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A literature review on moisture resistant pit and fissure sealants

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ABSTRACT

Preventive approaches in dentistry have focused on the factors to prevent the initiation of caries and to arrest them in case of incipient or early caries lesion. The most common preventive approaches include inhouse and professionally applied topical fluorides and resin based pit and fissure sealants. Due to the anatomy of the tooth, the deep pits and fissures act as retentive sites to plaque, food materials, micro-organisms, eventually becoming caries susceptible as compared to smooth surfaces. Evidence has shown, that application of sealants to such sites being the most effective measure. This procedure is minimally invasive as the sealant material bonds micro-mechanically to the tooth surface, acting as a barrier. Sealant adhesion is the major factor to be considered with the use of conventional sealants. Conventional hydrophobic sealants are moisture sensitive, hence they require a dry enamel surface while sealant placement. To overcome this drawback, moisture friendly or hydrophilic sealants were introduced in to dental market. Hydrophilic sealants are water miscible, have fluoride releasing properties, are thixotropic in nature, thus allowing the material to flow onto the etched enamel and thus creating a better retention due to the stronger bond. This scientific paper reviews the literature and elaborates the significance of pit and fissure sealants and exclusively discusses about the newly developed hydrophilic or moisture tolerant pit and fissure sealants.

Keywords: *Moisture tolerant sealant, Thixotropic, Caries, Children, Fluoride release*

INTRODUCTION

Dental caries has emerged as a public health problem as it is highly prevalent across all age groups, in almost all nations. It is a complex diseases caused due to changes in the structure of bacterial bio-film leading to an imbalance between the re-mineralization and de-mineralization process, eventually causing cavitated lesions in the teeth surfaces [1][2].

Carious lesions in the pits and the fissures of permanent posterior teeth account for almost half of all caries cases. Studies show that this has to do with the interlobar groove-fossa system's internal morphology having a direct impact on caries progression, as they accumulate bacteria easily and the anatomy makes it difficult to remove plaque from the narrow and deep surfaces [3–5].

To safeguard pits and fissures, more effective methods are required, such as the use sealants.

The application of sealant is a preventive approach which involves introducing sealants into the caries prone occlusal surfaces of the teeth following which the material bonds micro-mechanically to the teeth surface, creating a physical barrier and thus blocking the bacteria from their nutrition source [6]. The basic premise for the resin sealant's caries prevention is its capacity to completely cover pits, fissures, and/or morphological flaws while remaining totally intact and attached to the enamel surface [7]. The introduction of sealant dates back to 1971, when Nuva Seal was invented and since then a variety of newer sealing materials have been available. A moisture-tolerant chemistry has also been added to resin-based sealing technology.

Sealants can be generally hydrophobic; however unique moisture tolerant sealants which are hydrophilic in nature have also been introduced. The hydrophilic sealants are water miscible and have the ability to flow into moisture containing etched enamel and create a better retention forming a stronger bond [8]. Hydrophobic nature is a characteristic of traditional pit and fissure sealants. Many manufacturers advocate using them in conjunction with hydrophilic bonding agents to access the dry field requirement; however, the bonding agents add significant time and expense to the operation, and leads to technique sensitivity. Recent advances of pit and fissure sealants includes hydrophilic dental sealants and this literature review aims to enlist and review the moisture resistant pit and fissure sealants.

History of pit and fissure sealant development

Attempts to protect the occlusal surfaces of a tooth have been ongoing since the early 19th century. From sealing the pits and fissures using ammoniacal silver nitrate [9] to mechanical widening of fissure to convert them into cleansable ones [10]. However, none of these measures proved to be highly successful. In 1923, Hyatt introduced a more invasive approach where a class I cavity preparation was done to include all the susceptible pits and fissures and a prophylactic restoration was placed [11]. The method of etching the tooth surface was described in 1955 by Buonocore, where the tooth surface has to be soaked in 85% phosphoric acid for 30 seconds to increase the adherence of resin material [12] .

