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Dental Sealants: A Literature Review

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ABSTRACT

Dental sealants were introduced in 1960's to prevent occlusal dental caries. They arrest the growth of caries causing bacteria, preventing their progression and subsequently avoiding early caries. Dental sealants act as caries preventing agents only till the time they remain bonded to the tooth. The intent of this review is to focus on dental sealant materials, discussing their effectiveness in preventing caries, caries risk assessment between sealant protective and no sealant tooth, compare different types of sealants-on the basis of their effectiveness, newer advances in sealant placement and elucidate upon the harmful effect of bisphenol A, a regular component of dental sealants.

Keywords: Dental caries, Pit and fissure sealant

INTRODUCTION

Tooth decay is one of the most common reasons for a patient's dental visit, especially in pediatric age group. Previous studies have shown occlusal surface of molars to be the most commonly affected with caries, contributing a percentage of 52.7%-66.3% of all lesions. [1] This can be attributed to their anatomy comprising of multiple pits and fissures, which provide an adequate niche for food and bacterial lodgment if not cleaned properly. [2] Many preventive measures have been put forward over the years to combat early decay of these teeth such as early blocking of fissure with zinc phosphate cement, [3] mechanical fissure eradication [4] and use of prophylactic odontotomy, [5] and chemical treatment with silver nitrate [6] to name a few. No satisfactory and universally acceptable success was achieved with any of these methods, with each having their own set of drawbacks.

Pit and fissure sealants are chemical agents applied on the occlusal surface of caries susceptible posterior teeth. The material acts as a physical barrier, forming a protective layer which simultaneously debars the access of caries causing bacteria to the nutrient source. These can either be auto polymerizing or cured with visible light. [7] Nuva-seal along with chaulk Nuva life, were among the first pit and fissure sealants to be introduced in February 1971. It's curing initiator and ultraviolet light source was the first clinical benefit from Buonocore's classic work of 1955, [8] introducing the acid etch bonding to enamel and subsequently the resin cements. [9] Cueto and Buonocore used 50% phosphoric acid buffered with 7% zinc oxide as etchant along with a mixture of methyl-methacrylate monomer and powder from silicate cements as the sealant in their first study. After a clinical follow-up of 1 year, they reported, a caries reduction of 87% with 71% complete retention of the sealant material. [10] Literature presents only one report of adverse reaction with use of pit and fissure sealants. [11]

Pit and fissure sealants should be directed to teeth susceptible to a high risk of caries instead of all teeth with pits and fissures. Clinical studies show reduction in caries progression by more than 70% by placing dental sealant in comparison to no treatment. [12] Ultraviolet activated, auto-polymerized or light cure resin-based sealant and glass ionomer cement sealants (GIC) are various types currently employed in the clinical practice. Resin based sealants have shown to have a higher retention rate compared to GIC sealants. Sealants materials and their method of application have continued to advance over the last three decades of research with a major breakthrough made by Feigal and colleagues [13] who reported an improved sealant retention by use of bonding agent between the sealant and saliva-contaminated enamel.

The following review aims at discussing the various sealant materials currently available with their advantages and disadvantages and a special focus of the effects of bisphenol-A, a regular component of dental sealants.

DENTAL SEALANT MATERIALS

Pit and fissure sealant can be broadly classified into three types with glass ionomer based-sealant and resin-based sealant forming a predominant portion of the currently available materials (figure 1). [14]

