International Journal of Paediatric Dentistry 2004; **14:** 272–278

Microleakage assessment of pit and fissure sealant with and without the use of pumice prophylaxis

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Summary. *Objectives.* This study evaluated the effect of pumice prophylaxis on the level of microleakage around and between the sealant and enamel.

Materials and methods. A total of 32 freshly extracted sound upper first premolars, assigned as suitable for sealant application, were chosen and divided randomly into two groups: (1) a test group, without prophylaxis; and (2) a control group, with prophylaxis. Sealant was applied to all teeth using the same conventional technique, with prophylaxis being omitted in the test group. The sealed teeth were thermocycled (120×30 s, 5 and 55 °C cycles) and then immersed in 2% Basic Fuchsin solution for 72 h. Each tooth was sectioned and examined for dye penetration under a stereomicroscope (× 60 magnification).

Results. No dye penetration was seen in 19 (29·6%) of the teeth in the test group and 36 (56·2%) of the teeth in the control group. Dye had penetrated to the base of the fissure in 31 (48·4%) of the teeth in the test group and 23 (35·9%) of the teeth in the control group. Using a chi-square test for trend, the frequency of microleakage was significantly higher in the test group compared to the controls ($P < 0{\cdot}016$).

Conclusion. Prophylaxis has a role in improving sealant retention. Removing this step may cause an increase in microleakage.

Introduction

The success of pit and fissure sealant in preventing caries in fissures has been well-documented [1–3]. Indeed, it is considered to be the most effective caries-preventive measure that may be offered to a patient [4]. To achieve the greatest benefit, sealants should bond appropriately to the enamel surface [1–3]. It has been agreed that adequate retention of a sealant will be achieved if the tooth has a wide surface area, and deep, irregular pits and fissures. A number of studies have suggested that bur preparation and air abrasion will enhance sealant penetration and adaptation, by virtue of providing a greater surface area for retention as well as an increase in the bulk of sealant which improves wear resistance [5–8]. It has also been suggested that a combination of these measures could lead to increased clinical longevity. Conversely, a few investigators have reported no significant difference between conventional acid etch alone, and bur preparation followed by acid etching of pit and fissures [9,10]. A significantly greater level of microleakage was seen following the use of air abrasion alone compared to that following either acid etching alone or tooth preparation using a bur together with acid etching [11–14]. Hatibovic-Kofman *et al*. (2001) indicated that microleakage may be prevented most effectively with a combination of mechanical air abrasion and chemical acid etching [10].

The surface should be clean and dry at the time of the material placement [1–3]. This means that sealant should be applied after cleaning and polishing the teeth [1]. The use of drying agents such as ethyl

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alcohol is thought to remove any residual moisture left after air drying the acid etched surface [10]. Complete drying may also improve the ability of the sealant to wet enamel, allowing superior penetration and resin tag formation resulting in reduced microleakage [10]. Penetration of Ultra Seal XT *plus* into fissures was reported to be significantly greater when a drying agent was used [15]. Pumice prophylaxis with a rubber cup or brush has been used for many years as the conventional method prior to sealant application [1,3,16].

Mechanical removal of debris from the tooth surface has been mentioned as an important step in sealant application by some investigators [17–19]. In spite of such evidence, at least two laboratory studies [20,21] have shown little difference in surface changes in enamel, and several clinical trials [22–25] have demonstrated favourable sealant retention rates for bonded resins, composites and glass ionomers in the absence of pumice prophylaxis. Several other investigations have also shown that prophylaxis is an unnecessary step in the fissure sealant procedure, although it was thought to be useful if there was evidence of poor oral hygiene, heavy calculus or plaque accumulation [26–28].

Because of the controversy and since application technique is one of the main factors influencing the longevity of a fissure sealant [29,30], this study was designed to evaluate the effect of pumice prophylaxis on microleakage around sealants applied to the fissures. It was believed that the findings would have potentially important implications for clinical use of sealants.

As a subsidiary aim, the authors evaluated the effect of fissure configuration as a confounding variable since this might affect the quality of prophylaxis and sealant penetration, and thus microleakage around the sealant.

