International Journal of Enhanced Research in Medicines & Dental Care (IJERMDC),
ISSN: 2349-1590, Vol. 11 Issue 11, November-2024, Impact Factor: 8.325

A Compendium on Pit and Fissure Sealants

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ABSTRACT

The pits and fissures found on the chewing surfaces of back teeth are highly susceptible to decay because of their complex grooves, which make thorough cleaning difficult and allow plaque to accumulate. Unlike smooth enamel surfaces, these deep grooves do not receive adequate protection from fluoride, making them more prone to cavities. Applying pit and fissure sealants is an effective preventive strategy, as these sealants form a barrier that prevents food particles and bacteria from becoming trapped in these areas, thus reducing the risk of decay. Among permanent teeth, the first molars tend to have the highest rate of decay, followed by the second molars, often shortly after they erupt. Therefore, preventing decay in the molars' occlusal surfaces is a key focus in dental care.

Keywords: Sealants, Types, Molars

Dental caries is a multifactorial disease caused by the alteration in the composition of the bacterial biofilm, leading to an imbalance between the demineralization and remineralization processes. The phenomenon is manifested by the formation of carious lesions in primary and permanent dentition[1].The prevalence of smooth surface caries in children is decreasing but still the epidemiological data shows that the occlusal surface of the molars carries the burden of the caries in children and adolescents, particularly occurring in deep pits and fissures[2]. Due to their complex morphology, there is accumulation of plaque and debris, rendering them more prone to carious attack and compromised remineralization of the incipient lesion[3]. Also, they restrict the beneficial effects of fluorides and tooth brushing.

The management of occlusal caries on molars represents a significant challenge because the onset of caries occurs soon after they erupt into the oral cavity[4]. Molars are the teeth of most importance in the oral cavity as they are first to erupt and last to exfoliate in a lifetime. Therefore, it is always best to retain the natural teeth whenever possible and prevention should always be the first choice.

Therefore, pit and fissure sealant, introduced in 1960's, is one of the preventive tools to prevent occlusal carious lesions, by creating a physical barrier, preventing food impaction, plaque accumulation, and subsequent demineralization of the deep occlusal pits and fissures[5]. They hold a great significance in the preclusion of inception of caries process, exclusively on molars.

Advantages and Disadvantages Of Pit And Fissure Sealants

- Pit and fissure sealants are regarded as a minimally invasive technique that effectively seals the pits and fissures of teeth, offering protection against decay while preserving the integrity of the tooth structure.
- Fluoride-releasing sealants contribute additional protection to adjacent areas by allowing fluoride to diffuse.
- These sealants can be utilized at the community level as a preventive measure against cavities.
- Research indicates that after the application of sealants, teeth that experience complete or partial loss of the sealant do not exhibit a greater risk of caries compared to those without any sealant[6].
- Furthermore, one of studies have evaluated the efficacy of pit and fissure sealants have demonstrated that these sealants effectively inhibit the progression of dental caries. The evidence suggests that they prevent bacteria from accessing fermentable substrates, thereby diminishing their cariogenic potential[7].

Disadvantages:

- The drawbacks of sealants include the risk of inadvertently sealing over undetected cavities or the possibility of sealants detaching over time, which may allow caries to develop beneath them. These underlying cavities can progress unnoticed, making diagnosis more challenging for dentists.[8]

INDICATIONS AND CONTRAINDICATIONS OF PIT AND FISSURE SEALANTS

Indications:[9]

- Deep, retentive pits and fissures that may trap an explorer
- Stained pits and fissures with minimal signs of decalcification
- No clinical or radiographic evidence of caries in proximal areas
- Ability to achieve sufficient isolation for sealant application
- Presence of questionable caries in pits and fissures
- Pits and fissures free from caries
- When requested by the patient
- A pattern of caries indicating multiple lesions per year
- Pit morphology that presents a caries risk
- Factors linked to an increased likelihood of caries
- Routine dental care within an active preventive dentistry program, such as a community-based sealant initiative

Contraindications for Pit and Fissure Sealants[9]:

- Pits and fissures that are well-coalesced and self-cleansing
- Clinical or radiographic signs of interproximal caries
- Tooth that has not fully erupted
- Inability to achieve proper isolation
- Limited life expectancy of the tooth
- Presence of dentinal caries
- Absence of preventive care practices

Types of Fissures Present On Molars

According to the morphology, different types of pits and fissures are seen on the occlusal surface of the molars-U type, V type, I type, IK type and inverted Y type. For prevention of caries in these pits and fissures, various pit and fissure sealants are available[6] based on the generations of sealants, color, composition of matrix and fillers and they can be classified into various categories[9].

