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Fissure Sealant for prevention of fissure caries

A project submitted to the college of dentistry at the University of Baghdad, department of Pediatric and preventive dentistry in partial fulfillment of the requirements of B.D.S degree.

By

Duaa Mazin Abbas

Supervised By

lecturer:

Juman D. Alkhayoun

B.D.S, M.Sc.

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Certification of supervisor

I certify that this project entitled —Prevention of dental caries — was prepared by (Duaa Mazin Abbasa) under my supervision at the College of Dentistry / University of Baghdad in partial fulfilment of the graduation requirements for B.D.S degree.

Signature

lec. Juman D.Alkhayoun

College of Dentistry, University of Baghdad

Supervisor

DEDICATION

To **Allah**, my infinite love .

To the kindest hearts in my life my **mother** and my **father** … for their love and endless giving , they give me all the support and care in my life .

To the closet person to me , my lovely **sister** for her unlimited support.

To the love of my life ..my **husband** , who encouraged me and carried his faithful loving with his eyes to get this degree, I am really lucky to have you in my life.

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Abbreviation	The words
ART	Alternative restorative technique
BIS-GMA	bisphenol A-glycidyl methacrylate
HEMA	Hydroxyethyl methacrylate
ITM	Interim therapeutic restoration
MS	mutans streptococci
RMGI	resin-modified glass-ionomer
TEGDMA	Triethylene glycol dimethacrylate

Introduction

Permanent posterior teeth are especially susceptible to the risk of developing caries within the first 3 years following the eruption **(Mejare,2011; Carvalho, 2014)**.

Pits and fissures are highly susceptible to caries as they have for plaque accumulation and are almost impossible to clean when they have a narrow and deep morphology **(Zenkner et al., 2013; Alves et al., 2014; Ahovuo-Saloranta et al., 2017)**. Therefore, the overall incidence of occlusal caries lesions in permanent posterior teeth still has not decreased to the same extent as the rate of caries on smooth surfaces in children and adolescents **(Ahovuo-Saloranta et al., 2017; Koch, Helkimo and Ullbro, 2017).**

Fluorides are highly effective in reducing the number of carious lesions that occur on the smooth surfaces of enamel and cementum. Unfortunately, fluorides are not equally effective in protecting the occlusal pits and fissures, where the majority of carious lesions occur. Systematic reviews and meta-analyses have concluded that pit and fissure sealants are the optimal treatment options to prevent pit and fissure caries which would provide a physical barrier between the surface of the tooth and the oral environment **(Schwendicke et al., 2015; Wright et al., 2016; Ahovuo-Saloranta et al., 2017).** The placement of a sealant on the occlusal surfaces of primary and permanent molar teeth will reduce caries by 75% after 2–3 years compared with no sealant **(Deery, 2017).**

A definition of pit and fissure sealant was proposed by Simonsen in 1978. He defined it as “a material that is introduced into the occlusal pits and fissures of caries susceptible teeth, thus forming a micro-mechanically bonded, protective layer cutting access of caries-producing bacteria from their source of nutrients.” This definition leaves out glass-ionomer and resin-modified glass-ionomer sealants because these are chemically bonded to enamel; therefore, it is important to modify

the above definition to read "…, thus forming a micro-mechanically or chemically bonded, …". Pit and fissure sealant has been used both as primary and secondary preventive measures against occlusal caries **(Chandra et al., 2010)**.

After nearly 4 decades of clinical use, the pit and fissure sealant is now recognized as one of the most effective methods for preventing occlusal caries in children. Their cost effectiveness has been demonstrated in school-based preventive programs especially among high-risk groups, such as children with disabilities or from low social economic backgrounds **(Ngo, 2010) .**

Although there are numerous options for sealant materials, resin-based sealants are the main preferred type **(Botton et al., 2016; Kuhnisch et al., 2020).** The preventive effect of resin pit and fissure sealant depends on their retention ability in the absence of micro leakage, resulting in better clinical success **(Ahovuo-Saloranta et al., 2017; Kuhnisch et al., 2020).**

Aim of the study :

The aim of this project is to summarize the findings of reviews regarding the types of pit and fissure sealants, indications and contraindications for their use.

Review of Literature :

1-Dental Caries:

Dental caries (tooth decay) is a bacterial infectious disease that can be characterized by a progressive demineralization process that affects the mineralized dental tissues. It is considered to be the most prevalent oral disease worldwide and it is the main cause of tooth loss among the population **(Selwitz et al., 2007).** The prevalence of dental caries among the general population is linked to their socio-economic and demographic conditions, including some behavioral aspects **(Veiga et al., 2015).** Hence, the prevalence of dental caries in the most developed countries show an obvious tendency to decline in the last three decades of the twentieth century and early twenty-first century **(Costa et al., 2012).**

Throughout the 20th century, the most etiological factor of dental caries that captured the most attention was the mutans streptococci (MS) group. Researchers succeeded to isolate Streptococcus mutans from human carious lesions. Even though the S. mutans is one of the most researched cariogenic microorganisms, it is only one of more than 500 species that are found in dental plaque **(Paster et al., 2001).** Some previous studies had shown the role of yeast (Candida albicans) and some novel species of bacterial communities are strongly associated with dental caries **(Becker et al., 2002; Klinke et al., 2009).**

Dental caries cannot occur in the absence of dietary fermentable carbohydrates (like sugars and starch-containing food), it is initiated due to the interaction between the acid-producing bacteria and the fermentable

carbohydrate and for that reason it has been characterized as a ―dietobacterial‖ disease **(Bowen and Birkhed, 1986).**

In Iraq, many studies had been conducted to determine the caries experience among the children and adolescents.In **(2000) Al-Azawi** examined 4695 students and found that only 30% is caries free.

