Pit and Fissure Sealants as a Caries Preventive Measure

Malka Ashkenazi D.M.D., Haim Sarnat D.M.D. M.Sc.**, Shoshana Cohen L.D.S. R.C.S. (Eng.) M.Sc.**

SCHOOL OF DENTAL MEDICINE, TEL-AVIV UNIVERSITY

Pit and fissure sealant is a composite material that acts as a mechanical barrier by sealing the pits and fissures of the occlusal surfaces in posterior teeth against cariogenic bacteria. The use of this procedure is a recognized measure in preventive dentistry today, along with the use of fluoride products systemically and topically. The main reduction of caries, due to fluoride treatment, was observed in the interproximal surfaces. Its effect on the occlusal surfaces was much less pronounced. Therefore, this surface needs additional protection (1, 2) (Fig. 1). The acid-etch technique is the accepted method used to seal these pits and fissures with the aid of a composite resin. It is based on Buonocore's observation (1967), that acid causes selective demineralization of the enamel surface and the appearance of micropores. These micropores are filled by the composite material that hardens, creating a mechanically bonded film (3) (Fig. 2).

The purpose of this paper is to discuss the principles of the sealing method, the different materials in use, and to consider the advantages it provides and the questions it raises.

PRINCIPLES OF THE SEALING METHOD

Selection of the Tooth

Primary prevention, by sealing, must be performed when teeth first erupt. It is most significant in permanent molars. In high risk populations, primary molars and permanent premolars shouls also be sealed. Sealants should be placed in teeth with deep pits and fissures, with deep and narrow fossae or with small developmental defects. The success of this treatment depends largely on following the technique very carefully.

* Section of Pediatric Dentistry
** Senior Lecturer and Head, Section of Pediatric Dentistry

Procedure

The technique includes several steps: isolation of teeth, cleansing, etching, rinsing, drying, and application of composite material (4).

1. **Isolation**

Isolating the treated tooth, thereby keeping it dry, is extremely important and is a crucial step with regard to success or failure of the method (2). The tooth can be isolated by the use of rubber dam or cotton rolls. No significant difference was noted between the use of rubber dam as compared to cotton rolls (5). Salivary ejection, tongue guard, lip spreader and the buccal absorbent shield, are a few more aids employed in isolating the teeth (4).

2. **Cleansing**

The surface of the tooth should be thoroughly cleaned from plaque and pellicle (2), with a pointed bristle brush or rubber cup. It can be used dry or with a pumice paste that does not contain any additives (6). Cleaning with peroxide on a brush without pumice has been suggested recently in the CRA newsletter (7). When the pits and fissures are mechanically cleaned, a sharp probe should be passed through; the tooth should then be washed and dried thoroughly.

3. **Etching**

After isolation, cleaning and drying, acid is placed in the pits and fissures causing etching of the enamel. It is essential to etch at least 2 mm of the surrounding surfaces of exposed grooves in order to attain a sufficient area of etched enamel for better sealant retention (6). When etching, it is advisable to add fresh acid solution to reduce localized stagnation of the chemical products of the reaction which might limit the etching effect (6). One must refrain from rubbing the enamel surface area. The acid solution is best



Fig. 1. A deep fissure penetrating most of the enamel depth.

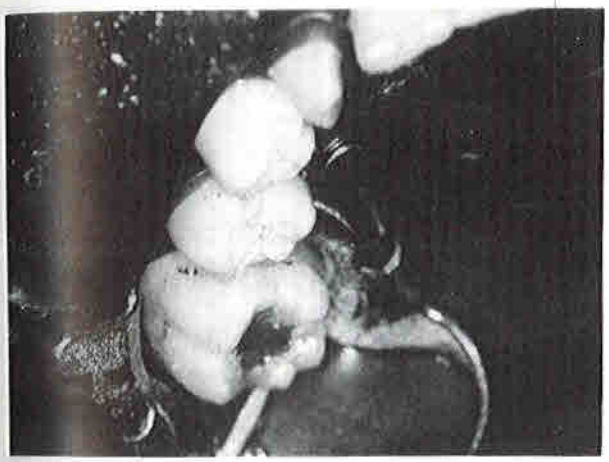


Fig. 2. Etching of occlusal surface with diluted phosphoric acid will leave "frosty" look.

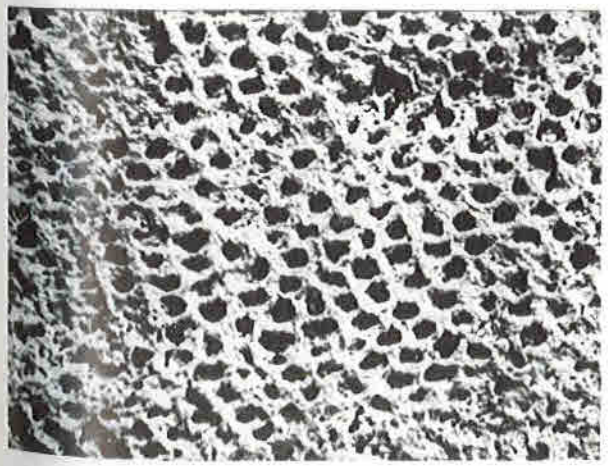


Fig. 3. Preferential decalcification leaving minute pores into which the sealent flows and forms tags.

applied with a fine brush, thus allowing better placement in the pits and fissures, while the use of cotton pledget might include air bubbles (8). The acid dissolves the remaining enamel pellicle and creates micropores in the enamel which permit the retention of the resin material. Microscopically, the surface displays a variety of morphological patterns related to the preferential etching of different structural components of the enamel, reaching a depth of 50u—52u (4, 8, 12).

