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Retention and effectiveness of fissure sealants in Kuwaiti school children

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Objectives To evaluate the retention and effectiveness of fissure sealants in permanent first molars in a public programme. ***Methods*** Sealant retention in permanent first molars was evaluated in 452 children aged 6-8 years in 20 primary schools under the care of the School Oral Health Programme, Kuwait-Forsyth. The sealants were placed using rubber dam or cotton roll isolation, after cleaning with pumice and rubber cup, and 15 seconds etching. Sealant retention was evaluated at one and two years and scored as complete, partial or complete loss of sealant. Caries was scored when sealant was partially or completely lost. ***Results*** A total of 2,744 sealants were applied, with 2,324 and 2,288 sealants examined at the end of the first and second year respectively. In two years, 75% of the sealants were completely retained, 2.9% partially lost, 7.3% completely lost, and 14.8% resealed or restored. A small proportion of teeth (0.9%) were carious. Multivariate analyses showed that occlusal surfaces were 2.8 times more likely to retain a sealant than the buccal and palatal pits (95% CI 2.7-3.9, p<0.0001), and maxillary teeth were 1.3 times more likely to retain their sealant than the mandibular teeth (95% CI 1.01-1.5, p=0.04). Maxillary teeth were less likely to be carious (OR=0.6, 95% CI 0.4-0.97), p=0.03) and occlusal surfaces were 2.8 times more likely to be carious (95% CI 1.9-4.3), p<0.0001). No differences in sealant retention (p=0.24) and caries (p=0.19) were seen between teeth isolated using rubberdam or cotton roll. ***Conclusions*** Sealant retention was high, and sealants were effective in preventing caries.

Key words: Effectiveness, Kuwait, retention, school programmes, sealants

Introduction

Fissure sealants are efficient and safe means of preventing pits and fissure caries in recently erupted teeth (Ahovuo-Saloranta *et al*., 2004). According to Simonson (1991) placement of a sealant will avoid an initial occlusal restoration, which begins the "molar life cycle" which may proceed later to cuspal fracture, complex restoration and a possible extraction. Griffin *et al*. (2008) in their systematic review have shown that properly applied sealants are highly effective in protecting the tooth surface from caries and preventing caries progression. Because sealants act as a physical barrier to decay, protection is determined by the sealants ability to adhere to tooth surface. Sealant protection is reduced or lost when part or the entire bond between the tooth and sealant is broken (Mascarenhas and Moursi 2001).

Success with pit and fissure sealants is very dependent on technique. While there is no guarantee that a sealant is going to survive on any particular surface for a specified period of time, studies show that correctly placed sealants are likely to be retained over a period of years rather than months, or weeks (Simonson, 1991; Wendt *et al*., 2001). Studies have also shown that the loss of surface material may still confer protection due to the resin tags present in the sub-surface enamel (Thylstrup and Poulsen, 1978).

The possible length of service of sealants has been reported as between 10 and 15 years following placement by a single clinician (Simonson, 1991; Wendt *et al*., 2001). In public programmes, multiple clinicians are employed and more variable retention rates will be observed than with a single clinician. However few studies have evaluated both sealant retention and effectiveness, and factors affecting retention and effectiveness in public programmes. Anson *et al*. (1982) studied the benefit of sealants placed over a 33-month period in a dental school pedodontic clinic by multiple clinicians with various qualifications. After six months retention rate was 85% and a failure rate of 4% was observed at each subsequent six-month examination. After 33 months, 67% of sealants were completely retained.

The aim of the present study was to evaluate sealant retention and effectiveness, and the factors affecting pit and fissure sealant retention and effectiveness in a school oral health programme in Kuwait. Factors evaluated were child's age at sealant application, type of isolation, tooth surface sealed and arch.

Materials And Method:

452 children aged 6-8 years with a mean age of 7.1±0.6, from 20 primary schools under the care of the School Oral Health Programme Kuwait-Forsyth in Kuwait, in whom fissure sealants were placed on one or more caries free permanent first molars were examined in the present study. Fissure sealants were placed by 20 dentists between the period of November 2001 through April 2002. These dentists working for the School Oral Health Programme Kuwait-Forsyth have varying qualifications and have trained in several different countries.

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The following technique was used to place sealants. Teeth were isolated with rubber dam and cleaned with pumice using rubber cup, then rinsed well. In cases where rubber dam was contraindicated or difficult to place, cotton roll isolation was used. The teeth were then etched with 3M Scotchbond etching gel for 15 seconds, rinsed thoroughly with water for 15 seconds and dried. Fissure sealants (Delton Plus) were applied along the fissures and buccal and lingual pits according to the manufacturers instruction and photopolymerized for 20 seconds. The sealed areas were checked with an explorer for complete coverage and retention.