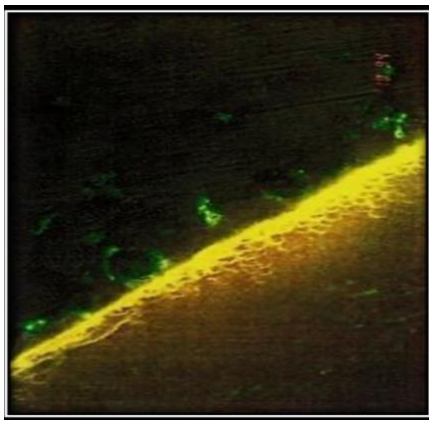
In (2007) Ryadh examined 1050 students and the caries prevalence was 72%, a study performed by **Ahmed in (2007)** found that the prevalence of dental caries in 12- year- old schoolchildren from Baghdad was 62%. Another study done by **Abdulla in (2009)** found that caries prevalence is 78.2%.

2- Importance of enamel structure study :

Many structural features of enamel are acutely relevant to restorative dentistry and the application of fissure sealants. The understanding of the initiation and progression of dental caries has been based on a knowledge of enamel composition and morphology, on which different preventing methods of dental caries depend including fissure sealants. This has led to a much more conservative approach by utilizing the phenomenon of remineralization and reducing the need for the removal of sound tissue. This reduced sacrifice of the sound tooth structure has also been brought about by the development of adhesives that will bond to enamel, a development that is based on an understanding of the prismatic structure of enamel and the controllable effects of acids on it **(Carvalho et al., 2010).**

Different acids at different concentrations can produce a variety of patterns of partial prism dissolution to provide a roughened surface suitable for adherence to fissure sealants and restorative materials (acid conditioning). This reduces or eliminates the need for mechanical retention cut into sound tissue for cavity preparation. For agents mechanically bonding to enamel, it is necessary to produce microporosities on the surface by acid-etch techniques. Thus, when bonding agents

are applied to such a surface, microscopic tags can be seen invaginating into the roughened surface as shown in **(Figure 1) (Berkovitz et al., 2009).**



Figure(1) : Microscope image showing the penetration of a (yellow) dye-labeled bonding agent into acid-etched enamel. Note tags of resin around the prism boundaries are made porous by acid etching (x450) (Berkovitz et al., 2009).

When cavities are prepared for fissure sealants (ameloplasty) or restoration, knowledge of the micro anatomy of enamel, particularly in terms of prism orientation, is essential to conserve as much as possible of the original strength of the tissue. Cutting cavities into enamel with rotary instruments will inevitably lead to subsurface cracking **(Berkovitz et al., 2009).**

3- ORAL BIOFILM :

Dental caries is a chronic, lifestyle associated,dieto-microbial, and site-specific disease that can affect dental hard tissue, through a localized and excessive demineralization of tooth structures . There is a dynamic interaction between the fluid phase of oral bio-films and the mineral contents of enamel, dentin, and cementum. These interactions are mostly governed by the bacterial metabolic activity and the resulting fluctuation in the pH of plaque fluid. The presence of bacteria in the oral cavity is essential because the resident microflora inside the oral biofilm contributes to the well being of the host in general and more specifically to the underlying tooth structure. **(Zero et al., 2009)**

A healthy pellicle layer and biofilm are protective against erosion, can store fluoride and minerals to facilitate remineralization, and delay cavitation **(Marsh 1994; Ngo and Gaffney, 2005)**. The challenge for the clinician is to select treatment strategies, which modulate the pH fluctuation in favor of remineralization without disrupting the beneficial behavior of the resident microflora **(Marsh, 1994)**.

On the crown of a tooth, carious lesions usually start in enamel and because this tissue is acellular, the living reparative events that are generally triggered by an infectious process in soft tissues cannot occur. Furthermore, the stability of enamel is entirely dependent on the chemical balance of its immediate surrounding environment. The breakdown of enamel is gradual and will eventually expose the pulp-dentinal organ to bacterial metabolic products long before any bacteria can be detected at the dentino-enamel junction **(Thylstrup and Qvist, 1987)**.

The concepts, described above, underpin the rationale for sealants in general. They prevent the growth of biofilms in hard to reach areas on a tooth and therefore have the ability to disrupt bacterial physiology and prevent the initiation and progression of lesions **(Oong et al., 2008).**

4- Site specificity of dental caries :

Caries susceptibility is site specific, and these sites can be roughly divided into the following segments:

1. Exposed smooth surfaces: Because demineralization is associated with stagnant accumulation of oral bio-films, these exposed smooth surfaces are considered to be the least susceptible because they are subjected to good mechanical cleansing and salivary flow. It is important to point out that in some situations, the “exposed” status of a surface can change. For example, the distal and mesial surfaces of a first permanent molar can be classified as “exposed” toward the end of the mixed dentition stage, when the second primary molar exfoliates and the second permanent molar is still unerupted. The authors propose that in high-risk children, these surfaces can be protected from future proximal

caries prior to their returning to a “hidden” status upon the eruption of the second permanent molar and premolar. These surfaces should be sealed, with a thin and hard-wearing sealant, while they are still “exposed,” therefore having easy access. This principle should be extended to any smooth surfaces deemed to be at risk**.(Pitts et al.,2017)**

2. Hidden smooth surfaces: Smooth surfaces with well-established contacts are considered to be “hidden” because they are less accessible to mechanical cleansing and chemical protection from saliva and fluoride and are more susceptible to caries. Common examples of “hidden” sites are the interproximal surfaces, however, the same surface can change its risk status over time **(Figure 2)**. For example, a large carious white spot lesion that was formed on the proximal surface of a tooth when it was “hidden” could become “exposed” with the removal of an adjacent tooth. **(Nyvad et al., 1999).**

Another example is the occlusal surface of an erupting tooth can be classified as “hidden” while it is covered by an operculum and inaccessible to a toothbrush. It becomes “exposed” after eruption and benefits from the self-cleansing effect of a functional occlusion. A slowly erupting permanent molar usually has problems of plaque accumulating under the operculum and requires professional preventive care throughout the erupting phase **(Carvalho et al., 1992).**

The prolonged period of eruption results in large areas of plaque stagnation under the operculum so that the area of demineralization would not be limited to the pits and fissures but usually extends to an extensive area of enamel under an operculum, as shown in **(Figure 3)** .