CLASSIFICATION OF PIT AND FISSURE SEALANTS

1. **Polymerization Type[9]**:
    - **First-generation sealants**: Cure using ultraviolet light at a wavelength of 350 nm.
    - **Second-generation sealants**: Harden chemically without fillers and may be available in transparent, opaque, or colored options.
    - **Third-generation sealants**: Polymerize with visible light in the 430-490 nm range, typically appearing white or transparent.
    - **Fourth-generation sealants**: Enhanced with fluoride for added protective benefits.

2. **Filler Content**:
    - **Sealants without fillers**: These have a more fluid consistency.
    - **Sealants with fillers**: Offer greater strength and resistance to abrasion.
    - **Partial filler sealants**: Contain a moderate level of fillers for balanced properties.

3. **Fluoride Content**:
    - Fluoride-containing sealants
    - Non-fluoride sealants

4. **Color Options**:
    - Colored sealants
    - Transparent sealants
    - Opaque sealants

5. **Resin System**:
    - Bisphenol A-glycidyl methacrylate (Bis-GMA)
    - Urethane Acrylate

Many sealants are available in the market containing fluoride, selenium, etc. Fluoride releasing pit and fissure sealants have been used by the dental professionals since years. Over the years, many modifications have been done in the conventional sealants and marketed.

Various types of pit and fissure sealant materials available in the market include:

