IN BRIEF

- Pit and fissure sealants are an effective preventive technology for children at high risk of dental decay as long as the sealant is retained.
- Autopolymerizing sealants and visible light curing sealants have high retention rates; glass ionomer cements have lower retention rates and their use is not recommended.
- Isolation of the tooth from contamination by saliva is the most important aspect of sealant placement.
- Cost-effectiveness requires that only those sites, surfaces and teeth at greatest risk should be sealed.

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VERIFIABLE CPD PAPER

Prevention. Part 8: The use of pit and fissure sealants in preventing caries in the permanent dentition of children

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This paper reviews evidence concerning the use of pit and fissure sealants in preventing caries in the permanent dentition of children. While the evidence with respect to some sealant types and application techniques is incomplete, systematic reviews have clearly demonstrated that sealants are an effective preventive technology when used in high risk children, and that with proper application techniques long-term retention rates can be achieved. However, careful selection of patients and teeth for sealant placement is required to ensure cost-effectiveness.

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Over the past three decades there has been a substantial improvement in the oral health of children as evidenced by declines in the prevalence and severity of dental decay. Systematic exposure to fluorides, along with better nutrition, rising material standards of living and better access to dental care have reduced the susceptibility of contemporary child populations to infectious diseases affecting the oral cavity. For example, a recent study of Canadian children aged 13–14 years found that 64% were caries free.[1] However, among those with some experience of decay DMFT values ranged from 1 to 11 with a mean close to 3.0. This indicates that in this population a substantial minority remain susceptible to decay and that there is significant variation in the risk of disease among those who remain susceptible. For many of these children, effective caries preventive techniques are available which can reduce substantially their experience of this disease.

These preventive methods can be easily applied in dental practice and there is a substantial body of research evidence with respect to their effectiveness. For example, systematic reviews have been published for fluoride gel, fluoride varnish, chlorhexidine, pit-and-fissure sealants and dental health education.[2] This review summarizes the evidence for pit-and-fissure sealants when used to prevent caries in the permanent dentition of child populations. The rationale for the use of sealants as a major preventive intervention is the high prevalence of pit and fissure caries. Evidence suggests that between 90% of caries in children occurs in pits and fissures.[3]

The review considers the following questions:

- How effective are sealants in preventing dental caries in children?
- Which is the best sealant material to use?
- Does the placement technique have an influence on effectiveness?
- Which tooth and tooth surfaces should be sealed?
- How soon after tooth eruption should sealants be placed?
- Which children should receive sealants?

The strength of the evidence having a bearing on these questions can be classified using the following typology:

Type 1: Systematic review of two or more clinical trials
Type 2: At least one randomized controlled trial
Type 3: Non-randomized intervention studies
Type 4: Observational studies
Type 5: Other designs, traditional literature reviews, expert opinion

SEALANT MATERIALS

Since their inception, a number of types of sealants have been developed and tested for effectiveness. These differ according to the base material used, the method of polymerization and

Table 1 Types of sealants evaluated in effectiveness studies

- Autopolymerizing
- Visible light curing
- Fluoride containing visible light curing
- Autopolymerizing glass ionomer cements
- Resin-modified (light-cured) glass ionomer cements
- Resin-bonded amalgam

whether or not they contain fluoride.[4] The types of sealants that have been assessed are summarized in Table 1.

EFFECTIVENESS OF SEALANTS

The effectiveness of sealants has been documented in numerous clinical studies. A systematic review published in the early 1990s found that the preventive fraction (PF), that is the proportion of occlusal decay prevented, among children receiving a one-time application of autopolymerizing sealant was 71%.[5] This preventive fraction PF is given by $(I_0 - I_1)/ I_0$ where I_1 is the incidence of dental caries in the group treated with fissure sealants and I_0 is the incidence in the control group. Ultra-violet light polymerized sealant had a PF of 46%, but this 'first generation' product is no longer available. Although studies had been undertaken of visible-light cured sealants, none allowed the PF to be calculated so these were excluded from this review.

This original review was updated in 2001 by the inclusion of an additional five studies.[2] While only one of these used the split mouth design, they provide additional evidence of the effectiveness of autopolymerizing sealants and some evidence that visible-light cured resin sealants are also effective. A second review of studies also reported that there is good evidence that sealants are effective in high caries risk children as long as the sealant is retained.[3]

Since sealants are accepted as an effective preventive method, it is no longer ethically acceptable to compare the decay experience of teeth that are sealed with teeth that are not. Consequently, new sealant materials cannot be assessed in this way. Rather, since occlusal caries does not develop as long as the sealant remains adhered to the tooth, the length of time sealants are retained is now used as a surrogate measure of their effectiveness in preventing decay. Studies can be conducted on the relative caries preventive effect of two or more types of sealant since all teeth involved in the study are sealed. However, sealant longevity tends to be the most common outcome in this type of study.