3. Pits and fissures: These are found on the occlusal surface of posterior teeth and on buccal and palatal surfaces of molars. Epidemiological and clinical data consistently show that the pit and fissure systems of molars are the most vulnerable to caries; this is supported anecdotally by clinicians. The risk status of the occlusal surface and external opening of the pits and fissures will be lowered when they become “exposed,” after full eruption to the oral environment and mechanical cleansing. However, the risk status at the base of pits and fissures does not usually

change because their morphological features tend to harbor undisturbed microflora and restrict access to the remineralization properties of healthy saliva (**Farges et al., 2015)** .

Figure -2- A non-cavitated carious lesion was formed on the mesial surface of the maxillary left canine during the time this surface was "hidden." It is likely that, when it became "exposed," the lesion became arrested. (Nyvad et al., 1999).

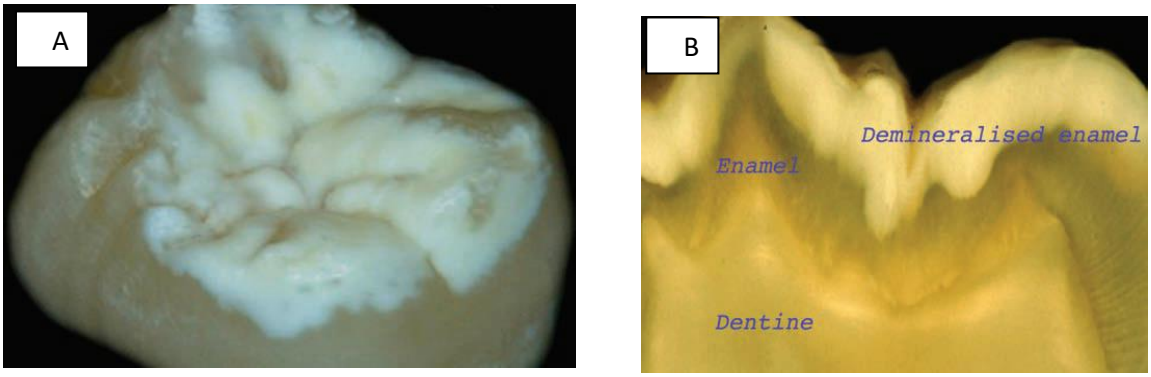


Figure -3- The pattern of demineralization follows the pattern of plaque accumulation under the operculum. On an erupting tooth, it is possible for the entire occlusal surface to be demineralized. (Carvalho et al., 1992).

5- Prevention of Dental Caries:

Because caries is a multifactorial disease, different methods are used to control and prevent dental caries; these are:

A. Maintenance of oral hygiene and plaque control: This method is important in the prevention of caries and treatment of early caries which depend on the basis that to tip the balance in favors of remineralization and away from demineralization. Thus, caries is prevented by procedures that minimize plaque formation, which considered a source of acid producing substrate, render the enamel mineral less soluble and encourage remineralization **(Berkovitz et al., 2009)**.

B. Fluoride use and nutritional measures: fluoride has unique effects on caries initiation and progression. It has a pre-eruptive and post eruptive effect on the composition of tooth that replace hydroxyapatite crystals by fluorapatite crystals which is more resistant to acid solubility. It has also antimicrobial effect that help in reducing plaque formation and inhibit dental caries **(Krishna and Dasar, 2010).** The introduction of fluoride in prevention of dental caries has been widely accepted. However, the benefits of fluoride have been seen largely in the prevention of smooth surface caries without much benefit on the occlusal surfaces. This may be due to the presence of developmental pits and fissures on the occlusal surface that favors food lodgment and prevent access to oral hygiene measures **(Beauchamp et al., 2008; Damle, 2009).**

C. Dental caries vaccines: A vaccine is defined as an agent prepared to produce active immunity that usually kills microbes, attenuated live microbes, or in variant strains of microbes and that can induce antibody production without producing diseases **(Berkovitz et al., 2009).**

D. Pit and fissure sealants: which are defined whereby pits and fissures that occur principally on the occlusal surfaces of the molars and premolar teeth are occluded by application of fluid materials, which are then polymerized **(Krishna and Dasar, 2010).**

6- Pit and Fissures :

A Pit is defined as a small pinpoint depression located at the junction of development grooves or at terminals of those grooves. The central pit is described as a landmark in the central fossa of the molars where developmental grooves join **(Chandra et al., 2010)**.

Fissure is defined as adeep cleft between adjoining cusps. They provide areas for retention of caries producing agents. These defects occur on occlusal surfaces of the molars and premolars, with tortuous configuration that are difficult to assess from the surfaces. These areas are impossible to keep clean and it is highly susceptible to advancement of the carious lesion **(Krishna and Dasar, 2010)**. Pit or fissures with high steep walls and narrow bases are those most prone to develop caries **(Rao, 2008).**

6.1. Morphology of Fissures

On crown longitudinal sections there are different types of fissures based on the alphabetical description of shape (Figure. 1.3), **(Rao, 2008):**

1. V type ……. 34 %
2. K type ……. 26 %
3. I type ……. 19 %
4. U type ……. 14 %
5. Inverted Y type …...…… 7 %.

The deep, narrow, I and K shaped fissures are susceptible to caries **(Krishna and Dasar, 2010).**

