# EAPD guidelines for the use of pit and fissure sealants

R. WELBURY*, M. RAADAL**, N.A. LYGIDAKIS

***Definition***
*"A fissure sealant is a material that is placed in the pits and fissures of teeth in order to prevent or arrest the development of dental caries".*

## Introduction

Tooth surfaces with pits and fissures are particularly vulnerable to caries development [Manton and Messer, 1995]. Ripa [1973] observed that although the occlusal surfaces represented only 12.5% of the total surfaces of the permanent dentition, they accounted for almost 50% of the caries in school children. This can be explained by the morphological complexity of these surfaces, which favours plaque accumulation to the extent that the enamel does not receive the same level of caries protection from fluoride (F) as does smooth surface enamel [Ripa, 1973; Bohannan, 1983; Ripa, 1990]. The plaque accumulation and caries susceptibility are greatest during the eruption of the molars [Carvalho et al., 1989], and caries susceptible individuals are therefore vulnerable to early initiation and fast progression of caries in these sites. Brown et al. [1996] and Kaste et al. [1996] showed that in fluoridated communities over 90% of dental caries is exclusively pit and fissure caries.

## Types of pit and fissure sealants

*Resins.* Resin based fissure sealants (FS) are bonded to the underlying enamel by the use of the acid etch technique. Their caries preventive property is based on the establishment of a tight seal, which prevents leakage of nutrients to the microflora in the deeper parts of the fissure. The resin sealants may be either pure resin, composites or compomers, and their polymerisation may be initiated chemically or by light.

Several studies reported the effectiveness of second generation chemical initiated FSs. Wendt and Koch [1988] reported, under optimal dental office conditions, 80% complete retention after 8 years and combined partial and 94% complete retention after 10 years. Romcke et al. [1990], in a Canadian study after 10 years reported 41% complete retention and 8% partial retention. Eighty-five per cent of the sealed teeth were caries free after 8-10 years. Simonsen [1987] reported 57% complete retention 10 years after a single FS application and 28% after 15 years [Simonsen, 1991]. After 15 years 74% of surfaces that had been sealed were caries free. Chestnutt et al. [1994] reported on more than 7,000 FSs after 4 years where 57% of the sealed tooth surfaces remained fully sealed, with 18% scored as deficient or failed and 24% completely missing. Of the surfaces originally scored as deficient at baseline 23% were scored as carious compared with 21% of surfaces not sealed. Only 14.4% of the sound/sealed surfaces at baseline became carious. Wendt et al. [2001a] reported 95% complete or partial retention without caries in second permanent molars after 15 years and 87% complete or partial retention without caries in first permanent molars after 20 years. In a different study the same authors [Wendt et al., 2001b] reported that 74% of first permanent molars that had been sealed were caries free after 15 years.

Ripa [1993] reviewed numerous studies that have been carried out comparing the retention rates between third and first and/or second generation FS. The results indicated that the performance levels for chemical initiated FS and visible light photoinitiated FS were similar within an observation period of up to 5 years. However, in three comparison studies of longer

*Department of Paediatric Dentistry, Dental School, University of Glasgow, Scotland, UK; **Department of Paediatric Dentistry, Dental School, University of Bergen, Norway; ***Department of Paediatric Dentistry, Community Dental Center for Children, Athens Health Authority, Greece

E-mail: r.welbury@dental.gla.ac.uk

duration, greater longevity was reported for the chemically cured pit and FS [Rock and Evans, 1983; Rock et al., 1990; Shapira et al., 1990].

The addition of filler particles to FS likewise appears to have little effect on clinical results [Waggoner and Siegal, 1996]. Filled and unfilled FSs penetrate the fissures equally well [Feldens et al., 1994] and have similar retention rates [Barrie et al., 1990; Boksman et al., 1993].

Pit and fissure sealants are available as clear, opaque or tinted. No product has demonstrated a superior retention rate but the tinted and opaque FSs have the advantage of more accurate evaluation by the dentist at recall [Waggoner and Siegal, 1996]. Rock et al. [1989] found significant differences in the accuracy with which three dentists identified a clear and an opaque FSs.