Methods

A total of 32 freshly extracted sound first upper premolar teeth, assigned as suitable for sealant application, were chosen and stored in 10% formalin solution [31–34]. All teeth were washed under tap water for 30 min to remove formalin from their surfaces prior to sealant application. Teeth were then allocated randomly into two treatment groups, i.e. test and control. A light-cured, fluoride-releasing sealant (Helioseal F, Vivadent Ets, Schaan, Liechtenstein) was used for this study.

The occlusal surface of specimens in the control group received a thorough prophylaxis with a water-based slurry of pumice, using a prophy brush in a slow-speed handpiece, for 10 s. This step was omitted in the test group. Teeth in both groups were then subjected to a washing procedure for 15 s followed by drying for 10 s. Each tooth was then etched using 37% phosphoric acid gel, washed for 15 s and dried for 30 s. Helioseal F was used for sealing the fissures, and was polymerized with an Arialux (Apadana Tak Co., Tehran, Iran) light-curing unit. The margins of sealants were then checked for any failure of sealant retention and application.

All teeth were then thermocycled 120 times in water baths of 5 and 55 °C, with a dwell time of 30 s in each bath [35]. Apices were covered with sticky wax and the surface of each specimen covered with two layers of nail varnish leaving a 1-mm window around the sealant. All specimens were immersed in a 2% Basic Fuchsin dye solution [36] for 72 h. A pretest was performed prior to this immersion step to determine the best dye immersion time for this investigation. Three teeth were prepared as explained above, but with the omission of the enamel-etching step. All teeth were immersed in a dye solution for 24, 48 and 72 h. Complete dye penetration into the base of the fissure was seen in the 72-h specimen.

Following immersion in the dye solution, the teeth were subsequently washed under running tap water for 30 s for removal of excess solution. The mesial and distal sides of each tooth were ground using a disk mounted on a slow-speed handpiece. Grinding was carried out to reach the enamel–sealant interface. Each tooth was subsequently sectioned longitudinally in a bucco-lingual direction through the line connecting the buccal and palatal cusp tips to provide four sections from each tooth for evaluation of microleakage (two lateral sections and two central ones). One trained (and blinded) examiner was asked to score the dye penetration depth in each section using a stereomicroscope (× 60 magnification). The scoring system used was that described by Grande *et al*. [31], and was as follows: (0) no dye penetration; (1) dye penetration into the occlusal third of the enamel–sealant interface; (2) dye penetration into the middle third of the interface; and (3) dye penetration into the apical third of the interface. As in previous studies, the final score was established as the highest score obtained after examination of both the buccal- and palatal-inclined cuspal planes in each section [36,37].

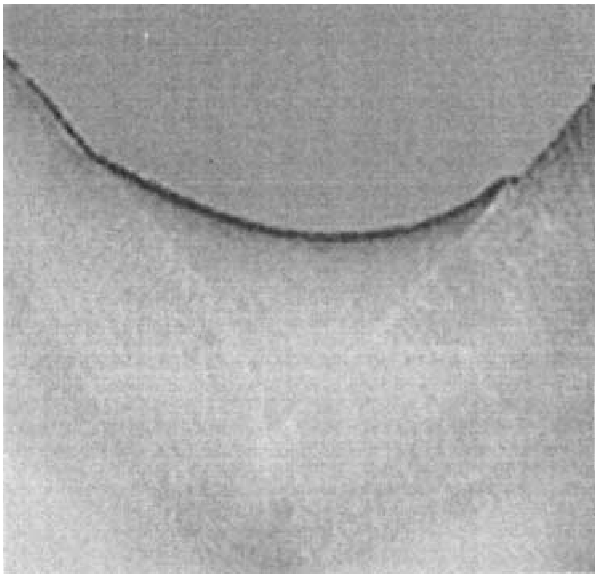

Fig. 1. No dye penetration (V-type).

