Evaluation of fissure sealant applied to topical fluoride treated teeth

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Fissure sealant is an important tool in the prevention of dental caries. This study evaluated the effect of treating the enamel with topical fluoride gel prior to acid etching on sealant retention clinically (Part I) and in vitro *(Part II). In part I a split mouth design using contralateral first permanent molars was conducted. Seventy (35 pairs) molars were sealed. Fissure sealant was applied on one side of the mouth (control group) and the contralateral tooth received acidulated phosphate fluoride gel (test group) prior to acid etching. The sealant was evaluated after 6 and 12 months and scored as intact, partially lost or completely missing.*

In part II, the shear bond strength between sealant and buccal enamel of extracted permanent molars without or with topical fluoride treatment was evaluated. Results showed no statistically significant differences between the test and control groups either clinically or in vitro*. It is concluded that topical fluoride application prior to acid etching does not have a deleterious effect on sealant retention. However, further investigations should be conducted using different types of fluoride before altering the traditional practices.*

J Clin Pediatr Dent 29(3): 215-219, 2005

INTRODUCTION

Sealants have been developed to protect pits and fissures from caries by preventing the impaction of food and bacteria, which produce acidic conditions that result in caries initiation.[1] Different researchers have assessed the clinical efficiency of sealant use and showed good results of this material after a follow-up period of six months up to ten years.[2-5] A recent longitudinal study showed that pit and fissure sealants applied during childhood have a long lasting caries preventive effect for up to 20 years.[1] There is good evidence that pit and fissure sealants can be used efficaciously and effectively in high-risk children as long as the sealant is retained.[6]

There are now a number of different approaches to prevent dental caries available to the clinician. Fissure sealant are only a part of the program of prevention, but an important part of the armamentarium against dental caries and must be combined with other preventive methods.[7] A recent study reviewed the potential effectiveness of combinations of preventive methods and concluded that the most promising combination program currently appears to be the use of fluoride with fissure sealing.[8]

Topical application of an acidulated phosphate fluoride to enamel surfaces before acid etching has been reported to significantly reduce the bond strength of pit and fissure sealant.[9,10] For this reason it is not recommended to place sealants after topical fluoride application, and for regular dental care, sealant placement is done either before fluoride application or postponed for another visit after fluoride application. Again, surface deterioration and weight loss of filled sealant have been reported when treated with topical fluoride gels.[11]

On the other hand exposure of enamel to fluoridated prophylaxis pastes,[12] fluoride containing etching gel,[13] or fluoride solutions after etching[14] has been found to have no significant effect on the bonding of sealants or orthodontic brackets. More recent studies have reported that exposure of the enamel to topical fluoride treatment before placement of composite or sealant has no effect on resin bond strength to enamel *in vitro*.[15-17]

The aim of this study was to evaluate the effect of topical fluoride application prior to acid etching on the retention of pit and fissure sealant.

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MATERIALS AND METHODS

This study was undertaken in two parts:

Part I: A clinical investigation that evaluated the effect of topical fluoride application on sealant retention to the first permanent molars in children.

Part II: An *in vitro* investigation that evaluated the shear bond strength of pit and fissure sealant to enamel treated and untreated by topical fluoride.

Part I: Clinical investigation

Subjects

Healthy child patients between the ages 7 and 10 years attending the pediatric dental clinics at the Faculty of Dentistry, King Abdulaziz University, having pairs of clinically sound contralateral first permanent molars were selected.

Study design

A split mouth design using contralateral teeth was conducted. Treatment was selected by reference to random number tables, read strictly in sequence, for odd numbers the patient right side received fissure sealant only (control group). For even numbers the patient right side received topical fluoride gel prior to etching (test group). The contralateral teeth in each case received the alternative treatment. A total of 70 first permanent molar (35 pairs) were sealed.

Procedure

Following rubber dam isolation the enamel surface was cleaned by a water slurry of non-fluoridated pumice, using a prophylaxis cup, rinsed and dried. In the test group acidulated phosphate fluoride (APF) gel (NUPRO - APF, Dentsply International INC., USA) was applied on the enamel surface with a Q - Tip and left for 4 minutes, then rinsed with an air water spray for 20 seconds and dried for 20 seconds. In both groups, 30 seconds etching with 35% phosphoric acid (Scotchbond etchant, 3M Dental Products, St. Paul, MN, USA) using the instructions of the manufacturer, followed by a water spray wash for 15 seconds and drying for 15 seconds. Sealant (Vesioseal, ESPE, Germany) was applied according to the instructions of the manufacturer and light cured using a visible light gun (Spring Health Products, USA) for 40 seconds. The sealants were then tested with an explorer for verification of retention. The condition of each sealant was checked after 6 and 12 months with an explorer and scored as:

- Intact: when completely sealed or when the loss was clinically insignificant.
- Partially missing: when some parts the sealant were missing.
- Completely missing: when no sealants could be detected.