During the mid-1990s safety concerns were expressed regarding leaching of bisphenol-A (BPA) and bisphenol-A dimethacrylate (BPA-DMA) from FS, and a possible oestrogenic effect. However, Soderholm and Mariotti [1999] concluded that the short term risk of oestrogenic effects from treatments using bispenol-A based resins is insignificant and Fung et al. [2000] showed that BPA released orally from a dental FS may not be absorbed at all or may only be present in non-detectable amounts in the systemic circulation.

*Glass ionomer cements (GIC).* One of the main clinical advantages of GIC is their ability to bond chemically to dentine and enamel without the use of the acid-etch technique [Aboush and Jenkins, 1986], which makes them less vulnerable to moisture. This, in conjunction with active F release into the surrounding enamel [Komatsu et al., 1986], has led to the development and evaluation of GIC as an alternative FS system, particularly in cases where moisture control is difficult to achieve. Experiments have established that the F release in distilled water is very high during the first 24 hours (burst effect) and it drops rapidly during the following 48 hours before reaching a relatively constant level during the second week. This pattern of F release is common for all the conventional and resin modified GICs [De Moor et al., 1996; Grobler et al., 1998].

Studies on the use of GIC [Raadal et al., 1996; Boksman et al., 1987; Forss et al., 1994] and resin modified glass ionomers [Smales and Wong, 1999] as FS indicate significantly lower retention rates than resin based ones. However, several studies have found that GICs exert a cariostatic effect even after they had disappeared macroscopically, and that this effect might be based on remnants of the cement in the fissure as well as increased levels of F on the enamel surface [Williams and Winter, 1981; Shimokobe et al., 1986; Ovrebo and Raadal, 1990; Skartveit et al., 1990; Mejàre and Mjör, 1990]. However, F varnish (Duraphat) alone [Bravo et al., 1996] and tooth brushing technique alone [Carvalho et al., 1992] have been shown to be specifically beneficial in reducing occlusal caries.

The use of GIC has been suggested for erupting teeth where isolation is a problem [Gilpin, 1997; Raadal et al., 2001], especially in the high caries risk individuals. In this situation they can be considered more a F vehicle than a traditional FS.

*Compomers.* Compomers are currently being investigated widely in both in vitro and in vivo studies. As the amount of F released in distilled water is considerably less than GIC [Grobler et al., 1998; Shaw et al., 1998; Meyer et al., 1998], and as three year clinical results show comparability with resin FS [Glavina et al., 2001], their properties should be estimated as comparable to the resins.

*Fluoride containing sealants.* The durability of F containing FS would now appear to be comparable to conventional resin FS [Lygidakis and Oulis, 1999; Morphis et al., 2000]. However, further long term clinical trials are necessary to determine that the clinical longevity of FS retention is not adversely affected by the presence of incorporated F. Also the clinical importance of the F ion in F containing FS in terms of caries prevention remains to be shown.

## Sealing of carious fissures

Several studies have shown that resin FS are able to stop further progression of carious lesions in pits and fissures, and even in dentine lesions [Mertz-Fairhurst et al., 1986; Handelman, 1991]. The rationale for this approach is that the placement of a FS isolates the carious lesion from the surface biofilm. This suggests a therapeutic use for FS in addition to a preventive one. However, it seems to be a general convention that normally the use should be limited to fissures where the lesion seems to be confined to the enamel, and that dentine lesions should be restored, preferably by the use of minimal intervention techniques, such as the preventive resin restoration [Waggoner and Siegal, 1996; Workshop on Guidelines for Sealant use: recommendations, 1995].

## Technique for resin sealants

*Time to seal.* There is good evidence that teeth sealed very early after eruption require more frequent re-application of the FS than teeth sealed later [Dennison et al., 1990; Walker et al., 1996]. Therefore, FS

placement may be delayed until the teeth are fully erupted, unless high caries activity is present. Placement of FS even in the absence of regular follow-up is beneficial [Cueto and Buonocore, 1967; Chestnutt et al., 1994].

