are further described in Table 1. Both cohorts had access to comprehensive and preventive oriented dental care provided free of charge by the Public Dental Service and were recalled and examined at least once every year from the age of three years. The first cohort (group P) consisted of all children in the city of Laholm, in which a population-based strategy was adopted concerning the newly erupted first permanent molars with the intention to seal all occlusal surfaces on the first permanent molars as soon as possible after eruption. In the second cohort (group R), consisting of approximately one third of all children in the city of Halmstad, a risk-based philosophy was predominant, with application of fissure sealants on individual indications. The treatment decision was taken by the responsible individual dentist and based on a subjective risk assessment in which previous caries prevalence, fissure morphology and 'gut feeling' were the major predictors. In both cohorts, however, the sealings were carried out mainly by dental hygienists or dental assistants and only in rare occasions by the dentist. All therapists had specific training in sealant application. The material of choice was a light-cured resin-based sealant (e.g. Delton) and the procedure was carried out according to the manufacturer's instructions after thorough cleaning with a rubber cup and pumice paste. Both groups had a low fluoride content (< 0.3 ppm) in their piped drinking water but > 95% used fluoridated toothpaste on a regular basis during childhood and adolescence. Five and two subjects were lost during follow-up in groups P and R respectively, due to incomplete or lost records. Thus the final material comprised 231 subjects in group P and 258 in group R.

Study design

The study had a retrospective longitudinal design. Data on fissure sealants, reapplications, check-ups, decay, restorations and extractions were extracted from the dental records and bite-wing radiographs of each child and transferred to a predetermined intermediate protocol. The total caries experience at the ages of six and 19 years were calculated and expressed as decayed, extracted and filled surfaces (defs) or teeth (DEFT). The cumulative time spent on applications and reapplications of the fissure sealants between ages six and 19 years was noted and expressed in minutes. The data extraction was carried out simultaneously by two of the investigators and in the case of any disagreement, a consensus was reached.

Statistical methods

All data were entered in the SPSS software (version 11.5, Chicago Ill., USA) and processed with descriptive methods. Differences in proportions were assessed by a two-sided Chi-square test with Yates' correction for continuity. Two-by-two tables were formed with calculations of odds ratio and risk reduction. The number needed to treat (NNT) was calculated as 1/ARR (absolute risk reduction). A p-value of <0.05 was considered as statistically significant.

RESULTS

There was no significant difference in caries prevalence between the two cohorts at the age of six years.

Table 1 Description of the two cohorts born in 1982 and caries prevalence in the primary dentition (mean±SD) at six years of age (1988)

	Group P n=236	Group R n=260
Girls/boys	130/106	129/131
Lost due to incomplete/lost records	1/4	1/1
defs/DEFS (1988)	2.30±2.45	2.33±2.21
Fissure sealant, %	86.7%	20.2%
No sealants	8.7%	67.8%
One sealed molar	3.0%	8.1%
Two sealed molar molars	3.9%	5.0%
Three sealed molar molars	3.9%	4.3%
Four sealed molar molars	80.5%	14.7%

Table 2 Mean value and frequency of reapplications in relation to first permanent molar

Tooth #	Group P (n=231)	Group R (n=258)
16	14.7%	10.5%
26	12.0%	7.8%
36	12.5%	8.1%
46	9.5%	6.0%
Total	10.7%	7.9%

Table 3 Time related to fissure sealant treatment in the two cohorts

Time (min)	Group P (n=231)	Group R (n=258)
0	7.8%	68.2%
5–15	5.2%	11.6%
20–30	28.6%	12.8%
35–45	26.5%	5.0%
50–60	19.9%	1.9%
65–75	7.8%	–
80–90	2.6%	0.4%
>90	2.1%	–
Total treatment time/child (median)	40 min	10 min

In group P, 86.7% of first permanent molars were sealed within the first year after eruption, compared with 20.2% in group R, and the distribution is presented in Table 1. In group P, the vast majority had all four first molars sealed, while the corresponding figure in group R was close to 15%. The frequency of reapplications during the observation time in the two groups is shown in Table 2. The total frequency was 10.7% and 7.9% in groups P and R respectively, a difference that is statistically non-significant. The time spent on fissure sealant application and maintenance is given in Table 3. The median value was 40 minutes per child in group P, compared with 10 minutes in group R.