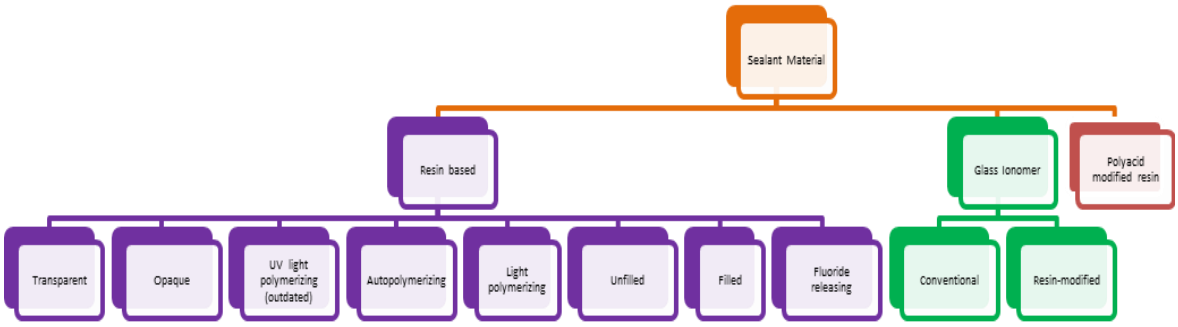

Figure 1: Classification of sealant material14

RESIN-BASED SEALANT

Based on polymerization reaction, resin-based sealants are classified into four generation.

Nuva-Seal, the pioneer of resin based sealants, is a first generation sealant, which utilized ultraviolet (UV) light to undertake polymerization reaction. This resin-based sealant is now redundant and no longer used. [15] The second-generation resin-based sealants falls under the category of auto-polymerizing / chemically cured sealants which contain tertiary amine as an activator. The reaction generates Free radicals which help in initiation of the polymerization reaction. [14] Third generation sealants are again photo-initiators but, they utilize visible light unlike the first generation. These photo-initiators are sensitive to visible blue light in the wavelength region of 470nm and do not begin setting reaction until adequately exposed. [16] Visible light cured sealants have better qualities over the previous generation in that they provide a longer working duration with a reduced setting time of 10-20 seconds. Nullifying the mixing of components in the third generation also leads to reduced incorporation of air bubbles during sealant application. [17] The fourth-generation sealants are similar to second generation but has added fluoride releasing particles with an aim of inhibiting caries. This type of sealants are not considered as fluoride reservoir providing a long term release, thereby providing no additional clinical benefit to light-polymerizing sealants. [18, 19, 20]

According to viscosity, resin-based sealant can be classified as filled or unfilled. Addition of fillers provides small effect on clinical outcome. Although they provide higher wear resistance, their fissure penetration ability is low, requiring additional occlusal adjustments which lengthen the clinical procedure. The unfilled sealant, due to its low viscosity provides greater penetration and better retention properties. [17, 21]

According to translucency, sealant materials can also be classified into opaque and transparent. [17] Transparent materials can be pink, clear or amber while opaque materials are either white or tooth-colored. As compared to tooth colored opaque or clear sealants, white opaque fissure sealant materials are easier to visualize during application as well as clinically detect on recall examinations. [14] Though the choice of sealant material is a matter of personal-preference, clinical study has shown identification error was only 1% with use of opaque resins compared to 23% error with clear sealants. [22]

With advances in technology, color changing property has been incorporated in resin-based sealants. The color change property can be seen either in the phase after polymerization, such as in Helioseal clear (Ivoclar Vivadent, Schaan, Liechtenstein) or in curing phase, such as in Clinpro (3M ESPE, Saint Paul, MN, USA). The advantage of this technology has not yet been fully proven, but better recognition of sealed surface is a proposed advantage offered by this technology. [14, 17]

Light polymerizing, unfilled, opaque sealant therefore seems to be the most suitable choice of resin-based sealant.

GLASS IONOMER SEALANT MATERIALS

Conventional glass ionomer (GI) materials have also been used as pit and fissure sealants. [14] It undertakes an acid-base reaction between polyacrylic acid solution and fluoroaluminosilicate glass powder which enables chemical bonding of the material to enamel and dentin. [23] GI sealants are superior in their properties of continuous fluoride release and fluoride recharging ability. GI sealants can be classified into low and high viscosity materials. Fuji iii, an old generation dement, is one of the most commonly used GI sealant in clinical studies which has shown to have poor physical properties with low viscosity. Fuji Triage vii (GC, Tokyo, Japan), has now replaced this sealant and is designed to release a higher amount of fluoride and has better physical properties. [24] Fuji ix (GC, Tokyo, Japan) and high viscosity glass ionomer cement (HVGIC) such as Ketac Molar Easymix (3M ESPE, Seefeld, Germany) has been used in studies following atraumatic restorative treatment (ART) approach.