Phosphoric acid in gel or solution in concentration of 30%—50% is the most accepted etchant. The desirable length of etching time is 60 seconds, in both the primary and permanent dentition (2, 6, 9). However, a recent investigation showed that 20 seconds might be sufficient and even superior to 60 seconds (10).

4. **Rinsing**

After etching it is essential to rinse the tooth thoroughly to remove the acid and the remnants of the chemical reaction. Rinsing is performed by a stream of water for 5 seconds, followed by the use of a strong water spray for an additional 15 seconds. When gel is used, it is necessary to double the rinsing time (4).

5. **Drying the etched enamel**

After rinsing, the tooth should be dryed and re-isolated. This procedure is crucial as moisture left on the surface will hinder the penetration of the resin into the pores. It is imperative to prevent the saliva from coming into contact with the etched surface. Salivary contact causes contamination of the etched enamel by its organic components and reduces the bond strength (4). If this occurs, re-etching must be performed for 20 seconds and the tooth rinsed and dried again (2).

The usual drying time is about 15 seconds per tooth, and 20 seconds for a quadrant area. The surface must remain dry until the sealant material is placed (6). Contamination of air by water or oil should be avoided. Clinical appearance of the etched surface should have a dull white, "frosty" look (Fig. 3).

6. **Sealant application**

Several methods are available for placing the sealant material: a delicate small brush, an applicator with a small plastic head, and a hollowed fine tube.

The time needed for placement of resin is dependent on the type of material. Substances that polymerize by chemical reaction have a limited working time, and must be mixed and placed before the start of the hardening process. Otherwise, it becomes too thick, its flow is reduced, and it does not reach the required depth. In contrast, materials that harden by light curing, provide unlimited working time that allows resin placement during its lowest viscosity. Too little material can cause early loss of the sealant, due to limited retention surface, while an overfilled sealant will only be abraded within a short time (6). Houpt and Shey (11) proposed to check the sealant retention by trying to dislodge it with an explorer. The procedure should be repeated if there is any defect.

7. Sealant Resin Materials

Materials used as sealants are resins based on bisphenol A — glycidyl methacrylate (BIS-GMA), which are divided into two main groups: those which harden by chemical reactions (mixing basic material and catalyst); and those which harden by the use of ultraviolet light or visible light.

The use of visible light as a curing method was first described by Buonocore (12). This method provides unlimited working time and short curing time. The first material using light cure was sensitive to ultraviolet light (12). However, concentrated visible light can also produce efficient curing of composite material and it is preferable (13).

Recently, colored sealants (pink, red, yellow and white) were introduced. By adding color, the presence and extent of the sealant can easily be examined after placement and at recall examinations by both the operator and the patient. The white sealant especially was well accepted by both parents and children (14) (Fig. 4,5).

DISCUSSION

A number of questions that need special consideration arise from the use of this method.

Susceptibility of enamel due to acid etching

The question was raised whether acid etching made the enamel surface more susceptible to caries. Numerous papers cited changes that occur in the enamel after it was treated with acid. Silverstone (15) found that the etched surface of enamel exposed to saliva for 24 hours **in vitro**, did not show any difference in solubility from unetched enamel. Even after removal of the sealant, the enamel was not more susceptible to acid attack than adjacent sound enamel. Recently, these laboratory findings were confirmed **in vivo** by Kastendieck and Silverstone (16). The exposure of etched enamel to saliva for one hour caused rapid remineralization of its surface.

To prevent further caries development in cases where the fissure sealant is lost, several investigators proposed the addition of fluoride to the etching solution (17).

Sealing initial carious lesions

The danger of caries developing under the sealant was the concern of research projects undertaken in recent years. Handelman, Washburn and Wopperer (18) sealed teeth affected by caries in young adolescents and children. During the two years of the study, specimens of carious dentin were cultured. A reduction of 99.9% of bacterial colonies was noted and there was no spread of caries both clinically and radiographically.

Mertz-Fairhurst (19) reported that carious lesions that were sealed became microbiologically sterile and had no meaningful progress. Going et al (20) found that fissure sealants caused a reduction of 89% in bacterial growth and caused the active lesion to become arrested. However, further long-term studies are needed to confirm these findings.

