A Review of Glass Ionomer as 'ART' Sealant

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Abstract

Pit and fissure sealants are a highly effective method for prevention of dental caries by forming a physical barrier, preventing accumulation of micro-organisms and food debris in the fissures. Currently, resin-based sealants and glass-ionomer sealants are the two main forms of sealants used clinically. Resin-based sealants are highly moisture sensitive and hence, glass-ionomer sealants which are less sensitive to moisture are used. With the advent of the Atraumatic Restorative Treatment (ART), high-viscosity glass-ionomers were introduced as ART sealant, which are retained longer than low and medium viscosity glass-ionomers, but shorter than resin-based sealant materials. Use of ART sealants is an effective caries preventive approach in partially erupted young permanent molars of children and in community based dental programs where electrically powered dental equipment is not available.

Keywords: *Atraumatic restorative treatment, Resin-based sealants, Glass-ionomer sealants.*

Introduction

Pit and fissure sealants are highly effective method that helps in preventing caries development and arresting caries progression, by forming a physical barrier which helps in preventing accumulation of micro-organisms and food debris in the fissures(1). In the current scenario, resin-based sealants and glass-ionomer sealants are the two main forms of sealants used clinically. However, the efficiency of resin-based pit and fissure sealant in preventing occlusal caries is dependant primarily on the retention of sealant mainly the moisture control, which may not be available in some situations like community based dental programs, uncooperative children, partially erupted permanent molars and contamination of the operating field.(2,3) In these conditions, the rate of failure are higher for resin-based sealants and hence glass-ionomer based sealants can be used which are less moisture sensitive.(2)

Glass-ionomer materials are easy to apply than resin sealants and chemically bond to the tooth structure and release fluoride, which contributes to caries prevention.(4) Glass-ionomer sealants have the disadvantage of poor retention and reduced strength, hence strengthened high viscous glass-ionomer sealant can be used, using Atraumatic Restorative Treatment (ART) technique.(4,5) ART is a preventive and restorative technique implemented 25 years ago, in management of dental caries in underprivileged populations. ART approach involves the restoration of tooth cavities and sealing of caries-prone pits and fissures.(6) For ART, the material of choice is strengthened highly viscous glass-ionomer cement, which has rapid setting property, significantly decreased sensitivity to moisture during the initial setting stage and decreased solubility in oral fluids, which makes it suitable to be used as sealants.(7) Application of ART sealant uses a form of glass-ionomer cement material to seal pits and fissures

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using a "finger-press" technique similar to that used in the ART restoration procedure. When comparing to low viscosity glass-ionomer sealant it has been observed that retention rate of ART sealants was higher.[8]For a long term, low-viscosity glass-ionomers with the powder liquid ratio less than 1.5:1 was used although it had poor retention and did provide caries preventive effect. Till mid 1990s medium-viscosity glass-ionomers sealants but over the years it was replaced by the high-viscosity glass-ionomers.[9]

When are ART sealants indicated?: Children with high caries risk, with presence of decay in primary dentition, tortuous pits and fissures on non-carious teeth and persistent enamel lesions are indicated for use of ART.[10] Application of sealants to deep pits and fissures, regardless of child's risk status must be deemed over-treatment.

In comparison to the resin-based sealants, glass-ionomers are hydrophilic in nature and hence they are indicated in partially erupted molars, where the operculum covers the distal half of the tooth and releases crevicular fluid. In case of moist to dampened conditions, application of resin-based pit and fissure sealant is contra indicated as they are Bis-GMA based materials, which are mainly hydrophobic in nature and necessitates a dry field. Electrically powered dental equipment and good clinical conditions are required for placement of high quality resin-based sealant. In community based programs where availability of modern equipment is limited, ART sealants should be the choice of sealants.[2]