The total caries prevalence at the age of 19 years and caries incidence of the first permanent molars is presented in Table 4. There were no statistically significant differences between the mean total DFT and proximal DFT values in the two study groups. In group P, 36.6% of all occlusal surfaces of the first permanent molars were decayed, restored or extracted and the corresponding value in group R was 43.9% (non-significant). The fate of the sealed and non-sealed first permanent molars is further presented in the two-by-two Tables 5 and 6. In group P, a statistically significant treatment effect was demonstrated with a calculated odds ratio of 4.6 (95% CI: 3.0 – 6.9; $p < 0.05$) and a relative risk of 2.1 (95% CI: 1.6 – 2.8; $p < 0.05$). The risk reduction was 36.3% and the NNT was 2.8. In group R, no statistically significant treatment effect was disclosed. The odds ratio was 1.3 (95% CI: 0.9 – 1.7; NS) and the relative risk = 1.1 (95% CI: 1.0 – 1.3; NS). The ARR was obviously very marginal (5.5%) and the estimated NNT was 18.2.

Table 4 Total caries prevalence and status of the occlusal surfaces of the first permanent molars at the age of 19 years in the two study cohorts

	Group P (n=231)	Group R (n=258)
DFT (mean ± SD; range)	3.45 ±3.76 (0–19)	3.72 ±3.44 (0–19)
DFT approx. (mean ± SD; range)	6.88 ±5.60 (0–27)	5.86 ±5.62 (0–24)
Total number of occlusal surfaces	924	1027
Total number of sealed surfaces (6–7 yr)	802	228
Decayed surfaces	2.2%	1.4%
Filled surface	33.3%	41.8%
Extracted	1.1%	0.7%

Table 5 Two-by-two table showing the efficacy of the population-based fissure sealing strategy in group P at the age of 19 years. Values in table denote the number of first permanent molars

Treatment at six years of age	Outcome at 19 years of age			
	Sound	Diseased (DMF)	Sum	Event rate (DMF)
Fissure sealed	547	255	802	31.7%
Non-sealed	39	83	122	68.0%
Sum	586	338	924	

Odds ratio = 4.6 (95% CI: 3.0–6.9; $p < 0.05$)
Relative risk = 2.1 (95% CI: 1.6–2.8; $p < 0.05$)
Absolute risk reduction = 36.3%
Number needed to treat = 2.8

Table 6 Two-by-two table showing the efficacy of the risk-based fissure sealing strategy in group R at the age of 19 years. Values in table denote number of first permanent molars.

Treatment at six years of age	Outcome at 19 years of age			
	sound	diseased (DMF)	sum	event rate (DMF)
Fissure sealed	137	91	228	39.9%
Non-sealed	436	363	799	45.4%
Sum	573	454	1027	

Odds ratio = 1.3 (95% CI: 0.9–1.7; NS)
Relative risk = 1.1 (95% CI: 1.0–1.3; NS)
Absolute risk reduction = 5.5%
Number needed to treat = 18.2

DISCUSSION

The present study was undertaken to gain additional information on the more or less 'eternal' question concerning the most effective way of utilising fissure sealants in the prevention of caries in the first permanent molars. As in all retrospective studies, the outcome was highly dependent on the quality of the caries recordings and the accuracy of the notes concerning applications, reapplications and time consumption. A definite strength was the relative stability in the region, which enabled us to longitudinally follow the cohorts with very few lost individuals due to relocation. On the other hand, a number of therapists, approximately seven to eight in each cohort, were involved in the record-keeping over the years, which naturally brings some uncertainty to the registrations. However, all dentists in the region participated in regular diagnostic calibration exercises for caries scoring during the 1980s, and there was no reason to believe that the diagnostic criteria were used differently in the two groups or that under- or over-scoring was more or less predominant in one group or the other. The sealant applications were performed during a relatively short time-span (1988–1990) by auxiliary personnel with basically the same resin-based material. In group R, no formal risk-grouping scheme was applied, which means that the risk assessment was due to a high extent to the convenience, experience and beliefs of each responsible dentist. Although most of the sealants were carried out by dental hygienists and dental assistants, it should be underlined that all therapists had received specific training in how to apply the sealants. Previous studies have indicated that the long-term sealant effectiveness was equal or even better by delegation (Holst et al, 1998; Simonsen, 2002; Folke et al, 2004). Considering the limitations mentioned above, the results of the present study must be interpreted with caution and should not uncritically be used as an argument to claim a superiority of the population-based preventive strategy concerning fissure sealants. It must be underlined that the present odds ratio and risk values were calculated with the single molar tooth as an independent unit and not on the basis of the individual who harbour four dependent molars each. Also, the present NNT values need a further comment. NNT calculations are based on a comparison between a test and a control group in prospective trials. It can be questioned whether or not the non-sealed teeth in groups P and R can be regarded as controls since the allocation was not randomised. Especially in group R, the non-sealed subjects were those with lower risk and therefore not 'classical' controls, which is likely to lead to an overestimation of NNT. Therefore, the calculated data on NNT should be regarded with caution and not directly compared between the groups. Since no validated risk-grouping of the subjects could be obtained from the records of the late 1980s, the material did not allow a further evaluation of the long-term effect of fissure sealants in high-risk subjects.