Although rates of dental caries in children have declined, a substantial minority remain susceptible to the disease and there is significant variation in risk among those who remain susceptible. The majority of caries in children occurs in pits and fissures

WHICH IS THE BEST SEALANT MATERIAL TO USE?

Studies of the retention rates of different types of sealant are complicated by the fact that studies used different follow-up times. While autopolymerizing sealants have been observed for as long as 15 years, newer materials have only been subject to short-term follow-up. Since the highest rate of sealant loss occurs during the first year after application,[6] the calculation of annualized loss rates can mean that sealants observed for short periods of time can appear to be less effective. Nevertheless, currently available evidence indicates the following:[7]

- Autopolymerizing sealants have high long-term retention rates, with 60% of surfaces remaining covered after 5 to 7 years.
- Visible light curing sealants have retention rates similar to autopolymerizing sealants.
- Fluoride-containing visible light cured sealants have only been evaluated in short-term studies but have retention rates similar to autopolymerizing and conventional light cured sealants for the equivalent follow-up periods. Whether or not the incorporation of fluoride leads to further reductions in caries incidence or enhances the inhibition of incipient or inadvertently sealed hidden caries has not been determined.
- Retention rates for glass ionomer cements, both conventional and resin-reinforced, are significantly lower than that of resin based sealants and their use is not recommended.
- Since the probability of sealant failure is highest soon after placement for all types of sealant, they should be evaluated clinically for partial or total loss within 1 year of placement.

DOES THE PLACEMENT TECHNIQUE HAVE AN INFLUENCE ON EFFECTIVENESS?

A detailed description of current thinking regarding sealant application techniques is to be found in Waggoner and Siegal.[8] They describe the following steps:

Cleaning the pit and fissure surfaces

Before acid etching and sealant placement the tooth surface must be cleaned of plaque and other debris. Surfaces can be cleaned using a prophy cup or brush with or without pumice, with an explorer and forceful rinsing with water, with a toothbrush and toothpaste or by means of air abrasion. Where different cleaning methods have been compared, no differences in retention rates have been found. Although widening of fissures with rotary instruments has been recommended, current evidence does not conclusively support this practice. One disadvantage is that in most jurisdictions this means that hygienists and dental assistants cannot be given the task of sealant placement.

Isolation of the tooth

Complete isolation of the tooth from contamination by saliva is the most important aspect of sealant placement. Isolation by rubber dam or cotton rolls are equally effective and result in similar retention rates. Since teeth that are not completely erupted are difficult to isolate, sealants should not in most circumstances be placed on teeth until the occlusal surface is completely free of gingival tissue.

Etching the enamel surface

In order for the sealant to adhere the enamel surface needs to be etched, usually with an orthophosphoric acid liquid gel. Liquid and gel are equally effective in terms of surface penetration and sealant retention. Clinical studies indicate that a 15 second etch is adequate for sealant retention and no additional benefit received from longer etching times of 45 or 60 seconds. Studies

comparing acid etching with air abrasion as a method of enamel preparation are inconclusive. While bond strengths are comparable, one study found higher rates of micro-leakage for air-abraded enamel. However, a recent study[9] found no difference in retention rates on enamel surfaces prepared by the two methods.

Rinsing and drying the tooth

Rinsing and drying times are not important as long as they are sufficient to ensure the complete removal of all etching material from the tooth surface.

Applying the sealant

All pits and fissures should be sealed. The placing of a bonding agent on the surface prior to the sealant does not appear to enhance retention rates.

Polymerization

In order to reduce contamination, it is generally recommended that the polymerization of light cured sealants is undertaken immediately after placement. However, one study suggested that allowing the sealant to sit on the tooth surface for 20 seconds prior to polymerization increased sealant penetration.[10] Clinical studies of the effect of this on retention rates have not been conducted.

Evaluation of the sealant

The sealant should be inspected to ensure complete coverage of the occlusal surface and the occlusion checked for interferences. Filled sealants tend to be thicker than unfilled sealants and are more likely to require adjustment after placement.

WHICH TEETH AND TOOTH SURFACES SHOULD BE SEALED?

There have been changes in the distribution and severity of dental caries in the permanent teeth of children. The prevalence has declined, progression of carious lesions has slowed so that cavitation occurs later in the course of the disease and teeth appear to remain at risk beyond the first few years after eruption. According to Rozier[11] dental caries is now a disease that affects selected sites of selected surfaces of selected teeth. Since sealant placement is relatively expensive, this means that only those sites/surfaces/teeth at greatest risk should be sealed.

The teeth and tooth surfaces at greatest risk for caries are the pits and fissures of molars. While it was initially considered that the first molars are at greatest risk of attack, epidemiological studies indicate that first and second molars are at equal risk and have a higher probability of decay than any other tooth type. Consequently, both first and second molars are the main candidates for sealants. Premolars are much less susceptible to decay than molars and are less likely to be candidates for sealants.