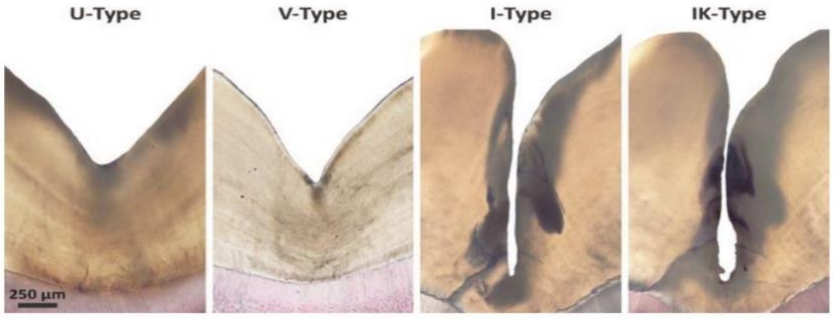
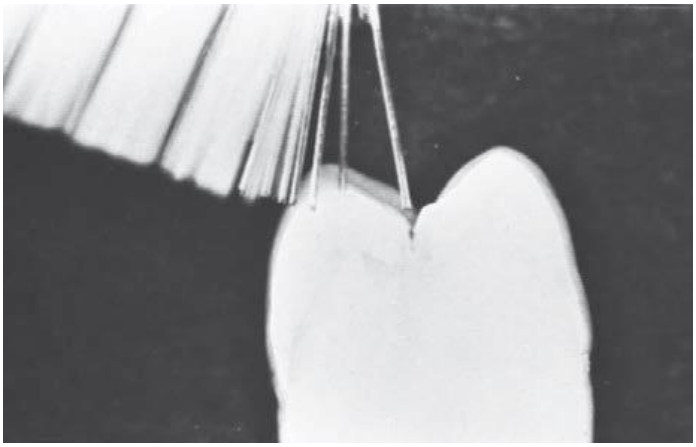


Figure -4-: Different fissure morphology. (Rao, 2008).

7- Pit and Fissure Sealants :

Fluorides are highly effective in reducing the number of carious lesions that occur on the smooth surfaces of enamel and cementum. Unfortunately, fluorides are not equally effective in protecting the occlusal pits and fissures, where the majority of carious lesions occur**(Wilson, 1985)** .The placement of sealants is a highly effective means of preventing carious lesions in the pits and fissures in both primary and permanent teeth**(Hotuman et al., 1998)** A Cochrane systematic review examined the effectiveness of second-generation resins compared with no treatment; the resin-based sealants were highly effective in preventing caries in permanent first molars in individuals under 20 years of age and in children 5 to 10 years of age**.(Ahovuo et al., 2004)** Another systematic review examined the efficacy of professional measures for caries prevention in high-risk individuals; sealants presented an 88% reduction in caries in that population. **(Bader et al., 2001)** Sealants present great preventive value when placed correctly and monitored regularly. A sealant is indicated if an occlusal fissure, fossa, or incisal lingual pit is present. When in doubt, the preferred course of action is to seal and monitor.A liquid resin, more commonly called a dental sealant, is placed over the occlusal surface of the tooth where it penetrates the deep fissures to fill areas that cannot be cleaned with the toothbrush **(Figure 5)** The resin then solidifies, and the hardened sealant subsequently presents a barrier between the tooth and the hostile oral



environment. Concurrently, there is a significant reduction of Streptococcus mutans on the treated tooth surface**.** Pits and fissures serve as reservoirs for mutans strepto-cocci; therefore, sealing the niche reduces their oral count **(Mass et al., 1999)**.

FIGURE-5- One reason that 50% of the carious lesions occur on the occlusal surface is that the toothbrush bristle has a larger diameter than the width of the fissure. (Mass et al., 1999)

7.1 History

In 1922, Hyatt first advocated the term "prophylactic Odontotomy" and published the same in (1923). He advocated filling the fissures of teeth with silver or copper oxyphosphate cement as soon as the teeth erupted and then later, when they completely erupted into the oral cavity, a small occlusal cavity is prepared and filled with silver amalgam.

Then Bodecker in (1929) suggested widening the fissures mechanically so that they would be less retentive to food particles and called it as "Fissure Eradication". In **(1939) Gore** used polymers as sealants. He used solutions of cellulose nitrate in organic solvents to fill surface enamel made porous by action of acids in saliva.

In **(1955), Buonocore,** in a classic in vitro study, advocated the filling of pit and fissure with bonded resin. He observed that after treatment of the enamel with a concentrated phosphoric acid solution (85%) for 30 seconds, attachment of acrylic resin to the tooth surface was greatly increased**. Bowen, (1965)** used bisphenol A-glycidyl methacrylate (BISGMA). In **(1967), Cueto** verified the effectiveness of acrylic resin sealants in prevention of dental caries in a clinical study. He demonstrated that acrylic resin has the capability to remain bonded to the tooth surface and that bonding depends on clean enamel surface that has been etched to produce microporosities. The first dental pit and fissure sealant, Nuva-seal, was introduced in (1971) along with its curing initiator and ultraviolet light source. In the same year, sealant got acceptance by the American Dental Association. In (1974) Glass Ionomer Cement was introduced as an alternative to the resin-based sealant **(Mclean and Wilson, 1974).** Then the sealant materials were considered to be used along several years ago and in 2002 color-changing sealants by 3M ESPE and Ivoclar Vivadent were produced **(Simonsen, 2002) .**

Reports for more than three decades have documented the efficacy of pit and fissure sealants in reducing occlusal dental caries. In addition to resin-based sealants, glass ionomer-based sealants are available **(Beauchamp et al., 2008; Ahmed, 2009).**

7.2 Ideal Properties of Sealant Materials

The desired clinical outcomes from the use of sealants are to prevent the establishment and stop the progression of carious lesions. However, to reliably prevent caries on any surface, the technique must provide good retention, a long-term seal, and be non-technique sensitive so that it can be applied by both dentists and dental auxiliaries such as hygienists and therapists. The requirements of an ideal material include biocompatibility, low viscosity, low solubility, esthetically acceptable, and reasonably visible to facilitate reassessment **(Bottenberg et al., 1996: Damle, 2009).**