In resin-modified glass ionomer (RMGI) sealant, resin is incorporated with GI. RMGI has also been used as a pit and fissure sealant materials. It has shown improved physical characteristics owing to addition of resin component as compared to conventional sealant. In fact, RMGI has less sensitivity to water and longer working time compared to conventional GI. [16] RMGI get activated by photoactivation of the resin component, followed by the acid-base reaction for the ionomer component making them a dual cured agent. [25]

Compared to the hydrophobic resin-based sealant, it is moisture-friendly and easier to place. [16] They can be conveniently placed in partially erupted permanent teeth, even in those with distal operculum as a transitional sealant. [26] In deeply fissured primary molars that are difficult to isolate, due to a child's pre-cooperative behavior, GI sealant can be used. [14] However they act as provisional material needing replacement when better isolation is possible. [27]

POLYACID-MODIFIED RESIN BASED SEALANTS

Also referred to as compomers, polyacid modified resin based sealants combine the advantageous properties of GI

sealant such as fluoride releasing property with those of visible light polymerized resin-based sealant. Compared to glass ionomer sealant, it is less water soluble and has a better adhesion property to enamel and dentin. [28] They are also less technique sensitive compared to resin-based sealant.

SEALANT EFFECTIVENESS

Dental sealant can be very effective against pit and fissure decay. Post application, they prevent about 80% of caries progression for two years. They play an important role in preventing progression of caries in deep pit and fissure, where caries progression is more likely to occur. They could also have an effect on overall count of Streptococcus mutans. [14]

CARIES RISK BETWEEN SEALANT PROTECTIVE AND NO SEALANT TOOTH

In the literature, role of fissure sealant in caries prevention is well established. Sealant reduced the risk of caries on sound occlusal surface by 74%, compared to the no use of sealant during the two to three year of follow up period, according to moderate quantity of evidence. [29] A recent update of a Cochrane review evaluated the caries preventive effect of sealant in children and adolescent aged between 5 and 16 years old, compared with a no sealant control group, there was 7924 participants and 38 trials were included. Fifteen trials compared resin-based sealant with no sealant, when applied on first permanent premolar. The evidence showed that caries increment reduced around 11% to 51% in two year follow-up period. Application of sealant reduced the caries risk from 40% to 6.25%. At longer follow up period of 48 to 54 months, caries preventive effect was retained but quality of evidence was low. [30] When GIC sealants are applied instead of resin-based sealant, no conclusion could be drawn due to very poor quality of evidence. [15, 31]

COMPARISON OF DIFFERENT TYPES OF SEALANT

FILLED versus UNFILLED

Penetration is inversely proportional to viscosity. It is an important yet poorly recognized factor in sealant application and retention. For unfilled resin, it could be reasoned that unfilled resin will penetrate deeper into the tissue system, therefore perhaps be better retained. [18] In an in-vivo study comparing unfilled and filled sealant, it was found that unfilled light cured resin sealant had significantly better retention than filled light cured sealant. Also, unfilled sealant was superior to filled sealant in preventing microleakage after conventional bur and air abrasion preparation of pit and fissure. [32] For filled sealant occlusion adjustment is required, as routine part of application procedure which increase the time and cost. Unfilled sealant does not require occlusal adjustment and abrades rapidly, within 24 to 48 hours, if left in improper occlusion.