No re-sealing was done at the six-month follow-up examination. The data were analyzed statistically using the Chi-Square test and Mann-Whitney U test at 5% level of significance.

Part II: *In vitro* investigation

Twenty extracted human sound permanent molars were used in this investigation. Each tooth was embedded in cold cure acrylic resin so that the buccal surface was perpendicular to the long axis of the resin block using a split metallic mold. The buccal surfaces were flattened and stored in distilled water. The specimens were randomly divided into two equal groups: Group I (control) consisted of 10 specimens that were cleaned with rubber cups and aqueous slurry of pumice using the conventional speed, then rinsed and dried.

Group II (test) consisted of 10 specimens that received pumice, rinsed and dried. Then APF gel (NUPRO, APF Dentsply, International INC. USA) was applied on the enamel surface and left for 4 minutes, the rinsed for 15 seconds and dried for 15 seconds.

In both groups the enamel surfaces were acid etched, rinsed and dried as previously reported in part I. The sealant material (Vesioseal, ESPE Germany) was then applied to the etched enamel using a cylindrical plastic tube (4.2 mm in diameter and 2.5 mm in length) perpendicular to the buccal surface. The sealant was the cured for three- 20 seconds intervals, one from the top and two from the sides. The plastic matrix was carefully removed and the specimens were placed in distilled water for 72 hours at room temperature. Shear bond strength was evaluated using a universal testing machine (Conten Industries Inc. Florida USA). A shear force was applied to the base of the bonded sealant cylinder parallel to the buccal surface of the tooth at a cross-head speed of 5 mm/minute until de-bonding occurred. The shear bond strength was calculated by dividing the obtained load by the surface area of attachment and expressed in kg/cm^2. Each fracture surface was a then examined under a light microscope to assess the mode of bond failure. The data were statistically analyzed using the t-test and Mann-Whitney U test at 5% level significance.

RESULTS

Part I

Out of the 35 pairs, the number of molars that were available for examination after 6 and 12 month were 28 and 29 pairs respectively. Sealant retention on the first permanent molars without (control) or with topical fluoride treatment (test) are shown in Table 1 and 2. There were no statistically significant differences ($p>0.05$) between the two groups. After 12 months intact sealant

was found in 65.5% of the control group and in 58.6% of the test group.

On comparing the overall rate of retention on the maxillary and mandibular molars, no statistically significant differences were found (p>0.05). Although the difference was not significant, 60% of the partially lost sealants, at the 6-month follow up, were recorded in the maxillary molars. When the age of the patient was considered the completely lost sealants were observed among 7-year old children.

Part II

The mean shear bond strength values for the two groups are displayed in Table 3. There was no statistically significant difference between the shear bond strength values for the two groups (P>0.05). Table 4 shows the mode of de-bonding failure in the two groups. There was no statistically significant difference (p>0.05) in the mode of de-bonding failure between the two groups. Three specimens in the control group and two in the test group showed fractured enamel (enamel cohesive failure). The other specimens showed adhesive failure.

Table 1. Sealant retention after six months in the control and test groups.

Group	Missing(%)	Partial(%)	Intact(%)	Total(%)	P
Control	0 (0)	4 (14.3)	24 (85.7)	28 (100)	
Test	1 (3.6)	7 (25)	20 (71.4)	28 (100)	
Total(%)	1 (1.8)	11 (19.6)	44 (78.6)	56 (100)	
Chi-square Value	2.182				>0.05
Mann-Whitney U-value	334.0				>0.05

Table 2. Sealant retention after twelve months in the control and test groups.

Group	Missing(%)	Partial(%)	Intact(%)	Total(%)	P
Control	0 (0)	10 (34.5)	19 (65.5)	29 (100)	
Test	2 (6.9)	10 (34.5)	17 (58.6)	29(100)	
Total(%)	2 (3.4)	20 (34.5)	36 (62.1)	58 (100)	
Chi-square Value	2.111				>0.05
Mann-Whitney U-value	381.5				>0.05

Table 3. Mean shear bond strength (kg/cm^2) of sealant to enamel in the two groups.