There are two main types of materials that can be used as sealants: unfilled or lightly filled composite resins and glass ionomers. Neither of these can be regarded as ideal so the selection of which material to use will be driven by the requirements of each case. Over time both groups have evolved, and today there are subdivisions within these two, the compomers and resin-modified glass ionomers **(Mount et al., 2009).** The common denominators are that both groups are tooth colored and can adhere to tooth surfaces but beyond that, the differences are profound, and it is important for clinicians to understand the advantages and disadvantages of each so they can choose the most suitable material for the situation and then handle it correctly **(Simonsen, 2002) .**

7.3 Classification of pits and fissures sealants:

Pits an fissure sealants can be classified into different types depending on the following : **(Takamori et al., 2001; Warnock and Ruegebberg, 2004 ,Damel , 2009)**

1. Depending on the type of curing:

a. First generation sealants: polymerized with ultraviolet light of 350 nm wavelength. Light intensity varied from lamp to lamp.

b. Second generation sealants: It is chemically cured. Most of them are unfilled (without fillers), can be transparent, opaque or tinted .

c. Third generation: Visible light cured of 430-490 nm wavelength. May be unfilled which is usually white color or filled which is usually clear.

d. Fourth generation: with addition of fluoride for added benefit.

Sometimes lasers are used for curing due to several advantages including;reduction in setting time, control of specific radiation energy wavelengths, control of area of exposure and decrease in the percentage of unpolymerized resin .

2. According to filler content:

a. Unfilled which is better flow.

b. Filled which is strong and resistant to wear.

c. Semi filled.

3. According to fluoride content:

a. Fluoridated.

b. Non-fluoridated.

4. According to color:

a. Tinted-for easy identification.

b. Clear-which is difficult to detect.

c. Opaque-for easy identification.

5. According to resin systems.

a. Bis-GMA.

b. Urethane Acrylate.

Clear sealants have been shown to have better flow characteristics than tinted or opaque, but this can be an advantage or disadvantage depending on the

position of the tooth to be sealed. Although the retention rates of the two types are similar, colored sealants can be easily appreciated by the patient and also monitored by the dentist at subsequent recalls **(Krishna and Dasar, 2010)**.

7.4 Indications and contraindications of pit and fissure sealants

A. Indications: Clinical judgment is the deciding factor in the placement of sealant. Sealants are advised in **(Damle, 2009)**:

1. Recently erupted molar and premolar in patient with high risk of occlusal dental caries.
2. Tooth with deep narrow retentive pits and fissures.
3. Tooth with proximal surface caries.
4. Many occlusal lesions with few proximal caries in primary teeth.
5. Patient with high caries activity.

Age of application for pit and fissure sealants differs according to the age of tooth eruption, 3-4 years of age for primary molars, 6-7 years of age for first permanent molars and 11-13 years of age for second permanent molars and premolars **(Antonson et al., 2006; Damle, 2009).**

B. Contraindications: The sealant materials are contraindicated to be used in the following cases **(Krishna and Dasar, 2010)**:

1. Teeth which remain caries free for 4 or more than 4 years.
2. Shallow wide self-cleansing pits and fissures.
3. Tooth with no proximal surface caries.
4. Individual with no previous caries experience.
5. Uncooperative patient.

7.5 Advantages and disadvantages of pit and fissure sealants

1) ADVANTAGES :

Pit and fissure sealants are a non-invasive technique that help in sealing of pits and fissures to prevent tooth decay without cutting of tooth structure **(Star and Gratitz, 1985).** The using of fluoridated sealants can confer protection to adjoining areas by fluoride release **(Hicks, 1998).**

The sealants can be used at the community level for prevention of caries **(Sanzi-Schaedel et al., 2001).**

The conclusion of a study on caries risk in firmly sealed teeth showed that the teeth with fully or partially lost sealant were not at a higher risk of developing caries than were teeth that had never been sealed **(Griffin et al., 2009).** Moreover, two studies on the effect of dental sealants on bacterial level in caries lesions, and on the effectiveness of sealants in managing carious lesions, concluded that sealants prevent progression of dental caries. These sets of findings suggest that "when sealants are retained, and thus access to fermentable substrates is blocked, bacteria do not appear capable of exerting their cariogenic potential" **(Griffin et al., 2008; Oong et al., 2008)**.

2) DISADVANTAGES :

The presence of moisture during sealant application interferes with retention and attachment of sealants to the enamel surface, therefore, it needs complete dryness of tooth during application procedure. This technique sensitivity is considered as a disadvantage **(Borsatto et al., 2004).**

Other disadvantages of sealants are if they are placed over hidden caries, or if the sealant placed and then dislodged by time leading to initiation of caries underneath the sealants. The underlying caries may progress underneath sealants and become difficult to be diagnosed by the dentist **,** but this point is a controversy because there are different opinions depending on the fact that when the sealant is applied in a viscous liquid state that enters the micropores, which have been enlarged through acid etching. **(Takamori, 2001; Damle, 2009),**

The resin then hardens because of either a self-hardening catalyst or application of a light source, extensions of the hardened resin that have penetrated and filled the pores which are called resin tags **(Krishna and Dasar, 2010).**

7.6 Resin-Based Pit and Fissure Sealants

Resin-based dental sealants are generally based on Bis-GMA or urethane with the addition of diluents such as triethyline glycol dimethacrylate (TEGDMA)and/ or 2-hydroxyethyl methacrylate (HEMA). A wide variety of resin sealants is available, from unfilled to partially filled and from clear to white or other colors. These materials are either chemically polymerized or initiated by visible light **(Simonsen, 2002).**

Despite the presence of two hydroxyl groups, the Bis-GMA monomer is inadequately hydrophilic to compete with water for interaction with the enamel surface. Water within the microscopic capillaries would prevent complete penetration of the acrylic resin. Contamination of the etched enamel surfaces with saliva prior to sealant application will also prevent proper bonding, because the micropores become occluded.Therefore, moisture contamination of etched enamel during application of the sealant is the most frequently cited reason for sealant failure **(Silverstone, 1984; Peutzfeldt, 1997**).