COLORED versus CLEAR

3M's concise white sealant is the first colored sealant to be introduced in US market in 1977. There are some advantages of colored sealant over clear sealant as long it is esthetically acceptable. It is easier to document retention of colored sealant over long time period. [33] Some color is incorporated in either the polymerized phase [Helicoseal clear chroma, Ivoclarvivadent, Amherst, NY] or in curing phase [Clinpro, 3M ESPE, St. Paul, Minn]. The color changing sealant have some clinical utility for example; Helicoseal changes its color from clear to green on exposure to light which benefits the dentist in subsequent follow up examination. But the usefulness of color change technique remains a perceived marketing benefit because one cannot argue that it is easy to see opaque sealant compared to white sealant. In an interesting study carried out by Rock, it was found that identification error rate was only 1% with opaque resin based compound while it was 23% with clear resin. Most

common error with clear resin is to identify its presence on untreated tooth. [22]

AUTOCURE versus LIGHTCURE

In one study, it was concluded that auto polymerizing resin performed better than early ultraviolet light-initiated resin sealant because former shows 84% complete retention at two years compared to 74% shown by later. [34] No significant differences were found with visible light cured resin in retention over 31 months. Thus, both self-cure and visible light-cure materials provide equal effectiveness in terms of both retention and caries prevention. [35]

IMPROVEMENT IN DENTAL SEALANT

With advancement of dental material and technique changes in sealant placement, improvement is recorded in sealant retention and effectiveness. The improvement in sealant materials may dramatically change the cost-benefit calculation. [36]

Fluoride is incorporated in dental sealant but there are no clinical studies to suggest its benefit. Fluoride availability and release is very less from the sealant compared to other dental material such as GIC. [37] It only increases the availability of resin since fluoride is less bound in chemistry. Its role in sealant improvement is yet to be proven clinically.

Bonding agent is used between sealant and etched enamel surface. In this technique, bonding primer and adhesive layer is applied. It improves bond strength and minimizes microleakage. Bonding agent also reduces the risk of sealant failure in occlusal, buccal and lingual surface. Use of self-etching primer and adhesive combination make the steps simple, which are involved in sealant application with equivalent sealant retention. Such simplifications minimize the time of treatment, potential errors in technique and reduce the need for patient compliance. Two years data shows that, as compared to normal etch and seal method, self-etching primer show equivalent retention on occlusion, buccal and lingual surface of permanent molar teeth. [38]

GIC was used as sealant, but it is brittle and susceptible to fracture under the effect of masticatory forces, therefore it cannot be used on occlusal surface. In some instances, it can be used as an interim preventive material on occlusal surface, before molar is completely erupted. GI, which can flow in pit and fissure well, have been shown to be an effective sealant over the evaluation period of 3.6 years. [39,40,41, 42]

HARMFUL AND TOXIC EFFECT OF BISPHENOL-A

Bisphenol-A is a precursor chemical component of bisphenol-A-di-methacrylate [Bis-DMA] and bisphenol-A-glycidyl dimethacrylate. These are important components of monomer in composite resin restoration and resin sealant. It is known for its estrogenic property with potential reproductive and developmental human toxicity. [43, 44] In monomer, it is not present as a raw material but a bisphenol-A derivative which can be hydrolyzed and present itself in saliva. [15] After placement of pit and fissure sealant, immediately or after an hour, bisphenol-A can be demonstrated in saliva and urine sample. [45] However, a report by the American dental association and the American academy of pediatric dentistry does not support the harmful effect occurred after sealant placement and described its effect as a small transient effect. [46,14] Some studies have reported technique that after sealant placement, if sealant surface is immediately cleaned and oxygen inhibition layer of unreacted monomer, which is present on outer surface of sealant is removed by using pumice or a rotatory rubber cup, potential exposure to bisphenol-A is reduced. [14]

SUMMARY

In this review article, we discuss about the dental sealant under the following heading

1. Sealant effectiveness.

2. Caries risk between sealant protective and no sealant teeth.
3. Comparison of different type of sealant.
4. Improvement in dental sealant.
5. Harmful effect of bisphenol-A.

CONCLUSION

Pit and fissure sealants are an effective way of caries prevention. They are applied on deep pits and fissures of caries susceptible tooth, thereby preventing caries progression. With advances in dental materials and development of newer techniques, sealant retention and its effectiveness has improved over time. A range of sealants are available with each having their own set of advantages. However, they also exhibit a small transient toxic effect due to release of bisphenol-A.

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