The major finding of this 13-year follow-up was that a significant treatment effect was demonstrated only when the fissure sealants were applied routinely and this was partly in contrast to the conclusions of some reviews (Locker et al, 2003; Ahovuo-Saloranta et al, 2004). The frequency of sealant application in the two groups presented here (87% and 20% for groups P and R respectively) differed slightly from previous studies on routine vs. risk-based applications, which may explain the somewhat diverging results. In the study by Virtanen et al (2003), approximately 30% of the molars were sealed in the group employing selective criteria. On the other hand, in the recent paper by Leskinen et al (2005) only 10% of the first molars were sealed.

The frequency of reapplications was lower in this report (8–11%) when compared with previous long-term follow-ups of non-risk-based applications. In the study of Lavonius et al (2002), 28% of the first molars were re-sealed during the 13-year follow-up and it is possible that our figures are underestimations. The majority of the reapplications were performed before the age of 10 years and it is likely that teeth with total or partial loss of sealant retention were not properly maintained at the older ages. It was worth noting that the frequency of reapplications was slightly higher in the upper first molars when compared with the mandibular first molars, but the difference was not statistically significant.

Interestingly, this study did not reveal any significant differences in the total caries prevalence between the two study groups in spite of the finding that more sound occlusal surfaces were evident in group P at 19 years of age. This would imply that the population-based programme was not effective with respect to general dental health, but that would be a premature conclusion. The general caries risk over the 13-year follow-up may have differed between the groups, and our proximal DFT data at 19 years of age suggests that the caries activity might have been higher in group P compared with group R. In that case, the fissure sealant programme may very well have been successful. The total incidence of caries, restorations and extractions in the first permanent molars was 37–44%, which was higher than in some previous studies (Lavonius et al, 2002; Leskinen et al, 2005) but lower when compared with others (Virtanen et al, 2003). One should, however, keep in mind

that our figures were based on all occlusal surfaces, sealed or not, which can make any comparison unfair. When the present incidence rates were calculated only on sealed teeth, the values diminished to 32% in group P and to 40% in group R, which was in harmony with Simonsen (1991), albeit still higher than in the reports by Lavonius et al (2002) and Wendt et al (2001a). Notably, the calculated NNT in group P was more favourable than the corresponding value in previous reports (Heidmann et al, 1990; Dennison et al, 2000). The risk ratio (0.47) in this group of routine sealants was close to the pooled value of 0.43 that was calculated in the recent Cochrane review (Ahovuo-Saloranta et al, 2004).

The recorded total time allocated to application and maintenance of the performed sealant may allow some speculations on the cost-effectiveness of the intervention in the two cohorts. The median times of application and reapplication for each sealed tooth in groups P and R were 11.5 and 11.0 minutes respectively. Using the calculated NNT values, a total treatment time of 32 minutes was needed to gain one sound occlusal surface of a first permanent molar as young adult in group P, which was much more favourable than in group R. Thus routine applications in this low-caries population seemed more efficient, a finding that may challenge previous suggestions that targeted applications generally increases the cost-effectiveness of fissure sealants (Mejàre et al, 2003; Locker et al, 2003). There is, however, a possibility that the treatment time was consequently under-reported in the present records, since a different system of financing dentistry for children was used during the 1980s. Furthermore, it should be stressed that our findings in a low caries situation by no means contradict the thinking that fissure sealant programmes may be more cost-effective in a high caries situation and that sealant programmes should be considered to be implemented in geographic areas with higher than average caries levels or socioeconomically vulnerable communities.

In conclusion, the present long-term evaluation of fissure sealants applied shortly after eruption in first permanent molars showed a statistically significant treatment effect at the age of 19 years in a cohort with population-based routine applications but not in a cohort with an individual risk-based strategy. There was, however, no significant difference concerning the total caries experience between the two cohorts. The findings reinforce previous suggestions that pit and fissure sealants applied in childhood may have a long-lasting caries-preventive effect on the sealed surfaces, although its long-term effect on the general dental health may be limited.

ACKNOWLEDGEMENT

This study was in part supported by a grant from the County of Halland, Sweden.

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