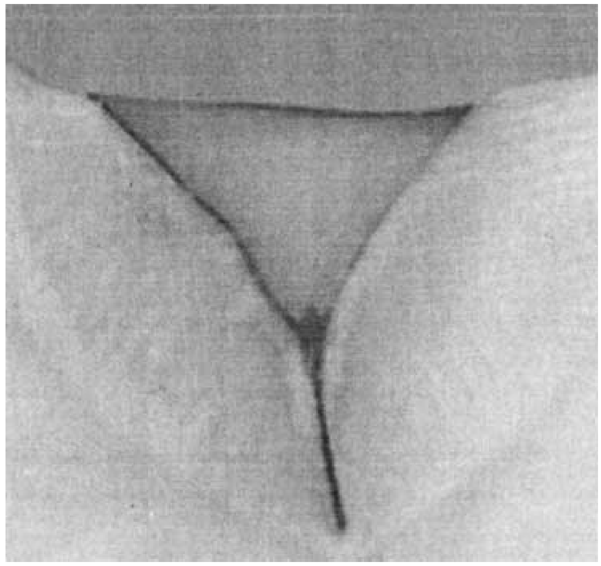

Fig. 2. Complete dye penetration (I-type).

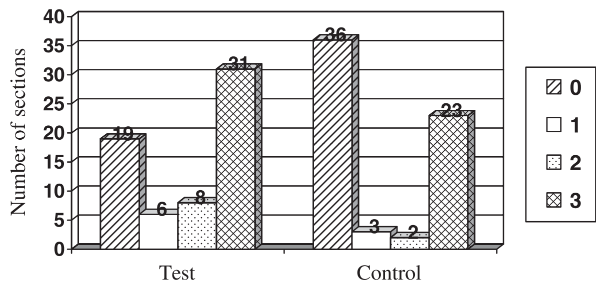

Fig. 3. Comparison of sealant microleakage between the test and control groups.

Results

Of the 64 sections examined in each group, no dye penetration was seen in 19 (29·6%) of the specimens in the test group and 36 (56·2%) of those in the control group (Fig. 1). The dye had penetrated to the base of the fissure in 31 (48·4%) test and 23 (35·9%) control sections (Fig. 2). The results showed a significantly higher level of microleakage in the test group (without prophylaxis) than in the control group, using a chi-square test for trend ($P < 0{\cdot}016$) (Table 1 & Fig. 3). This test was chosen because of the ordinal nature of the variable (microleakage) and assumes equal variances in the two groups.

As in two previous studies, fissures were classified by their configuration as V-, U-, I-, IK- and inverted Y-types [38,39]. The IK- and inverted Y-types were not seen in any of the sections. The differences in the frequencies of types of fissure configuration between the two groups were not statistically significant according to the χ^2 test ($P < 0{\cdot}6$) (Table 2).

Discussion

The caries-preventive effect of pit and fissure sealant has been well documented [1–3]. Meticulous

Table 1. Microleakage in the test and control groups in central and lateral sections.

Microleakage score	Test group				Control group				Total	
	Central section		Lateral section		Central section		Lateral section			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
0	9	28·1	10	31·2	18	56·2	18	56·2	55	42·9
1	4	12·5	2	6·2	2	6·2	1	3·1	9	7
2	5	15·6	3	9·3	1	3·1	1	3·1	10	7·8
3	14	43·7	17	53·1	11	34·3	12	35·5	54	42·1
Total	32	100	32	100	32	100	32	100	128	100

Table 2. Fissure configuration in the test and control groups in central and lateral sections.

Fissure configuration	Test group				Control group				Total	
	Central section		Lateral section		Central section		Lateral section			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
V-type	13	40·6	14	43·7	12	37·5	20	62·5	59	46
I-type	19	59·3	5	15·6	20	62·5	2	6·2	46	35·9
U-type	0	0	13	40·6	0	0	10	31·2	23	17·9
Total	32	100	32	100	32	100	32	100	128	100

application procedures have resulted in high retention rates and high *in vitro* bond strengths [21]. Some investigators have suggested that, even in the case of contamination by saliva, bonding agents may provide adequate bond strength and retention for resin sealant, and therefore, improve the success of applications [40–43]. While these results might imply that there may be little scope for improving adhesion still further, economic considerations now suggest the need to reduce the real cost of fissure sealants [21]. First, this might be done by minimizing the time for sealant application without adversely affecting retention. Many studies have been carried out to achieve this goal; for example, some have evaluated the effect of reducing etching time on sealant quality [21,44–46].