All children with sealed teeth were recalled after one year and two years. The sealants were evaluated for retention, extension of coverage, and caries. All examinations were done by one of the authors (RF). The criteria in Table 1 were used to score sealant retention. Previously sealed surfaces were assessed for fissure sealant coverage, re-sealing, restorations and the presence of new caries. Data collected was tooth and surface sealed, type of isolation, and sealant retention. Child's age at sealant application was also recorded.

Statistical Analyses

Data were entered into an especially designed data entry Programme using Epi-Info™ Version 2000 (Centers for Disease Control and Prevention (CDC), Atlanta). New variables, such as arch, caries status, and sealant retention were derived using Epi-Info. Sealant retention was measured by two variables: 1) sealant retention - proportion of sealants categorized at last evaluation as completely retained (score 1), and not retained (scores 2 to 7), and 2) sealant status – proportion of sealants categorized as completely retained (score 1), partially lost (scores 2 and 3), and completely lost (scores 4 to 7). Previously sealed surfaces that were resealed or restored were considered completely lost. Caries status variable was created by combining scores 3, 5 and 7. Descriptive analyses and bivariate analyses were first performed using Epi-Info. Bivariate associations between sealant retention, sealant status, and caries status and variables such as tooth, tooth surface, arch, and isolation were evaluated using chi-square and Fisher's Exact tests. Data were then exported into SAS for further analyses. Multivariate analyses were performed to evaluate sealant retention and caries status. The independent variables tested were tooth surface, arch, and isolation, controlling for child's age at sealant placement. In the model for caries, sealant status was also used. Sealant retention and caries was evaluated at two time points, one year after sealant application, and two years after sealant application.

Results

2,744 sealants on 1,372 caries-free permanent first molars were applied in 452 children. On every tooth, the occlusal and the buccal or palatal pits were sealed, resulting in 1372 sealants placed on occlusal surfaces, and 1,372 sealants placed on buccal or palatal pits. 51% of the sealants were placed on maxillary permanent first molars, and 49% were placed on mandibular first molars. Most of the sealants, 71.9% (1976), were placed using rubber dam, and 28.1% (770) were placed using cotton roll isolation. Because of children having left the school or absenteeism on the day of examination, data on sealant retention is available for 2,324 sealants at one year and 2,288 sealants at two years.

Sealant Retention

Table 2 reports sealant retention at the end of one year, and at the end of two years. As seen from Table 2, 79.8% of the sealants evaluated were retained completely at the end of one year, and 75% at the end of two years. Only 4.8% additional sealants were lost in the second year compared to the first year after placement. A small additional proportion of (0.4%) sealants were completely lost in the 2nd year. Twice as many sealants were replaced or teeth resealed in the second year compared to the

Table 1. Criteria for evaluating sealant retention

Score	*Criteria*
Score 1	Sealant completely covering all pits and fissures, buccal pit and palatal fissures
Score 2	Sealant partly covering the tooth and tooth is sound
Score 3	Sealant partly covering the tooth and tooth is carious
Score 4	Sealant completely lost, and tooth is sound
Score 5	Sealant completely lost, and tooth is carious
Score 6	Resealing done
Score 7	Preventive resin restorations or composite filling done.

Table 2. Sealant retention one and two years after placement.

Criteria	*After 1 year % (n)*	*After 2 years % (n)*
Sealant completely covering all pits and fissures buccal pit and palatal fissures	79.8% (1854)	75% (1717)
Sealant partly covering the tooth	4.3% (99)	2.9% (67)
Sealant completely lost	6.9% (160)	7.3% (166)
Resealing done	4.8% (111)	8.5% (195)
Preventive resin restorations or composite filling done	4.3% (100)	6.3% (143)

first year (8.5% versus 4.8%). Further results are being reported only for two years after application of sealant, as the associations seen one year after sealant placement were no different than two years after placement.

Bivariate analyses showed that sealant retention was significantly different by tooth ($p<0.0001$) and surface ($p<0.0001$), marginally significant by arch ($p=0.056$), but not by isolation ($p=0.72$). Sealants in maxillary teeth were 20% more likely to be retained than those in mandibular teeth ($p=0.056$). Fissure or occlusal surfaces were 2.8 times more likely to retain a sealant than the buccal and palatal pits (95% CI 2.3-3.4, $p<0.0001$).