Placement of ART sealants: The technique is characterised by the "press-finger" method, which ensures that the sealant penetrates deep into the pits and fissures.[8]A thorough oral prophylaxis and polishing, is followed by rinsing with water to remove any traces of polishing material. Isolation of the tooth is done with cotton rolls and kept free from saliva. 10% polyacrylic acid conditioner is applied on the fissures for 20 sec,rinsed with water for 20 sec and dried by blotting with cotton pellets and gently blowing with an air syringe. Care should be taken not to desiccate the enamel surface. Glass-ionomer cement is mixed in accordance to the manufacturer's instruction and applied using the round end of the ART applier/carver in all pits and fissures or agitate the encapsulated glass-ionomer in an appropriate mixing machine and the material is expelled into deep retentive grooves. A thin layer of petroleum jelly is applied on to the gloved finger and pressed against the sealant, such that the sealant is pressed deeply into the grooves and after 10-15 sec, the finger is removed sideways and excess cement which is visible is removed using carver/excavator (press finger technique).[11] Bite is checked using articulating paper and adjusted until comfortable. When the mixture is partially set, petroleum jelly is removed from the top surface and a new layer is applied. To surmount the problem of moisture sensitivity and to retain the water balance during maturation, petroleum jelly is applied over the sealant material immediately following the initial set. Patient is asked not to eat for at least one hour.[4,12]

Clinical performance of low viscosity ART sealants: In a systematic review by Beiruti et al [5]on the effectiveness of prevention of caries by resin sealants in comparison to low-viscosity glass-ionomer sealants, out of 12 eligible publications analyzed, two studies depicted statistically significant difference in caries prevention. After 3.8 years, in one study, low viscosity glass-ionomer sealant performed better, while after 3 years the auto-curing resin composite sealant performed better in another study. Four studies reported results of more than 3 to 7 years, of which two studies reported statistically significant difference in the two forms of sealants in preventing development of dentine lesions. However, due to lack of enough studies the systematic review was unable to prove that either of these materials was superior to the other. A critical review by Simonsen[13] suggested that the efficiency of caries-prevention was equivocal between composite resin and glass-ionomer sealants. However, retention rate of composite resin sealants is higher in comparison to low viscosity glass-ionomer sealants. Torppa-Saarinen and Seppa [14] also reported low retention rate of low-viscosity glass-ionomer. They examined the pits and fissures of recently erupted permanent second molars and premolars under scanning electron microscope (SEM) which had partial or complete loss of low-viscosity glass-ionomer sealant after 4 months. In majority of the cases examined, the deepest part of the grooves showed presence of low viscosity glass-ionomer. The small quantities of sealants are left at the bottom of the fissures tend to release fluoride and serves as a plug and the tags of glass-ionomer cement persist when applied even under moist conditions.[9,15] The remnants render the pit and fissures to be of less than normal depth, thus permitting better plaque control and prevention of demineralization.[12] Invitro studies[15,16] have revealed

initial release of large amount of fluoride from the glass-ionomer cement (burst effect). The fluoride release continues over the next few weeks, possibly due to slow dissolution of the glass particles into acidified water of the hydrogel matrix. Thus, inspite of the loss observed during examination, protection of the fissures against dental caries continues both due to physical presence of the tags, release of fluoride which help in enamel remineralization and increase in surrounding enamel resistance to demineralization.[17]

Clinical performance of high viscosity ART sealants: With the introduction of high-viscosity glass-ionomers, the rate of retention of glass-ionomer (ART) sealants increased significantly compared with that of previously used low and medium viscosity glass-ionomers.[6,8]Better retention of ART sealants is due to better mechanical strength and due to application procedure using press finger technique, resulting in better penetration of the material into the fissures.[18] A meta-analysis exhibited a weighted mean score of 71% after 3 years for completely and partially retained ART high viscosity glassionomer sealants, while during the 3 year observation period the caries-preventive value was 97%[8]. Systematic review by Mickenautsch and Yengopal[19] suggested that teeth sealed with high viscosity glass-ionomer cement are 71% less likely to be affected by dentine carious lesions than if sealed with composite resin.

