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Review Article

Pit and fissure sealants — A review

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ABSTRACT

Caries on the occlusal surface of dentition is a significant dental health problem. Among all of the teeth particularly molars and premolars have greater susceptibility to caries. Their susceptibility to caries is probably related to its occlusal morphology. Use of fissure sealant and fluoride have been shown to play an important role in reducing caries. This can be possible through converting the caries susceptible areas like pits and fissures into glazed surface which prevent bacterial colonization and makes the tooth easy to clean. Pit and fissure areas of enamel do not receive sufficient protection from topical or systemic fluorides, the reason for ineffectiveness of fluorides in the pit and fissure caries may be due to inaccessibility to these areas and due to the differences in enamel thickness. The most efficient way to prevent pit and fissure caries is by effectively sealing the fissures using resins called pit and fissure sealants.

1. Introduction

Tooth decay is one of the most common diseases in human history. It is one of the most chronic illnesses of childhood. In children, caries develops as soon as the teeth erupt and continue to grow at a remarkable rate during the formative years. Food retention occurs mainly in pits and fissures and these areas are difficult to clean with regular brushing. These inaccessible areas provide a favorable environment for oral bacteria to survive and digest carbohydrates into acids, leading to demineralization of the enamel.[1] The most effective way to prevent pit and fissure caries is to effectively seal these areas using pit and fissure sealants.

1.1. History of sealants

In the past decades, many attempts were made to prevent development of caries, especially occlusal caries as it was initially accepted that pit and fissures get infected with bacteria within 10 years of eruption.

Table 1: History of pit and fissure sealants

Years	Authors	Contributions
1895	Wilson	Placement of zinc phosphate cement in pits and fissures
1923	Hyatt	Prophylactic odontomy
1942	Kline and Knutson	Treatment with ammoniacal silver nitrate
1955	Buonocore	Sealing of pits and fissure with bonded resin material
1971		Pit and fissure sealant recognized by ADA
1978	Simonson	Preventive resin restoration
1986	Garcia-Godoy	Preventive glass ionomer restoration

ADA: American dental association

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1.2. Classification of pit and fissure sealants

1.2.1. Based on filler content

Depending on the presence / absence of fillers, sealants are classified into filled and unfilled resin systems. Most of the self-cured resins are unfilled. The filler is coated with products such as silane, to facilitate their interaction with bisphenol A and glycidyl methacrylate (BIS-GMA) resin. The filler material makes the resin more resistant to scratches and wear. In contrast, unfilled sealants wear quickly, but usually do not require occlusal adjustment. Unfilled resins will go deeper into the fissures, so they are probably better retained. Filled resins are available as opaque, tooth-colored or white-shades. Unfilled resins are color less or tinted transparent materials.[2]

1.2.2. Based on the color of the sealants

In March 1977, the first colored sealant (3M ™ ESPE ™ Concise ™ White Sealant) was introduced to the US market. In addition, parents are reassured when they see sealants on their child's teeth. As the sealant is clearly visible to the child, it is beneficial to encourage the child to periodically check for any sealant loss. This constant reminder of the existence of a preventive agent will help in the encouraging aspects of the prevention program. In 2001, dental manufacturers introduced color-changing sealants during polymerization. Helioseal Clear Chroma Ivoclar Vivadent AG changes from clear to green after photo — polymerization. 3M ™ ESPE ™ Clinpro ™ Sealant is pink in color when used and turns into a white opaque after light curing.[3]

1.3. Resin based sealant materials

Resin based sealants are classified into four generations based on method of polymerization.