When Cueto and Buonocore introduced fissure sealant in 1967, the use of polishing brushes associated with fine pumice before treatment was incorporated into the application procedure [47]. However, questions have been raised in many recent investigations about the need for prophylaxis prior to the fissure-sealing process [18,26,27,48,49].

Those researchers who support the use of prophylaxis believe that this step is essential for a sealant to be considered effective since it must be remain in place to prevent leakage [1–3]. To achieve this goal, the occlusal surface of the tooth should be free of plaque, pellicle, debris and moisture [18,19,21,27,50]. It is also believed that there are no established clinically efficient chemical methods to clean occlusal fissures adequately, and debris and micro-organisms remain under the sealed pits and fissures' hindering sealant retention [18]. Other investigators have also suggested that a rotating bristle brush with pumice paste is unlikely to clean pellicle from fissure embrasures because the bristles sweep across the inaccessible regions and polish only the more exposed superficial areas [26]. In addition, traces of pumice particles may be found in the depth of the fissures; these may interfere with acid etching and be incorporated into the sealant resin [21,26,49].

It has been pointed out that the acquired pellicle is a tenacious layer of salivary glycoproteins linked physicochemically to the hydroxyapatite of enamel surface and that it cannot be easily removed, even by the action of pumice prophylaxis [26].

The results of the present study do suggest that the microleakage of sealants was significantly higher in the samples in the test group (without prophylaxis) compared to the controls ($P < 0{\cdot}016$).

A microscopic study of fissure-sealed specimens has shown that conditioning alone produces a non-uniform effect, with islands of organic integument contaminating the conditioned surface. It was concluded that mechanical cleansing of enamel seems to be the more important step prior to sealant placement [19].

Miura *et al*. (1973) compared bond strengths attained with different enamel preparation procedures and stated that prophylaxis is essential for optimum enamel bonding [51]. However, enamel etching alone was reported to have given bond strengths of approximately one-third of the mean value [51].

Main *et al*. indicated that thorough prophylaxis of the fissures prior to etching may not be necessary [21]. These authors stated that acquired pellicle was completely removed by a standard acid etching treatment under laboratory conditions. Pellicle was deposited on enamel cores by immersing the cores in 20 mL of whole-saliva supernatant at 37 °C, produced by centrifuging freshly produced whole saliva [21]. Bogert and Garcia-Godoy believed that the amount of bacterial plaque formed by this method, *in vitro* would not be similar to *in vivo* conditions, and therefore, the need for prophylaxis cannot be meaningfully tested *in vitro* alone, although different prophylaxis methods could be compared [28].

Donnan and Ball (1988) stated that pumice prophylaxis is an unnecessary procedure for the purpose of removing plaque and pellicle, and could be legitimately omitted [26]. Patients were followed up for 12 months, and no statistically significant differences were found between the two groups who did and who did not receive prophylaxis [26]. However, a 12-month follow-up is not usually considered sufficient for the assessment of sealant retention [52]. In most cases, the period used for judging sealant quality has been between 2 and 6 years [29,42,50,53–56].

Conclusion

It is concluded that pumice prophylaxis prior to enamel etching reduces microleakage. This may be through its effect of removing plaque and debris from the enamel surface, an effect that seems likely to improve sealant retention and reduce microleakage.