7.7 Glass Ionomer-Based Pit and Fissure Sealants

Glass ionomer cements have been used as dental sealants. Studies have indicated that they do have the same effective retention rates as those of conventional sealants**.(Sachin, 2011)** Glass ionomer cement is most frequently

used when providing the alternative restorative technique (ART), formerly referred to as the atraumatic restorative technique. This technique is defined as the non definitive restorative treatment procedure for caries prevention that involves the removal of soft/demineralized tooth tissue using a hand instrument alone, followed by restoration of the tooth with an adhesive restorative material, such as a glass ionomer cement**(Muller et al., 2006)** .

ART is used extensively throughout the world as a method to alleviate pain and infection**.(Frencken, 2010)** Interim therapeutic restoration (ITM) more accurately describes the procedure used in contemporary dental practice in the United States, which can restore and prevent further decalcification and caries in young patients, uncooperative patients, or patients with special health care needs or when traditional cavity preparation and/or placement of traditional dental resto- rations are not feasible and need to be postponed. This technique is especially valuable in areas of the country where there are shortages of dentists and where dental hygienists are available to place sealants **(Muller et al., 2006)** .

7.8 Resin-Modified Glass Ionomer-Based Sealants (RMGI)

Other researchers have begun to look at other glass ionomer materials such as RMGI cements as a sealant option. RMGI cement as an occlusal sealant in a one-year clinical study appeared to wear markedly **(Winkler et al., 1996)**. Some clinical studies showed low retention of RMGI cement used as sealants compared with resin-based sealants with the difference in caries increment being minimal **(Smales et al., 1996; Smales and Wong, 1999).**

Furthermore, Vitremer (RMGI cement) with normal powder/liquid proportion (1:1) showed better retention performance than Delton (resin-based sealant), with or without bonding agent **(Oliveira et al., 2008).**

Pardi et al., (2006) conducted an in vitro study evaluating the micro leakage of resin-based sealant, flowable composite resin-based sealant,compomer based sealant, and RMGI-based sealant placed after 37% phosphoric acid etching. They found that all types of fissure sealants had similar marginal sealing ability. Results from this study suggested that etching pits and fissures with phosphoric acid may help in reducing micro leakage associated with RMGI.

7.9 Flowable Composite

Flowable composites were introduced in late (1996) They have a filler size similar to hybrid composites, but reducing the filler content (weight:60%-70%) than their hybrid analog (weight: 70%-80%) and allowing to increase resin to reduce the viscosity of the mixture **(Chuang et al., 2001).**

It is indicated to be used as a marginal repair (amalgam, composite, crown porcelain), also used as a liner, splinting and porcelain veneer cementation. In addition to these indications, it is also used as a pit and fissure sealants **(Bayne et al., 1994; Chuang et al., 2001; Moore et al., 2004**).

The physical and mechanical properties of flowable composite differ from that resin-based fissure sealant, glass ionomer sealant and also composite.The physical and mechanical properties of glass ionomer sealants are characterized by lacking of sufficient abrasion resistance and are easily lost.In addition, they are brittle and able to fracture, exposing the underlying part of unfilled pits or fissures to the intraoral environment **(Moore et al., 2004).**

Traditional composites, by themselves, are not good sealants because they do not penetrate into pits and fissures readily because of their comparatively high viscosity. Therefore, newer low-viscosity versions of composites, flowable composites, have been advocated, they have good wetting, sufficient flow, adequate abrasion resistance, and good fracture resistance. In fact, one of the earliest flowable composites was a pit and fissure sealant to which a modest amount of filler had been added **(Bayne et al., 2002).**

The filler level in a material determines its mechanical strength and physical properties. Higher filler levels dispose the material to improve wear resistance, compressive strength, reduce the coefficient of thermal expansion compared with an unfilled acrylic resin and less polymerization shrinkage.The resin-based pit and fissure sealants are similar to resin matrix of composite without filler or a little bit of fillers, also it is very similar to bonding system adhesive **(Chuang et al., 2001 and Bayne et al., 2002).**

The resin matrix of many currently available composite materials is bispenol A-glycidyl dimethacrylglycol dimathacrylate, a lower viscosity resin is added as a diluent. The macro fillers are ground particles of fused silica, crystalline, quartz, and glasses such as barium, strontium, and zirconium silicate glass. These particles resist deformation of the soft resin matrix. The micro filled resins are used to improve the ability of composite to be finished to extremely smooth

surface, which was a major problem with the conventional composites as shown in(**Figure -6-) (Moore and Avery, 2004)** .

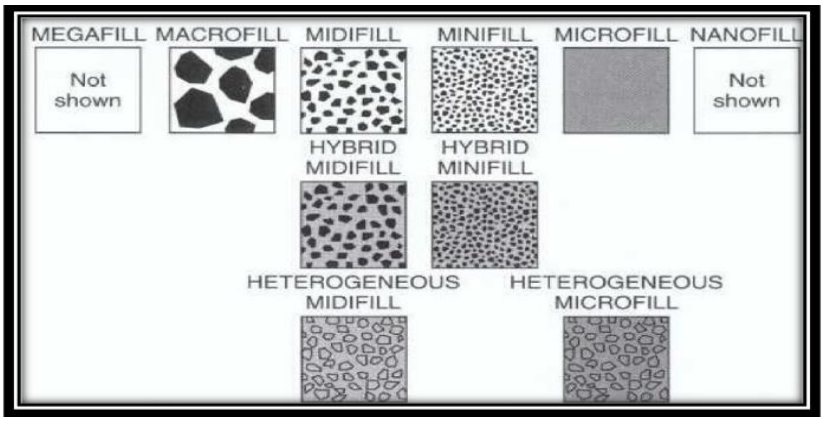


Figure -6-: Summary of filler particle size-based classification system for dental composites. Composites are grouped on the basis of: 1) primary particle size. 2) whether they are hybrids: because of particle size mixing,3) whether composite is a homogeneous mixture of filler and resin or includes precured composite (heterogeneous), and 4) whether chopped fiber is added to composite (not shown) . (Moore and Avery, 2004)

7.10 Preventive Resin Restoration

When the pits and fissures get minimally involved with caries, and there is need for restoring small pits and fissures on an unrestored tooth, an ultraconservative, modified preparation design is recommended. The defect is restored with composite filling materials, with minimum removal of tooth structure and combined with sealant application to seal radiating non-carious fissures **(Damle, 2009).**

There are three types of preventive resin restorations based on the extent and depth of the carious lesion **(Rao, 2008):**

1-Type A: Comprises of suspicious pits and fissures where caries is limited to enamel .