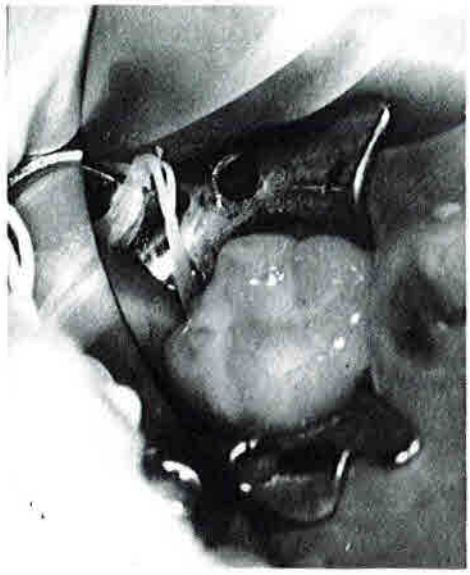


Fig. 4. Cross section of a molar showing sealant filling the fissures and the depth of the fossae.

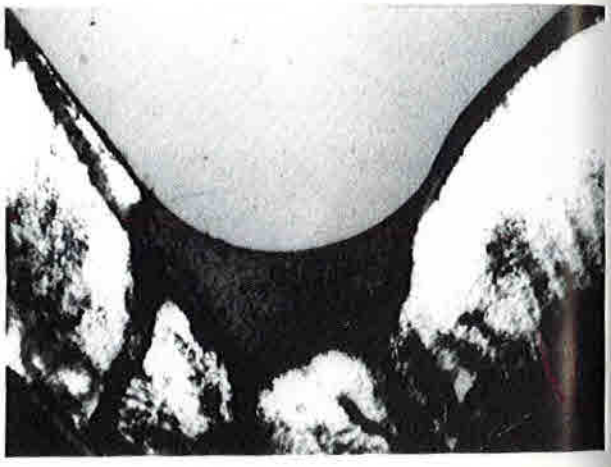


Fig. 5. First molar with sealant in place covering all pits and fissures on occlusal and palatal surfaces.

Efficiency of the Method

The objective of using sealants is to prevent occlusal caries. Therefore, the success of the treatment is measured by the length of time the sealant remains in position (sealant retention) and by the percent of sealed teeth infected by caries as compared to untreated teeth.

In the majority of studies, a significant difference in caries incidence was found after the use of sealants. After 2 years, a reduction of 70% was seen and after 7 years, a reduction of 56% in teeth where chemically polymerized sealants were used. Similar but varied results were obtained after using ultraviolet light cured sealants (Table 1). Some studies reported that after partial loss of the sealant, there was still reduction in caries incidence. It seems that this finding may be due due to the retention of the sealant material in the depth of the fissure and pores (21).

Table 1

Retention of varies fissure sealants and their efficiency in caries reduction

Author	Year	Material	Duration	Full Retention %	Partial Retention %	Efficiency in caries reduction
Horowitz (23)	1977	Nuva seal	5 years	42	56	92%
Brooks, et al. (24,25)	1979	Nuva seal	2 years	59	25	
			3 years	58	21	39%
			7 years	33	21	10%
		Delton	2 years	86	10.3	71%
			3 years	84	9.7	
			7 years	64	16	56%
Houpt & Shey (26)	1979	Delton	1 year	92		
			2 years	85		
			33 months	77		78%
Li, et al. (27)	1981	Delton	2 years	92		
		Nuva seal	2 years	78		
Williams & Winter (21)	1981	Concise	4 years	87.9		63.2%
		Nuva seal	4 years	35.9		
		ASPA	4 years	35.5		
		Nuva seal	4 years	34.4		31.2%
Ball (28)	1981	Concise	2 years	94	6	

Retention of the sealant material

Table 1 summarizes several research reports where the retention of the sealant was tested after 2—7 years. It is possible to reach a retention of 33%—64% after 7 years, using one application of sealant material, and to reach 58%—84% retention after 3 years. The efficiency of this method rises when at recall visits, pits and fissures whose sealant has been partially or completely lost, are resealed, thereby extending the protection.

Indication for use of sealants in Israel

The high incidence of interproximal carious lesions reduces the cost effectiveness of sealants (2, 22). The most efficient and successful use of sealants is in conjunction with fluorides taken topically and systemically. In this way, both interproximal and occlusal surface are protected. In Israel, with its high prevalence of the disease in the population and the low concentration of fluoride in the drinking water, a comprehensive preventive program is necessary.

The program should include all the elements contributing to the development of the disease:

Use of systemic fluoride via water fluoridation or, when not possible, by the use of drops or tablets.

Use of topical fluoride products such as rinses, gels, varnishes and toothpastes on a continuous regular basis.

Application of pit and fissure sealants to the occlusal surfaces of newly erupted, susceptible teeth.

Oral hygiene instruction and motivation to presevere with brushing aids such as dental floss.

Diet counseling towards reduction of carbohydrate consumption with emphasis on reduced frequency of eating.

In summary, fissure sealants are a treatment method which dramatically reduces the incidence of occlusal caries. Proper selection of patients and correct manipulation of the sealant material are the corner stones to its success as part of a comprehensive preventive program.

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