1. **Glass Ionomer Sealant Material**: Traditional glass ionomer (GI) material, which chemically bonds to enamel and dentin, is also used for pit and fissure sealants. GI sealants come in both high and low viscosity types.
2. **Resin-based pit and fissure sealants:** consists of bisphenol A-glycidyl methacrylate (Bis-GMA) resin, are designed to treat tooth pits and fissures. The Bis-GMA resin is combined with a diluent to create a flowable material that can penetrate these areas effectively. To enhance wear resistance and stiffness, filler particles like fumed silica or silanated inorganic glasses may be added.
3. **Giomer based sealants:** This is a tooth-colored sealant, which recharges fluoride and provides added protection for pits and fissures. Equipped with a self-etching primer, it shortens treatment time by removing the need for phosphoric acid etching. Giomer-based sealants contain Surface Pre-Reacted Glass (S-PRG), known for its properties that help prevent caries, neutralize acids, and inhibit plaque formation[10].
4. **Selenium-Containing Sealant**: This sealant type incorporates organo-selenium, which is chemically bonded to the sealant using polymer technology. Selenium-based sealants are effective in preventing the formation of *Streptococcus mutans* and *Streptococcus salivarius* biofilms in tooth pits and fissures. Due to the strong covalent bond of selenium with the sealant polymer, these sealants tend to be more durable than fluoride-releasing varieties, releasing small amounts of unbound selenium over time which is responsible for the cariostatic action.[11]
5. **Ion-releasing sealants:**Bioactive resin sealants could be one of the most desirable approaches for preventing caries due to the potential of providing localized ion release near the tooth surface. The resins are expected to release ions such as calcium and phosphate, to maintain physiological equilibrium between tooth minerals and oral fluids. These materials continuously recharge the ionic components of saliva, teeth, and the material itself[12].
6. **ACP- containing sealants :**Amorphous calcium phosphate (ACP) is a precursor to the formation of hydroxyapatite (HAP), which is the final product in the precipitation of the calcium and phosphate ions. Amorphous calcium phosphate has shown anti-cariogenic properties with remineralization potential. Amorphous calcium phosphate-containing pit and fissure sealant stimulate mineral growth on teeth (carious lesion) by increasing the calcium and phosphate concentrations within the lesion, especially in acidic oral environment, to levels above those existing in ambient oral fluids, thereby shifting the PH of the solution toward the formation of apatite[13].
7. **Light-Cure Nano Hybrid Resin Sealant with High Filler Content**: This sealant incorporates nano-fillers, enhancing flow properties and reaching a high filler content of 70% by weight. The increased filler level contributes to lower abrasion rates and high transverse strength. Additionally, it has minimal polymerization shrinkage, making it suitable not only for sealing pits and fissures but also for preventive resin restorations.
8. **Glass Carbomer-Based Sealant**: Glass carbomer cement is a monomer-free, nano-glass restorative material derived from conventional glass ionomer cement. It contains nanoparticles of hydroxyapatite and fluorapatite, which enhances its chemical and mechanical qualities. Compared to standard glass ionomer cement, glass carbomer offers greater resistance, improved flexural strength, durability, enhanced remineralization properties, and is compatible with LED-curing devices[14].
9. **Silver-Reinforced Pit and Fissure Sealant**: This type of sealant uses nano-silver particles to harness antimicrobial properties for dental applications. The silver nanoparticles contribute to a smooth, glossy finish that resists plaque buildup and assists in remineralizing tooth structures. It is known for its high wear resistance and low solubility, enhancing its longevity and efficacy in the oral environment[15].
10. **Clear Pit and Fissure Sealants**: These sealants offer an aesthetic, transparent finish. However, their clarity can make it challenging to spot during follow-up visits, which may complicate monitoring and evaluation[9].
11. **Fluorescing Pit and Fissure Sealants**: These sealants simplify the process of application and verification during follow-up appointments. When exposed to a UV pen light, they emit a blue or white fluorescence, allowing clinicians to easily see the sealant margins right after placement. This feature aids in confirming retention and inspecting the sealant during patient recalls, making it a practical choice for ensuring effective sealing.[9]
12. **Coloured pit and fissure sealants:** The sealant is clear to begin with but after polymerization it changes its color. The degree of color change is also an indicator of its setting and adequate polymerization. It is easy to see during placement and recall thus offering and added advantage over the other sealants[9].
13. **Moist Bonding Pit and Fissure Sealant:**This innovative sealant utilizes di-, tri-, and multifunctional acrylate monomers combined with advanced acid-integrating chemistry that activates in the presence of moisture. Unlike traditional sealants that are hydrophobic and do not adhere well to moist enamel, this sealant spreads effectively over the enamel surface. Its unique formulation allows it to mix with moisture in etched enamel,

creating a resin acid-integrating network (RAIN) that enhances penetration into pits and fissures, providing superior sealing at the margins. The sealant bonds chemically and micromechanically to the moist tooth structure, forming a robust, margin-free bond that significantly reduces microleakage. It boasts a compressive strength of 3,800 psi and a minimal film thickness of just 12 µm, allowing for application in thin layers without compromising strength. Its advantages include the ability to bond in wet conditions, integration with tooth structure, elimination of marginal chipping, no need for a separate bonding agent, and the absence of bisphenol A, Bis-GMA, or Bis-DMA[16].

14. **Hydrophilic Fluorescent BPA-Free Pit and Fissure Sealant**: This type of sealant incorporates many advantageous features from various sealants. Key characteristics include hydrophilic chemistry, advanced adhesion technology, fluorescent properties, and thixotropic viscosity, all within a BPA-free formula. These qualities allow for effective use in moist conditions, facilitate straightforward application due to its thixotropic nature, and enable easy follow-up checks thanks to its fluorescent capability[9].

CONCLUSION

Research indicates that approximately one-quarter of children and over half of adolescents exhibit dental carious lesions in their permanent teeth. The occlusal surfaces of posterior teeth are particularly vulnerable to caries due to the complex pits and fissures that provide an ideal environment for decay. Evidence strongly supports the effectiveness of sealants in preventing this common issue. For instance, a study involving children revealed a 37% reduction in the risk of dental caries with the application of pit and fissure sealants compared to a control group. Furthermore, the use of sealants led to a 44% decrease in the likelihood of developing caries in the first permanent molars after three years. Assessing caries risk is a crucial component of the decision-making process, and it is essential to regularly reevaluate each patient's risk status.

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