There is some evidence, although incomplete, that while the greatest risk for decay in molars appears to be 2 to 4 years after eruption, the pits and fissures of first permanent molars remain susceptible to primary decay into adolescence and beyond.[12] This evidence challenges early guidelines suggesting that teeth remaining caries-free for 4 or more years after eruption do not need to be sealed. Consequently, the length of time since eruption should not be the main factor determining the placement of the sealant. Rather, the patient's overall caries risk should be the main criterion employed.

Other tooth-level factors which should be taken into account in decisions to use sealants are:

Tooth morphology

Pit and fissure morphology has a significant influence on the risk of caries. Teeth with deep pits and fissures that catch an explorer are the best candidates for sealants while teeth with wide and easily cleaned grooves do not require sealing.

Status of the proximal surfaces of the tooth to be sealed

If a proximal restoration involves the pit and fissure surfaces it should not be sealed. If proximal caries is present a non-carious occlusal surface may be a candidate for a sealant if conservative procedures for managing the interproximal decay are feasible.

Caries status of the occlusal surface

Occlusal surfaces whose caries status is uncertain or surfaces where the caries is confined to the enamel can be sealed, since early lesions will not progress but will arrest as long as the sealant remains intact. Such tooth surfaces should be assessed at regular intervals to ensure the complete retention of the sealant. Where caries has progressed to dentine the tooth should be restored. Preventive restorations involving sealant materials or composites may be indicated.[13]

Eruption status

Since adequate isolation is needed for sealant retention to be ensured, it is generally recommended that sealants not be placed until the tooth is sufficiently erupted for the risk of contamination by saliva during sealant placement to be eliminated.

Overall caries activity

If the individual's caries history indicates that they are susceptible to pit and fissure caries, any caries-free pit and fissures of the teeth at greatest risk should be sealed. Susceptibility is usually indicated by the occurrence of one or more caries lesions per year.

WHICH CHILDREN SHOULD RECEIVE SEALANTS?

Since an increasing proportion of children are caries free significant effort has been devoted to

The caries preventive potential of sealants has been demonstrated in numerous studies. Sealant retention rates are now used as surrogate measure of their effectiveness in preventing decay

Retention rates for glass ionomer cements are substantially lower than that for resin based sealants and their use is not recommended. First and second permanent molars are at equal risk of decay and more likely to decay than any other tooth type. These are the main candidates for sealant application

Cost-effectiveness requires that only those children at high risk for caries should be considered for sealant application

developing methods for identifying those individuals at highest risk of caries. Cost-effectiveness requires that only those children at high risk should be considered for sealant applications. Numerous factors have been included in caries risk prediction models. However, none are totally accurate and given the variations in caries levels, and variations in risk factors between age cohorts, socio-economic and cultural groups and the fact that risk profiles are constantly changing, it is unlikely that a universally applicable model will be developed.[14] However, the majority of models include, as significant risk predictors:

- Caries history in the primary and permanent dentition, and
- Current level of caries activity

Consequently, these should be the main factors considered when assessing whether or not a child is likely to benefit sufficiently from sealants for their use to be considered cost-effective.

SUMMARY

Although the evidence having a bearing on all aspects of sealant use is incomplete and the strength of the evidence underlying some recommendations somewhat uncertain, a recent US Workshop on Guidelines for Sealant Use[15] and a Canadian evidence based care report[7] summarized some important scientific facts and principles:

- Sealants have been shown to be safe and effective in preventing dental decay in susceptible teeth and individuals (Type 1);
- In addition to preventing caries, sealants can arrest incipient decay (Type 2);
- Cost-effective use indicates that sealants should be placed on the pits and fissures of teeth at greatest risk (predominantly first and second permanent molars) in individuals susceptible to decay (Type 4);
- Children with previous or current caries experience should be considered for sealants (Type 3); others should not.
- Pit and fissure caries begins in childhood and can continue into adolescence and adulthood (Type 4).
- Sealants should be placed as early as possible after the occlusal surface is free of gingival tissue and up to 4 years after eruption (Type 3). Placement may be indicated beyond 4 years post-eruption depending upon the caries susceptibility of the individual (Type 4).
- Resin sealants should be used: autopolymerizing (Type 1) and light-cured (Type 2/3) have satisfactory retention rates. Glass ionomer cements should not be used (Type 2/3).
- Sealant use is technique sensitive; particularly with respect to moisture control (Type 3).
- Sealants should be evaluated clinically, especially when placed over incipient decay (Type 2).

The main principle underlying the use of sealants is that prevention is better than treatment. Sound, non-diseased teeth even though sealed are more valuable than properly restored teeth. Nevertheless, the indiscriminate use of sealants is not recommended. Maximizing the cost-effectiveness of this preventive technology is an important consideration.

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