2-Type B: Comprises of incipient lesion extending into dentin that is small and confined.

3-Type C: Characterized by the presence of deep caries and need for greater exploratory preparation in dentin.

One old study reported, complete retention of 55% of their preventive resin restorations, partial loss of sealant in 25% and complete loss of sealant in 20% after 9 years. Caries occurred in 25% of the teeth that had sealant loss and 88% of the restored surfaces remained caries free 9 years after treatment **(Houpt et al., 1994).**

Walker et al reported on preventive resin restorations placed in patient 6 to 18 years of age and observed for up to 6.5 years. Of the restorations, 83% did not require further intervention. Those requiring intervention included 37% that needed sealant alone and 21% that required treatment because of the development of an inter proximal lesion **(Walker, 1996).**

These researchers concluded that preventive restorations produce excellent long-term results. Conservative cavity preparation with sealing for prevention is a successful approach for treating selected decayed teeth **(Sanders et al., 2004).**

8- SEALANT PLACEMENT

For sealant retention, the surface of the tooth must

(1) have a maximum surface area . **(Gwinnett et al., 1956)**

(2) have deep, irregular pits and fissures. **(Konig, 1963)**

(3) be clean. **(Garcia and Donly, 2002)**

(4) for most sealant materials, be absolutely dry at the time of sealant placement and uncontaminated with saliva residue. These are the four commandments for successful sealant placement, and they cannot be violated. **(Pahlavan et al., 1976)**

8.1 Increasing the Surface Area

Sealants do not bond directly to the teeth. Instead, adhesive forces mainly retain them. Increasing the surface area, which in turn increases the adhesive potential, requires the use of tooth conditioners (also called etchants), which are

composed of a 30% to 50% concentration of phosphoric acid; the etchants are placed on the occlusal surface prior to placement of the sealant**.(Gwinnett et al., 1965)** The etchant can be in liquid or gel form; both are equal in abetting retention**.(Garcia and Gwinnett, 1987).**

Once a tooth is etched, it appears chalky white as shown in **(Figure7**). If any etched areas on the tooth surface are not covered by the sealant or if the sealant is not retained, the normal appearance of the enamel returns within 1 hour to a few weeks as a result of the salivary constituents' remineralization of the enamel**(Arana, 1974).**

FIGURE -7-Tooth after etchant is placed.
(Arana, 1974)

8.2 Pit-and-Fissure Depth:

Deep, irregular pits and fissures offer a much more favorable surface contour for sealant retention compared with broad, shallow fossae. The deeper fissures protect the resin sealant from the shear forces occurring as a result of mas-ticatory movements. Of parallel importance is the possibility of caries development increasing as the fissure depth and slope of the inclined planes increase. Thus, as the potential for caries increases, so does the potential for sealant retention**(Konig, 1963).**

8.3 Surface Cleanliness

The need and methods for cleaning the tooth surface prior to sealant placement are controversial. Methods used to clean the tooth surface

include air polishing, use of hydrogen peroxide, polishing with pumice, brushing with a non fluoridated tooth-paste, and use of laser. **(Garcia and Araujo, 1994)** Comparison of acid etching with laser alone did not demonstrate any significant difference of sealant retention or microleakage. In light of the expense of laser equipment, using a laser prior to sealant placement provides no advantage.**(Muller et al., 2006)** Furthermore, cleaning teeth with the newer prophylaxis pastes with or without fluoride (NuPro, opex) was not shown to affect the bond strength of sealants **(Bogert and Garcia, 1992).**

Interestingly, in the most cited studies on sealant longevity, Simonsen accomplished the most effective sealant longevity without the use of prior prophylaxis. however, cleaning the tooth surface with oil-free pumice is recommended for sixth-generation sealant material. Whatever the cleaning preferences, either by acid etching or other methods, all heavy stains, deposits, debris, and plaque should be removed from the occlusal surface before applying the sealant material **(Simonsen, 1987)** .

It was once thought that the use of fluoride prior to sealant placement would decrease sealant retention. The literature indicates, however, that this concern is not true and that, if the tooth is treated with fluoride and the sealant is not retained, the tooth will still benefit from the prior fluoride placement**(Warren et al., 2001;El-Housseiny and Sharaf, 2005) .**

8.4 Preparing the Tooth for Sealant Application

The preliminary steps for the light-activated and the auto polymerized resins are similar up to the time of application of the resin to the teeth. After the selected teeth are isolated, they are thoroughly dried. If a liquid etchant is being used, it is dabbed on the tooth with a small resin sponge or cotton pellet held with cotton pliers. More commonly, a gel etchant would be placed directly on the tooth by the supplied syringe/cannula delivery system. Following the manufacturer’s direction

for etch time is important; typically 20 to 30 seconds of enamel-etching time is recommended **(Pahlavan et al., 1976).**

The etched tooth is then rinsed and dried as shown in **(Figure -8-)** The dried tooth surface should have a white, dull, frosty, or chalky appearance because the etching removes approximately 5 to 10 micron of the original surface, although at times inter-rod penetrations of up to 100 micron can occur**(Silver stone, 1983)**.