Résumé. *Objectifs*. Evaluer l'effet de la prophylaxie par ponçage sur le niveau de micro-fissure autour et entre l'émail et les scellant.
Echantillon et méthodes. Un total de 32 premières prémolaires supérieures saines, récemment extraites, a été choisi et réparti au hasard en deux groupes; un groupe test, sans prophylaxie, et un groupe témoin avec prophylaxie. Le scellant a été appliqué à toutes les dents selon la même technique conventionnelle, sans prophylaxie dans le groupe test. Les dents scellées ont été thermocyclées (120/30 sec, cycles à 5 °C et 55 °C) et immergés dans une solution de fuchsine basique à 2% pendant 72 heures. La pénétration du colorant a été examinée au microscope (agrandissement 60X) dans des sections de chaque dent.
Résultats. Aucune pénétration de colorant n'a été observée dans 19 dents (29,6%) du groupe test et dans 36 dents (56,2%) du groupe témoin. La fréquence des micro-fissures était statistiquement plus élevée dans le groupe test ($p < 0{,}016$, test de Khi2).
Conclusion. La prophylaxie joue un rôle en augmentant la rétention du scellant. Eliminer cette étape peut entraîner une augmentation des micro-fissures.

Zussamenfassung. *Ziele*. Evaluation des Effektes einer Zahnreinigung mittels Bims auf den Grad der Farbstoffpenetration zwischen Schmelz und Versiegelung.
Stichprobe und Methode. Insgesamt 32 frisch extrahierte kariesfreie erste obere Prämolaren, die für die Applikation von Versiegelungen geeignet erschienen, wurden zufällig in zwei Gruppen eingeteilt: Eine Testgruppe ohne Zahnreinigung und eine Kontrollgruppe mit konventioneller Technik. Die versiegelten Zähne wurden einem Thermozyklus unterzogen (120/30 s, 5 °C und 55 °C) und danach für 72 h in 2% basisches Fuchsin eingelegt. Jeder Zahn wurde aufgetrennt und auflichtmikroskopisch bei 60facher Vergrößerung ausgewertet.
Ergebnisse. Keinerlei Farbstoffpenetration wurde bei 19 (29.6%) der Zähne der testgruppe und 36 (56.2%) der Kontrollgruppe gesehen. Die Farbstoffpenetration reichte bis in die Fissur bei 31 (48.4%) der Testgruppe und 23 (35.9%) der Zähne der Kontrollgruppe. Mit einem Chi-Quadrat-Test wurde eine signifikant höhere Farbstoffpenetration der Testgruppe im Vergleich zur Kontrollgruppe ermittelt ($p < 0.016$).
Schlussfolgerung. Zahnreinigung spielt eine Rolle bei der Versiegelerretention. Das Weglassen dieses Arbeitsschrittes könnte die Undichtigkeiten erhöhen.

Resumen. *Objetivos*. Evaluar el efecto de la profilaxis con piedra pómez en el nivel de microfilatrdo alrededor y entre el sellador y el esmalte.
Muestra y métodos. Se escogieron un total de 32 primeros premolares superiores sanos extraídos recientemente adecuados para la aplicación de un sellador, se escogieron y dividieron aleatoriamente en dos grupos; un grupo de prueba, sin profilaxis y un grupo control, con profilaxis. El sellador se aplicó a todos los dientes usando la misma técnica convencional, omitiendo la profilaxis en el grupo de prueba. Los dientes sellados se termociclaron (120/30 seg, ciclos de 5 °C y 55 °C) y luego se sumergieron en solución de Fucsina Básica durante 72 horas. Para la penetración del colorante se seccionó y examinó cada diente con un estéreomicroscopio (magnificación 60X).
Resultados. Se vio ausencia de penetración de colorante en 19 (29,6%) de los dientes en el grupo de prueba y en 36 (56,2%) de los dientes en el grupo control. El colorante había penetrado en la base de la fisura en 31 (48,4%) de los dientes en el grupo de prueba y en 23 (35,9%) de los dientes en el grupo control. Se usó la prueba de Chi-cuadrado para comparar las frecuencias de microfiltrado, siendo significativamente más alta en el grupo de prueba comparado con el grupo control ($p < 0.016$).
Conclusión. La profilaxis tiene un papel en la mejora de la retención del sellador. La eliminación de este paso puede causar un aumento en la microfiltración.

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