1.4. First generation sealants

The first sealant that used the acid etch process was introduced in the mid-1960s and it was cyanoacrylate (CA).[3] Artificial CAs are activated by an ultraviolet light source with a length of 365 nm. Nuva Seal® became the first commercially successful brand in 1972. CAs were not suitable as sealants due to the bacterial degradation of sealant in the oral cavity over time. The conquests of these CAs were replaced by second-generation sealant materials, which were found to be resistant to degradation and produced a strong bond with etched enamel.[4]

1.5. Second generation sealants

Second-generation sealants are dimethacrylates, representing the BIS-GMA reaction product, which is considered its founder as a hybrid between methacrylate and epoxy resin. Second-generation sealants include auto polymerizing sealants that set with a chemical catalyst-accelerator system.[4] They are generally "self cured" or "chemical cured" without the need for an external ultraviolet source. Many commercial products available today are BIS-GMA-based products or urethane dimethacrylates products. Auto polymerizing resins generally performed better than the early ultraviolet light-initiated resin sealants.[5]

1.6. Third generation sealants

Third-generation sealants are synthetic compounds that contain a dike tone initiator such as Camphoroquinone and a reducing agent such as a tertiary amine to initiate polymerization. The use of visible light source requires eye protection due to the magnitude of the generated light. Visual light activated sealants falls within the current period of clinical trials in which retention, rather than caries inhibition, denotes the principle criterion of success. Retention of the sealant is the main determinant of the preventive effects of sealant against caries.[3,4]

1.7. Fourth generation sealants

Fluoride pivot dental prevention continues to be the cornerstone of caries prevention programs.[6] In order to increase the duration of fluoride exposure to enamel for improved prevention of dental caries, fluoride-releasing materials have been developed. The literature reported a decrease in the dissolution of enamel and a decrease in secondary caries following fluoride treatment based on the fact that increased fluoride uptake by adjacent enamel prevents demineralization and promotes mineralization. It was recognized that the addition of fluoride to a sealant, or perhaps on its surface before applying the sealant, may have the potential benefit of additional protection against caries.[5]

1.8. Glass ionomer sealant material

Conventional glass ionomer (GI) material have also been used as pit and fissure sealants. It binds chemically to enamel and dentin through an acid-base reaction between an aqueous-based polyacrylic acid solution and fluoroaluminosilicate glass powder.[7,8] GI sealants can be divided into low viscosity and high viscosity types. It is important to note that most studies in GI sealants have used older generation, low-viscosity GI, similar to the Fuji III GI sealant with poor physical properties. It has now been replaced by a larger generation, such as Fuji Triage (VII) (GC, Tokyo,0 Japan), which has better physical properties and is designed to produce a higher amount of fluoride.[9]

High viscosity glass ionomer (HVGIC) cement, such as Ketac Molar Easymix (3M ESPE, Seefeld, Germany) and Fuji IX (GC, Tokyo, Japan), has been used in studies following atraumatic restorative treatment (ART). The concept of ART consists of two elements, namely, ART sealant and ART restoration. ART sealant is a preventive agent that incorporates the use of HVGIC into vulnerable pits and fissures using the finger compression process.[10]

When a resin is added with a glass ionomer, it is called a resin-modified glass ionomer (RMGI). It is also used as pit and fissure sealant. The setting reaction of this type of sealant is initiated by the photo activation of the resin part, followed by the acid-based reaction of the ionomer part. Its resin content has improved its physical properties, compared to normal GI. In fact, compared to normal GI, RMGI has less water sensitivity and longevity.[6]

1.9. Polyacid-modified resin based sealants

Polyacid-modified, resin-based composite material, also called compomer, has been used as a fissure sealant. It incorporates the beneficial properties of the visible light polymerized resin and fluoride releasing GI sealant material. This polyacid-modified resin sealant has a better adhesion to enamel and dentin and is also less soluble in water, compared to GI sealant materials,[11] and less sensitive to techniques, compared to resin-based sealants.

Indications and contraindications[12,13] for the use for fissure sealants explained in Table 2.

1.10. Age period for sealant placement

The susceptibility of the tooth to caries should be considered when selecting teeth for sealants and not the age of the individual.