The first sealing substance, methyl cyanoacrylate was developed in the mid-1960s by Cueto but it was never commercialized. However, with time, this substance proved prone to bacterial disintegration in the oral cavity [13]. Bowen later developed a viscous resin called bisphenol-a-glycidyl dimethacrylate (BIS-GMA), which is today known as BIS-GMA [2].

Classification of sealants

Sealants are broadly classified into three main types.

Resin based sealants: The original generation was polymerized by UV radiation acting on the polymerization initiators in the material; however, this kind is not used anymore. Nuva-Seal® (LD. Caulk Co.: Milford, DE, USA) is an example of the first generation resin based sealant. Auto-polymerizing resin-based sealants (ARBS) or chemically-cured sealants were the second generation; tertiary amine which acts as an activator was added to the component [14]. The third generation which comprises of visble light polymerizers had mostly displaced autopolymerizing resin sealants. The photoinitiators are a component of the sealant material and are sensitive to visible light in the wavelength range of about 470 nm. The fourth generation resin-based sealants are fluoride releasing in nature. The product of adding fluoride-releasing particles to LRBS in an attempt to prevent caries is fluoride resin-based sealant. The viscosity of RBS can also be used to classify them (filled and unfilled). Filler particles added to fissure sealing material appear to have just a little impact on clinical results [15]. Resin based sealants are also classified according to their opacity. According to a study, the identification mistake for opaque resin sealant was just 1%, as compared to 23% in the case of clear resin sealant [16]. The integration of a colour changing characteristic into resin sealant materials is one of the most recent advancements in resin sealant technology.

The colour property of Clinpro (3M ESPE, Saint Paul, MN, USA) and Helioseal Clear (IvoclarVivadent, Schaan, Liechtenstein) changes either during the curing process or after polymerization [17]. However, polymerization shrinkage which leads to micro leakage is a drawback since it breaks the occlusal barrier through saliva and germs and allows formation of biofilm which is greater in consistency than the resin [18].

Glass ionomer sealants: Glass ionomer sealants act as fluoride reservoirs and have lower susceptibility to moisture as compared to resin sealants, thus making the enamel more cariostatic [19,20]. A new generation of low viscous glass ionomer cement has been developed which releases more fluoride and even has the highest fluoride recharge capacity [21]. According to recent study, there is no substantial difference in sealant retention between GI and resin-based sealants [22,23].

Polyacid modified resin: As a fissure sealer, compomer has also been used which is a polyacid-modified resin-based composite material. It combines the benefits of a visible light polymerized resin-based sealant with the fluoride-releasing ability of a gastrointestinal sealant. In comparison to glass ionomer sealant material, a polyacid-modified resin-based sealant has greater adherence to enamel and dentin, is less water-soluble, and is less technique-sensitive than resin-based sealants [24,25].

Moisture resistant pit and fissure sealants

Embrace Wet Bond - When a fully dry field is necessary, traditional sealants were hydrophobic. With this in view, Embrace Wet Bond was developed which is a hydrophilic moisture tolerant resin based sealant [26]. It uses di-tri and multifunctional acrylate monomers in a moisture-activated acid-integrating chemistry [27]. According to a 2008 study, a 95% success rate was observed after 2 years of application of this material as compared to earlier sealant studies [28].

Embrace Wet Bond contains no Bisphenol A, BIS-GMA and BPA derivatives. It is fluoride releasing in nature and shows exceptional sealing ability and adaptation to tooth structure [29]. When compared to other popular brands, it exhibits longer-lasting antibacterial action, particularly against S. mutans[30]. Various studies have proved the efficiency of Embrace sealant in moisture contaminated situations [31]. A newer advancement of Embrace Wet Bond is the EWB-with modified calcium phosphate has been reported to have a significantly higher survival time and potential bacterial microleakage frequency compared to Embrace Wet Bond (EWB) [32].

Technique of use

Clean the tooth surface with a slow speed handpiece using an oil free pumice paste.