Sealant status when defined as completely retained, partially lost, and completely lost was significantly different by tooth ($p<0.0001$), by surface pit/fissure ($p<0.0001$), by type of isolation rubber dam versus cotton roll ($p<0.02$), and by arch maxillary versus mandibular ($p<0.003$).

In multivariate analyses (Table 3), after controlling for age at sealant application, isolation and arch, occlusal surfaces were still 2.8 times more likely to retain a sealant than the buccal and palatal pits (95% CI 2.7-3.9, $p<0.0001$). Maxillary teeth were 1.3 times more likely to retain their sealant than the mandibular teeth (95% CI 1.01-1.5, $p=0.04$). No differences in sealant retention (completely retained/not retained) were seen between rubber dam or cotton roll isolation ($p=0.24$). Children who were older when the sealants were applied, were less likely to retain their sealants ($p=0.02$).

Caries

A very small proportion of previously sealed surfaces were carious at the time of examination, with 0.8% surfaces carious at one year, and 0.9% at year 2 (Table 4). When restored surfaces were included, one year after sealant application, 5.1% of the surfaces had experienced caries, and two years after sealant application, 7.2% of the surfaces had experienced caries.

Although caries did not significantly differ by surface type ($p=0.09$) in the bivariate analyses, it differed by type of isolation ($p<0.006$), and arch ($p<0.0008$). Teeth isolated by rubber dam were 1.8 times more likely to be carious (95% CI 1.1-2.7), and mandibular teeth were 1.8 times more likely to be carious than maxillary teeth (95% CI 1.2-2.5).

In multivariate analyses (Table 5), after controlling for age of sealant application, status, arch and surface, no difference in caries was seen by type of isolation ($p=0.19$). Children who were older when the sealants were applied, were more likely to be carious ($p=0.03$). Maxillary teeth were less likely to be carious than those in the mandible (OR=0.6, 95% CI 0.4-0.97), $p=0.03$). Occlusal surfaces were 2.8 times more likely to be carious than buccal and palatal pits (95% CI 1.9-4.3), $p<0.0001$). Teeth that had completely lost their sealants were 13.5 times more likely to be carious ($p<0.0001$) than those that partially or fully retained their sealants. Although not significant, teeth isolated by cotton roll were 30% less likely to be carious than those isolated by rubber dam.

Table 3. Multivariate analysis for sealant retention

Variable	*Estimate*	*St. Error*	*p-value*	*Odds Ratio*	*95% CI*
Intercept	1.65	0.63	< .008	-	-
Age at application	-0.19	0.08	0.02	0.8	(0.7-0.97)
Isolation (cotton roll)	0.07	0.06	0.24	1.1	(0.9-1.4)
Arch (maxillary)	0.21	0.10	0.04	1.3	(1.01-1.5)
Surface (occlusal)	1.02	0.10	<0 .0001	2.8	(2.7-3.9)

Table 4. Caries in previously sealed teeth one and two years after sealant placement.

Criteria	*After 1 year % (n)*	*After 2 years % (n)*
Sealant partly covering the tooth		
Tooth is sound	3.7% (86)	2.2% (51)
Tooth is carious	0.6% (13)	0.7% (16)
Sealant completely lost		
Tooth is sound	6.7% (156)	7.1% (162)
Tooth is carious	0.2% (4)	0.2% (4)

Table 5. Multivariate analysis for caries in previously sealed teeth

Variable	*Estimate*	*St. Error*	*p-value*	*Odds Ratio*	*95% CI*
Intercept	-5.2	1.3	< .0001	-	-
Age at application	0.35	0.17	0.04	1.4	(1.02 – 2.0)
Isolation (cotton roll)	-0.16	0.13	0.19	0.7	(0.4 – 1.2)
Arch (maxillary)	-0.43	0.20	0.03	0.6	(0.4 – 0.97)
Surface (occlusal)	1.05	0.21	<0 .0001	2.8	(1.9 – 4.3)
Sealant Status (completely lost)	2.6	0.21	< 0.0001	13.5	(9.0 – 20.1)

Discussion

Complete sealant retention in this study at the end of one year was about 80%, and at the end of two years was 75%. These findings are comparable with those studies performed under similar situations by Mascarenhas and Moursi (2001) and Walker *et al* (1996), but much higher than that of Messer *et al*. (1997) and Anson *et al*. (1982). According to Simonsen (1991) the success of sealants depends on the application procedure. Although in our study all the fissures were sealed with chairside assistance under optimal clinical settings, the sealants were placed by 20 dentists from different academic background, training and qualifications. This could be one of the reasons why our retention rates are lower than those reported by do Rego and de Araujo (1996).