Group	Range	mean ± S. D.	P
Control	5.06 - 169.1	70.94 ± 55.01	
Test	13.73 - 187.14	64.81 ± 51.41	
t - value	0.258	> 0.05	

Table 4. The number of specimens with different modes of debonding failure in the two groups

Group	Adhesive	Cohesive failure	Total	P
Control	7	3	10	
Test	8	2	10	
Mann-Whitney U - value	45.0			> 0.05

DISCUSSION

Pit and fissure sealants and professional topical fluoride are the most important methods that the dentist can implement to prevent caries in children and adolescents. Fluoride has been negatively associated with resin bonding.[10,18] The results of the present study, however, showed clinically no significant difference in sealant retention between teeth treated or untreated with topical fluoride gel before acid etching. In addition, the shear bond strength of sealant to enamel was not significantly affected by fluoride application. These findings are in agreement with other studies, which found similar clinical results[19] and *in vitro* results.[15-17] However, they disagree with older studies,[10,20] (done three decades ago and used the ultraviolet light activated resin that no longer used), which reported that fluoride treatment reduced resin bonding to enamel. Since that time developments have occurred in the sealant materials. Based on the recent available longitudinal studies, it has been suggested that the light cured resins may retain better than the chemically cured ones.[7]

The overall complete retention rate of sealant (both treated and untreated) after 6 to 12 months was 78.6% and 62.1% respectively. These rates are comparable to the rates reported by other studies, which reported retention rates ranging from 48% - 80% in average at 12 months.[19,21,22]

The most critical period for sealant failure is at base line and during the 6 months following application.[23] Early loss of sealant, within the first few days or weeks after placement, is considered to be indicative of faulty application technique.[24] This may be caused by inadequate etching of the enamel.[25] However, if sealant survive this initial period, and as shown in most long term

studies, the subsequent losses tend to be more gradual and probably due to a combination of different causes.[25] In the present study only 3.6% of sealant placed after fluoride treatment showed complete loss after 6 months. This indicates that fluoride application did not jeopardize acid etching characteristics.

Maintenance and replacement of fissure sealant annually have been shown to be necessary for the high success rates of sealant (85 to 96%) after 10 years.[3] Gale *et al*.[26] have indicated that periodic recall to reseal lost sealant and thus maintain sealant integrity in order to prevent dental caries is a necessary component of a comprehensive dental care program. In the present study 34.5% of the sealants in both groups showed partial retention after one year. Partial loss of sealant is still an unresolved issue in sealant studies. Partial retention of sealant was often considered success. There has been an opinion that if some part of the sealant is missing in the fissures there is still enough resin in the deeper part to prevent caries.[27] However, data from past studies have shown that partial loss of sealant leaves a tooth equally susceptible to caries as an unsealed control tooth.[28,29] More recent studies using a computer-driven profilometer has documented that sealant loss of some types is continuous.[30,31] In addition, a recent review on sealant effectiveness suggests that deficient sealants are not effective in caries prevention and regular maintenance and sealant addition is important.[32] The application of topical fluoride gel prior to acid etching will increase the fluoride content of the enamel by forming calcium fluoride.[33] The later will act as a slow releasing agent to enhance remineralization and make the enamel more resistant to acid dissolution.[33] Thus, inhibits demineralization that may occur if sealant is lost between the recall visits.

Sealant retention is influenced by the type of sealant, position of the tooth in the mouth, and the age of the child.[34] In the present study loss of sealant was more common in the maxillary molars and in the young children. This finding agrees with Ripa,[34] who reported better sealant retention in mandibular than in maxillary teeth. It also agrees with Dennision *et al.*,[23] who reported that sealants placed on molars early in eruption were far more likely to require replacement within 3 years. Adding that, at a stage of eruption in which the distal tissue is at the level of the distal marginal ridge, the replacement rate for sealants was 26%. The younger the child, the more difficult it is to maintain a dry field because of behavior or eruption status of the tooth.

In part II of the study, the highest bond strength value was found in a fluoride treated specimen. The mode of failure was cohesive. With higher bonding values, large proportions of resin remained bonded to enamel surface, which caused fracture of the enamel. This indicates that the strength of bonding between the resin and tooth structure is higher than that showed by the shear value obtained.[15] This indicates that sealant bonding is not adversely affected by the application of fluoride prior to etching.

There are clinical and practical advantages to placing sealant immediately after topical fluoride application. First, if the sealant is lost, the tooth structure underneath it will benefit from fluoride. Compared to a newly erupted tooth that was sealed without exposure to fluoride treatment, the former would be more resistant to caries. Second, patients who have received a fluoride treatment, would not need to be rescheduled later for sealant placement.

CONCLUSIONS

1. The results of this study provide further evidence that the presence of fluoride does not adversely affect bonding of resin to enamel.
2. Sealant maintenance and replacement is needed to maintain the preventive effect over time.
3. Further studies are needed to examine the effect of using different types of fluoride on sealant retention before traditional practices are altered.

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