The etching does not always involve the inter-rod areas; sometimes the central portion of the rod is etched, and the periphery is unaffected. The pattern on any one tooth is unpredictable. In any event, the surface area is greatly increased by the acid etch **(Bozalis and Marshall, 1977).**

A

B

C

FIGURE-8-Sealant placement. A. Gel etchant is applied to teeth, including the lingual cusp on the first molar. B. Etched surface has a "frosty" appearance. C. Application of resin-based sealant.
(Silver stone, 1983)

8.5 Drying the Tooth Surface

The teeth must be dry at the time of sealant placement because sealants are hydrophobic. The presence of saliva on the tooth is even more detrimental than water because its organic components interpose a barrier between the tooth and the sealant. When the teeth are dried with an air syringe, the air stream should be checked to ensure that it is not moisture laden. Otherwise, if sufficient moisture is sprayed on the tooth, adhesion of the sealant to the enamel will be prevented. A check for moisture can be accomplished by directing the air stream onto a cool mouth mirror; any fogging indicates the presence of moisture. The omission of this simple step possibly accounts for the inter operator variability in the retention of fissure sealants **(Simonsen, 1987) .**

A dry field can be maintained in several ways including the use of cotton rolls, and/or the placement of bibulous (absorbent) pads over the opening of the parotid duct. The most successful sealant studies have used cotton rolls for isolation. In one a study comparing the retention rate of a rubber dam versus cot-ton rolls, the sealant retention was approximately equal. Other studies have shown excellent sealant retention after 3 years and after 10 to 20 years. Another promising dry-field–isolating device for single-operator use, especially when used with cotton rolls, is ejector moisture-control system, which suction and eject saliva from the mouth **(Wendt et al., 2001).**

The use of two operators, such as a dental hygienist or a dentist and a dental assistant, is preferred because it increases the likelihood that a dry field can be maintained. In the event that it becomes necessary to replace a wet cotton roll, it is essential that no saliva contacts the etched tooth surface. If saliva contact is suspected, it is necessary to repeat all procedures up to the time the dry field was compromised, including repeated etching to remove any residual saliva **(Wood et al., 1989).**

8.6 Sealant Application

With either the light-cured or auto polymerized sealants, the material should be placed first in the fissures of maximum depth. At times, penetration of the fissure is negated by the presence of debris, air entrapment, narrow orifices, and excessive viscosity of the sealant. The sealant should fill the fissures, but some bulk over the fissure should be present. After the fissures are adequately covered, the material is then brought to a knife edge approximately halfway up the inclined plane **(Silverstone, 1983).**

Following polymerization, the sealants should be examined carefully before the dry field is discontinued. If any voids are evident, additional sealant can be added without the need for additional etching. The hardened sealant leaves an oil residue on the surface. This residue is an unreacted monomer and should be removed with a gauze square. If a sealant requires repair at any time after the dry field is discontinued, repeating the initial etching and drying procedures is prudent. Because all commercial sealants, light-cured and self-cured, are of the same Bis-GMA chemical family, they easily bond to one another **(Myers et al., 1974) .**

8.7 Evaluating Retention of Sealants

The finished sealant should be checked for retention without using undue force. If the sealant does not adhere, the placement procedures should be repeated with only about 15 seconds of etching needed to remove the residual saliva before again flushing, drying, and applying the sealant. If two attempts are unsuccessful, the sealant application should be postponed until remineralization occurs and the patient can comply with the procedure **(Silverstone, 1983)** .

8.8 Placement of sealants over carious lesion :

Sealing over a carious lesion is important because of the professional concern about the possibility of caries progression under the sealant sites. Teeth that were examined in vivo and later subjected to histologic examination after extraction for orthodontic reasons were often found to have areas of incipient or overt caries under many fissures, which the explorer cannot detect. In one study, sealants were purposely placed over small, overt lesions; when compared with control teeth, many of the sealed carious teeth were diagnosed as sound 3 and 5 years later**(Mertz et al., 1991)** .

Handelman has indicated that sealants can be consider a viable modality for arrest of pit-and-fissure caries **(Handelman et al., 1976) .**

The number of bacteria recovered from the area decreased rapidly when the lesion was sealed **(Going et al., 1978) .**

This decrease in bacterial population is probably due to the integrity of the seal between the resin and the etched tooth surface, which does not permit the movement of fluids or tracer isotopes between the sealant and the tooth**.(Theilad et al., 1977;Jenses and Handelman, 1987).**

Sealants have been placed over more extensive lesions in which carious dentin is involved. Even with these larger lesions, there is a decrease in the bacterial population and arrest of the carious process as a function of time. Clinically detectable lesions in the dentin were covered for 5 years with Nuva-Seal. After that time, the bacterial cultures were essentially negative, and an apparent 83% reversal from a caries-active to a caries-inactive state was achieved**.(Going et al., 1978) .** Mertz-Fairhurst and colleagues demonstrated that sealed lesions became inactive bacteriologically with arrested carious lesions.(Mertz et al., 1986) Researchers found that there were clear efficiencies in sealing incipient surfaces and therefore recommended this practice **(Heller et al., 1995) .**

Sealants that have been placed over incipient lesions should be monitored at subsequent recall/annual dental examination. In addition, there have been reports of sealants being used to achieve penetration of incipient smooth-surface lesions (“white spots”) of facial surfaces **(Oong et al., 2008) .**

Many times dental providers perform enameloplasty using a bur or an air abrasion to remove demineralized areas and then place a dental sealant. In fact, enameloplasty has no significant differences compared with etching before sealants. Enameloplasty also requires a dentist, which increases the cost of placing sealants **(Cohen et al., 1988) .**

CONCLUSION:

Sealing with resin based sealants is a recommended procedure to prevent caries of the occlusal surfaces of permanent molars. However, we recommend that the caries prevalence level of both individuals and the population should be taken into account. In practice, the benefit of sealing should be considered locally and specified guidelines for clinicians should be used. The methodological quality of published studies concerning pit and fissure sealants was poorer than expected.

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