*Surface cleaning.* The need for surface cleaning and the method of cleaning pits and fissures prior to FS placement may seem to be controversial. One textbook [Raadal et al., 2001] suggests careful removal of plaque and pellicle by the use of pumice or air-polishing instruments in order to obtain optimal acid-etch pattern of the enamel, while another [Harris and Garcia-Godoy, 1999] maintains that the effect of acid etching alone is sufficient for surface cleaning provided obvious soft material has been removed. The literature is extensive on the efficiency of different cleaning procedures on bonding [Waggoner and Siegal, 1996], including the use of rotating burs in order to remove superficial enamel and open the fissure to have the resin penetrate into it. However, although cleaning the fissures with a bur has given superior retention in some studies [Shapira and Eidelman, 1986; Lygidakis et al., 1994], there is evidence in other studies that it provides no additional benefit [Blackwood et al., 2002]. Furthermore, purposeful removal of enamel or enameloplasty just to widen the base of a fissure in a sound tooth is an invasive technique, which disturbs the equilibrium of the fissure system and exposes a child unnecessarily to the use of a handpiece or air abrasion. It is concluded, therefore, that there is a need for removal of most organic substance in order to obtain sufficient bonding, but that the removal of sound tooth tissue by the use of instruments, such as a bur, is unnecessary and undesirable. There is a significant volume of evidence of high FS retention without the use of a bur.

*Isolation.* Adequate isolation is the most critical aspect of FS application [Harris and Garcia-Godoy, 1999]. If the enamel porosity created by the etching procedure is filled by any kind of liquid, the formation of resin tags in the enamel is blocked or reduced, and the resin is poorly retained. Salivary contamination, during and after acid etching, also allows the precipitation of glycoproteins onto the enamel surface, greatly decreasing bond strength to the FS [Silverstone, 1984; Donnan and Ball, 1988]. If this occurs, re-etching is therefore needed. However, in vitro work has shown that when complete isolation is impossible the placement of a bonding agent on the wet enamel surface prior to placement of the FS sealant can produce a bond strength comparable to normally etched and dried enamel and FS [Feigal et al., 1993].

The use of rubber dam is obviously the safest way of securing optimal moisture control, but in young and newly erupted teeth this is usually not practical as it demands the use of local analgesia for placement of the clamp. Additionally, there is sufficient evidence that careful isolation with cotton rolls gives similar retention results [Lygidakis et al., 1994]. The maintenance of a dry field must therefore usually be achieved by the use of cotton rolls and isolation shields, in combination with a thoughtful use of the water spray and evacuation tip. The isolation procedure may frequently be extremely challenging, particularly in the partially erupted teeth or in those children with poor cooperation.

*Etchants and conditioners.* The goal of etching is to produce an uncontaminated, dry, frosted surface [Manton and Messer, 1995]. The most frequently used etchant is orthophosphoric acid, provided that its concentration lies between 30% and 50% by weight. Small variations in the concentration do not appear to affect the quality of the etched surface [Waggoner and Siegal, 1996]. Duggal et al. [1997] showed no significant difference in retention of FS after one year follow-up on second primary and first permanent molars when 15, 30, 45 or 60 seconds etching times were used.

*Washing and drying.* The tooth is usually irrigated vigorously with air and water for about 30 seconds and then dried with uncontaminated compressed air for 15 seconds [Manton and Messer, 1995]. However, Waggoner and Siegal [1996] consider that exact washing and drying times are not as important as ensuring that both washing and drying are thorough enough to remove all etchant from the surface of the tooth to give a chalky, frosted appearance.