Our results on arch differences that maxillary permanent first molars were 1.3 times or 30% more likely to retain their sealants than mandibular molars, was also similar to those reported by Mascarenhas and Moursi (2001). However, it is also noted that mandibular permanent first molars were 1.7 times more likely to be carious at the end of two years than maxillary molars. Similar findings were seen in the studies by Wendt *et al*. (2001).

Loss of sealants in the present study was mainly from buccal or palatal pits. Occlusal sealants were retained 2.8 times more than buccal and palatal sealants. This is in agreement with the reports of Cooney and Hardwick (1994). There are several possible reasons for these failures in buccal and palatal pits such as insufficiently erupted teeth, difficulty in isolation, or inadequate etching.

Moisture control is highly essential for sealant success. Clinical studies show no significant difference in the retention of sealants placed regardless of isolation technique, whether rubber dam or cotton rolls and suction was used (Cooney and Hardwick, 1994; Lygidakis *et al*., 1994). Our study also shows that sealant retention was not affected by isolation used. On the other hand teeth isolated by cotton roll were 30% less likely to be carious in the multivariate analyses, suggesting that teeth isolated by rubber dam were 1.4 times more likely to be carious than those sealed using cotton roll isolation. A possible reason is that teeth isolated by rubber dam needed to be completely erupted into the oral cavity for the rubber dam to be placed; therefore they were exposed to the oral environment for a longer time without sealants. We therefore recommend using cotton roll isolation to place sealants on teeth that are not sufficiently erupted to place a rubber dam. Our study also showed that teeth that had completely lost their sealants were 13 times more likely to be carious. There is no doubt that sealant on surfaces act as a barrier against dental caries for as long as the sealant remains intact.

The effectiveness of a sealant programme can be measured in several ways. The only reason sealants are placed is to prevent caries, therefore the effectiveness of a sealant programme should be measured by its ability to prevent caries on the sealed surface. Other measures of sealant effectiveness such as percentage of completely retained sealants, and reapplication rates are interim measures. In the present study we measured effectiveness in terms of caries prevention on the sealed surfaces of permanent first molars in children considered to be at high risk of dental caries as done by Messer *et al*. (1997). Our study shows that at the end of two years, of all the surfaces sealed 6.3% were restored possibly due to caries, and 0.9% were carious (Tables 2 and 4). On the first permanent molars regardless of sealant retention, 92.8% of all sealed surfaces were sound. 100% of surfaces with completely retained sealants were sound compared with 76% of surfaces with partially retained and 97.3% of surfaces with missing sealants. Similar to the study by Messer *et al*. (1997), this finding suggests that sealants continue to prevent caries even when they appear partially or completely lost. Thylstrup and Poulsen (1978) have previously stated that even if some part of sealant is missing in the fissures, there is still enough resin tags in the deeper part to prevent caries.

The present study was conducted in a population with a relatively high level of occlusal caries and in an age group where the recently erupted permanent first molars are at high risk of developing dental caries. It is accepted among clinicians that if a tooth has no occlusal cavities 2-4 years after eruption, the tooth is unlikely to decay and there is no need to seal it (Council on Dental Research, American Dental Association, 1985). But lately several studies have shown a high prevalence of caries in permanent molars and relatively constant rate of caries attack in these surfaces up to10 years after eruption (Ismail and Gagon, 1995; Mejare *et al*., 1998; Ripa *et al*., 1988; Vehkalahti *et al*., 1991). Therefore, given the demonstrated effectiveness of sealants in preventing caries in the current study, in similar populations, it is advisable to routinely seal the most susceptible tooth surfaces i.e. the occlusal surface of the permanent molars, soon after eruption and to reseal deficient sealants regularly. This would also be in keeping with the workshop on "Guidelines for Sealant Use", that recommended sealants should be used for people whose teeth are at risk for pit and fissure caries, regardless of age (Siegal and Kumar, 1995).

Conclusions

A higher proportion of sealants were retained in the School Oral Health Programme Kuwait-Forsyth, Kuwait when compared to other public programmes with multiple operators. Factors affecting sealant retention were arch and tooth surface. Mandibular teeth and buccal and palatal pits were less likely to retain sealants. Mandibular teeth were also more likely to become carious. Therefore efforts should be made to improve the retention of sealants placed in mandibular teeth in this population.

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