1. Ages 3 and 4 years are the most important times for sealing the eligible deciduous teeth.
2. Ages 6-7 years for the first permanent molars
3. Ages 11-13 years for the second permanent molars and premolars[14]

1.11. Application of pit and fissure sealant

1.11.1. Cleaning the pit and fissure surfaces

Plaque and debris can interfere with the process of applying or entering of the sealant. Historically, it has been recommended to clean the area with a bristle brush and pumice. The use of prophy pastes, especially those containing fluoride, has been discouraged because it was thought that fluoride would make the surface of the enamel less reactive to etchant and thus reduce bond strength. Air abrasion is recommended for preparing the occlusal surface before applying the sealant.

1.11.2. Isolation of the tooth

Adequate isolation of the concerned tooth is the most critical aspect of the sealant application process. Salivary contamination of the tooth surface during or after acid etching process will adversely affect the final bond between enamel and resin. The rubber dam, when properly used, provides the best, most controllable isolation, and for the sole operator, ensures isolation from start to finish. Isolation using cotton rolls may offer some advantages over rubber dam isolation.

1.11.3. Etching

The introduction of the acid etch method has made the occlusal sealing of the areas more effective. A critical step in the process of applying a sealant is acid conditioning or acid etching process. Etching improves the acceptance of the tooth in binding to the sealant. With this critical step, careful maintenance of the dry operating area is essential for effective binding.[15]

The conventional 60 s etching was first used by Ripa and Cole. Increased etching time for deciduous teeth is attributed to various reasons like:

1. Deciduous teeth have less mineral and more organic material in the enamel
2. Deciduous teeth have a larger internal pore volume and thus more exogenous organic material
3. Deciduous teeth have more prism less enamel on their surface than do permanent teeth
4. The prism rods in deciduous teeth approach the surface at a greater angle and thus are more difficult to etch.

1.11.4. Thoroughly rinse and dry the tooth

Many sealant manufacturers recommend rinsing the tooth with 20-30 s to remove etchant. The exact rinsing time is probably not as important as making sure the rinse is long enough and perfect enough to remove all etchant from the tooth surface. Drying the tooth with compressed air pressure is likewise done not for a specific time but rather for a specific result. A completely dry tooth will show a chalky, frosted appearance.

1.11.5. Application of sealant

During sealant application, all the susceptible pits and fissures should be sealed for maximum caries protection. This includes buccal pits of mandibular molars and lingual grooves of maxillary molars. The sealant material can be applied to the tooth in a variety of methods. Many sealant kits have their own dispensers, some preloaded that directly apply the sealant to the tooth surface. Some common problems occur during sealant application. Small bubbles may form in the sealant material. If these are present, they should be teased out with a brush before polymerization.

1.12. Evaluation

The sealant should be visually and tactually inspected for complete coverage and absence of voids or bubbles. Attempts should be made to dislodge the sealant with an explorer. If the sealant is dislodged, the tooth should be carefully inspected to see that no debris has been left in

Table 2: Indications and contraindications

Criteria	Indications	Contraindications
Tooth age	Recently erupted	Teeth remains caries free for 4 or >4 years
Tooth type	Molar	Premolar except when caries risk is high
Occlusal morphology	Deep narrow retentive pit and fissures	Narrow wide self-cleansing pit and fissures
Status of proximal surface	Sound	Carious
General caries activity	Many occlusal lesions few proximal lesions	Many proximal lesions
Other preventive measures	Patient receiving approach systemic and topical F therapy and are still caries active	

the fissure, which may have interfered with the bond. Small voids in the sealant can be repaired simply by adding new material to the void and polymerizing. Some sealants will be completely or partially lost and will require reapplication. During routine recall examinations, it is necessary to re-evaluate the sealed tooth surface both visually and tactually for loss of material, exposure of voids in the material and caries development.

2. Conclusion

Along with proper diet, fluoride, and biofilm control, sealing pits and fissures should be considered as part of overall preventive program against caries rather than a separate procedure. Ideally, high-risk patients should apply sealants to all of their posterior teeth after eruption. Self-cleansing pits and fissures and proximal caries are contraindicated for sealant application. The dentist should be familiar with the different types of sealants and specific application methods for each product. With proper placement and maintenance, sealants can last for years.

3. Source of Funding

None.

4. Conflict of Interest

None.

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