## *Cost effectiveness of fissure sealants*

Pits and fissures are generally recognised as highly susceptible to caries and least likely to benefit from systemic or topical F. FS can prevent caries and are therefore considered cost effective [Mertz-Fairhurst, 1984; Simonsen et al., 1989]. In one study 78% of first permanent molars that had had a single application of FS placed in pits and fissures were caries free compared with 31.8% for the unsealed matched pairs [Mertz-Fairhurst, 1982]. However, it is also recognised that the cost effectiveness is dependent upon a number of factors that are related to its use, e.g. the caries prevalence in the population, the different tooth types (premolars, molars) sealed, whether all teeth and fissure sites are routinely sealed or based on specific indications, the retention of the FS, and to what extent other caries preventive methods are used (e.g. F varnish) [Raadal et al., 2001]. The caries rate in premolars is generally lower than in molars, and in

populations with an average prevalence of caries it has been calculated that 25-40 FSs must be placed in premolars to save one surface from becoming carious, while the corresponding rate is 5-10 for molars [Feigal, 1998]. If the retention rate is low, which is frequently the case if many 'difficult-to-seal-teeth' are treated, the need for re-sealing and restorative treatment of carious fissures increases, thus reducing the cost effectiveness.

It has therefore been suggested that FS should not be routinely used in all children and all teeth, but based on an individual risk evaluation [Workshop on Guidelines for Sealant use: recommendations, 1995]. In the future, Professions Complementary to Dentistry (PCD) will play a significant role in improving even further the cost effectiveness of sealants.

## Recommendations for use

The present recommendations are suggested for use in individual care programs, in which the caries risk assessment of the individual should have a strong influence in determining who receives FS. In community based programs the recommendations should be based on additional factors, such as the assessment of the oral health needs, the resources of the community and the availability of other preventive measures.

The decision to apply a FS should be made on clinical grounds based on a thorough clinical examination, supported by radiographs where appropriate, and taking into account risk factors such as medical and social history as well as past caries experience and present caries activity. FS may be used to prevent caries in teeth estimated to be at risk, or to arrest the progression of caries lesions limited to enamel.

*Patient and tooth selection.* This should be based on the following.

- Children and young people with medical, physical or intellectual impairment: the application of FS to all susceptible sites of primary and permanent teeth should be considered, especially when systemic health could be jeopardised by dental disease or the need for dental treatment.
- Children and young people with signs of acute caries activity: all susceptible pit and fissure sites should be considered for FS, including the buccal fissures of permanent molars.
- Children and young people with no signs of caries activity: only deeply fissured (extremely plaque retaining fissures) and thus potentially susceptible surfaces should be considered for sealing [Leake et al., 1997].

It should be mentioned that all children, irrespective of caries activity, should be regularly monitored for any change in risk factors and/or clinical or radiographic evidence of a change in their caries status.

## Clinical considerations

- When there is an indication for placement, then FS should be placed as soon as possible, as the tooth is most caries susceptible during the post eruption period. However, susceptible sites of teeth can be sealed at any age depending on assessment of risk factors.
- The choice between resin/composite and glass ionomer FS should be based on adequacy of moisture control. As the resins are most durable they should generally be preferred, while GIC should be used in cases where moisture control is difficult, e.g. in erupting or newly erupted teeth. GIC sealants in these cases are regarded more as a temporary FS or a F release vehicle, rather than a true FS.
- Where there is a real doubt about the caries status of a susceptible site on clinical examination, e.g. a stained fissure, then a bitewing radiograph should be obtained. If there is unequivocal evidence that the lesion is confined to enamel then the surface can be sealed and monitored clinically and radiographically. When the evidence is equivocal, then removal of the stained areas in the fissures (enamel biopsy) should be performed, using rotating instruments.
- If the lesion extends into dentine after removal of staining, then a sealant restoration ("preventive resin/GIC restoration") may be placed. A more extensive cavity will require a conventional restoration.

## Follow-up and review

- All sealed surfaces should be regularly monitored clinically and radiographically. Bitewing radiographs should be taken at a frequency consistent with the patient's risk status, especially where there has been doubt as to the caries status of the surface prior to sealant placement. The exact intervals between radiographic review will depend not only on risk factors, which may change over time, but also on monitoring of other susceptible sites, for example proximal surfaces [Rushton et al., 1996].
- Defective FS and/or preventive resin or GIC restorations should be investigated and the FS reapplied in order to maintain the marginal integrity, provided the surface is caries free [Walker et al., 1996; Gray and Paterson, 1998; Wendt et al., 2001a].

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