Following which, the tooth surface must be rinsed thoroughly with an air water spray to remove all residual paste from the pits and fissures and dry the tooth Upon drying, 35-40% of phosphoric acid etching gel should be used on the cleaned tooth surface to 15 seconds.

After rinsing the etchant , the tooth surface should be dried using a cotton pellet or clean compressed air. The tooth surface should be left slightly moist. It should appear shiny but no visible drops of water should be present on the tooth surface.

The Embrace Wet Bond is applied on the dried tooth surface using an applicator syringe. The sealant is applied using a micro brush and all the fissures and pity are covered. The final sealant thickness upon application should be at least 0.3 mm.

Light curing is done for 20-30 seconds holding the light-curing probe at right angles and as close as possible to the occlusal surface.

Ultraseal XT Hydro - It is hydrophilic in nature, light cured, radiopaque, and has fluoride releasing properties. This material is particularly tougher and more wear resistant as it is 53% filled resin. It is composed of Ultraseal XT hydro contains TEGDMA, DUDMA, Al2o3, MAA, TiO2 and Na2PO3F [33]. This material removes moisture into pits and cracks, avoiding moisture-related sealant failure [34]. It is composed of irregular submicron and nano sized silicon,

barium and aluminum bearing filter phases incorporated in a ductile resin matrix and this is shown to reduce micro leakage and subsequently increase enamel roughness [33]. However, in terms of retention and cariostatic effect, it was found to be lesser than hydrophobic sealant, as reported by another study [35]. It also has a potential anti-bacterial action [36]. The fluorescing characteristics of this sealant allow the dental professional to swiftly assess the retention during insertion and even on follow up visits. This eliminated the need for guesswork and makes sealant retention clinically obvious.

DISCUSSION

Recent investigations have revealed a global increase in caries, validating the cause of worry regarding the oral disease [37]. Regular dental hygiene methods which include fluoride-containing toothpaste, a reduction in the intake of cariogenic foods, and local and systemic fluoridation are all established methods for preventing caries. Additional methods exist for anatomically sensitive regions such as pits and fissures. Therefore, the dental sealants were introduced in the 1960s [38]. Resin-based sealants have been shown to offer substantial advantages over fluoride varnishes in several studies [39]. Regular supervision is necessary since the long-term effectiveness of pit and fissure sealing is dependent on the material's strong mechanical barrier.

This is true for the use of sealing materials in primary prevention, and even more so in secondary prevention [18]. Sealing materials on sound occlusal surfaces, have reported a caries incidence of only 27% in sealed surfaces compared to a caries incidence of about 77% in the unsealed control group, and about 56% in another control group using fluoride varnishes after nine years [40]. The introduction of hydrophilic sealants has brought about an ease of accessibility in terms of sealant placement and shows excellent retention abilities thus allowing a better clinical success as compared to resin based sealants, as proved in various studies [7, 41–43]. The ability of hydrophilic sealant materials to transport ions from the oral cavity to the tooth surface is an essential feature that must be highlighted. Water is required for this procedure, thus materials that are moisture-friendly are desirable. Despite the facr that this transport mechanism is passive and relies on ion concentration gradients and resin matrix permeability, it is continuous and results in re-mineralization and restoration of the tooth [44]. Considering the advanced nature of this system, the constant ionic exchange, the demineralization–remineralization process along with the multiple sources of ionic components, it's evident that hydrophilic sealants are a significant step forward in preventive dentistry [45,46].

CONCLUSION

Dental caries constitute a large portion of the global burden of oral diseases that affects people of all ages and gender. Among all preventive measures, pit and fissure sealant are minimally invasive dental care approach that focuses on preventive maintenance. The application of pit and fissure sealants on a routine basis is a practical and predictable preventative measure. Because of their hydrophilic characteristics, these sealants adapt better anatomy of the teeth and produce a better seal, making them less technique-sensitive and simpler to apply than traditional materials.

The bioactive characteristics promote remineralization of tooth structure by increasing ionic activity. Due to these actions, moisture tolerant pit and fissure sealants prove to be more effective than hydrophobic sealants.

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