Multiple studies have shown that the effectiveness of caries-prevention of high viscosity glass-ionomer sealants applied using ART was higher than that of resin sealants.[3,5] In a study carried out in newly erupted permanent molars, where it is difficult to isolate the tooth from saliva contamination during sealant application, at 5 year follow up, 29% of glass-ionomer sealants applied with ART procedure were retained, whereas only 21% of resin sealants were retained. 22% of teeth developed caries in the resin group in comparison to 11% in the glass-ionomer group[3]. Similar findings were seen by Taifour et al.[20] They concluded that ART sealants is an effective measure for caries prevention in newly erupted molars among children with high risk of caries. Compared to the complete and partial-retention survival percentage of resin-based sealants, the comparable retention survival of high viscosity glass-ionomer sealants used according to ART technique is lower.[6,12] On the other hand, Hilgert et al[18] did not find difference between the retention rate of resin sealants and glass-ionomer ART sealants at 3 year follow up. In this study[18], as well as a study carried out in Chinese population[6], occurrence of new carious lesion lagged sealant survival. Caries prevention remained high, 85% at 6 year follow up. However, to prevent cavitation it was recommended that missing sealants should be further resealed.

Use of additional measures such as application of topical fluorides or application of curing light does not improve the caries preventing ability of ART sealants. This was shown in a study by Liu et al [4], where application of sodium fluoride or silver diamine fluoride did provide any additional benefit. In another study, Chen et al [21], did not find any additional benefit in caries preventing ability of ART sealant by addition of light curing of the glass-ionomer sealant.

For describing the success rate of a sealant, retention of sealant alone should not be considered as the endpoint, as the biological outcomes take preference over mechanical outcomes.[12] Complete retention of fissure sealants is therefore not a valid surrogate endpoint for evaluating their caries-preventive effect. The caries preventive effect is more significant than sealant survival.[19] The reason for better caries prevention ART sealants was further investigated by Frencken and Wolke.[15] They evaluated high viscosity glass-ionomer sealants placed according to ART technique under SEM. Traces of high viscosity glass-ionomer sealant material were left behind in the deeper parts of pits and fissures that clinically appeared to be free of sealant material. These remnants of sealants retain probably because unlike resin-based materials, which tend to have adhesive fracture, glass-ionomer fractures cohesively.

Comparison of ART sealants with other pit and fissure caries prevention method: A study by Cabral et al[22] compared the effectiveness of preventing caries and the retention rates of resin modified glass-ionomer based fluoride varnish used as pit and fissure sealants and high viscosity glass-ionomer sealant applied according to ART approach. High-viscosity GIC performed better than the resin modified GIC based fluoride varnish over 2 years in terms of retention, however, results were not statistically significant for caries prevention. Monse et al [23] measured and compared the impact of a single application of 38% SDF with ART sealants and no treatment for the prevention of caries on the occlusal surfaces, with a school-based tooth brushing program with fluoride over 18 months. They concluded that single application of 38% SDF is not an efficient technique in preventing carious lesion.

Thus, in comparison to other materials like glass-ionomer based fluoride varnish and silver diamine fluoride, ART sealants have better retention as well as caries preventing ability.

Adding to the benefit of glass-ionomer as ART sealants, most of the resin-based sealants release Bisphenol A (BPA) derivatives which have been known to cause various biological disorders.[12]In accordance with this evidence a policy statement on BPA was issued by the World Dental Association (FDI). This policy discouraged the need of manufacturing of BPA containing dental materials, raised awareness and emphasized the need of preventing caries.[24] Therefore use of ART sealants with their high level of effectiveness, has a future scope in caries management.

Further studies are required to prove the effectiveness of high viscosity glass-ionomer sealants in caries prevention as the current studies are limited by risk of bias, lack of sufficient sample size and inadequate randomization. Hence, the choice of high viscosity glass-ionomer sealant for caries prevention of fully erupted permanent molars should be done cautiously based on clinical indications.

Conclusion

Retention and caries prevention of high viscosity glass-ionomer sealant appears to be longer in comparison to low and medium viscosity, although it is shorter than resin-based sealants. The use of ART sealants in permanent teeth to prevent and treat tooth decay is shown to be highly appropriate, effective and acceptable. It is an effective caries preventive approach in partially erupted young permanent molars of children and in community based dental programs where electrically powered dental equipment is not available.

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