The Use of Fissure Sealants in MIH-Affected Posterior Teeth

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11.1 Introduction

Pit and fissure sealants have been used for nearly 50 years to prevent and control fissure caries, by preventing bacteria biofilm growth that can lead to dental decay. When applied on occlusal surfaces of permanent molars, they are effective for preventing caries in children and adolescents, while their effectiveness is closely related to the longevity of sealant coverage (i.e. clinical retention). There is moderate-quality evidence that 48 months following placement, resin-based sealants reduced caries by between 11% and 51% when compared to no sealant placement; longer follow-up periods, however, have reduced quantity and quality of evidence [1].

First permanent molars affected by MIH require preventive care, as there is a high risk of posteruptive breakdown and acidogenic challenges of the oral cavity. Once the breakdown occurs, the subsurface enamel and/or dentin is exposed, resulting in sensitivity to cold, heat and brushing and possibly in further accumulation of plaque and development of caries [2, 3]. Moreover, MIH-affected enamel exhibits disorganized enamel prisms, porous structure, low mineral content and loosely packed crystallites, characteristics correlated with reduced strength and hardness [4–6]. These features can explain the risk of rapid caries development and restoration failures. Molars that are affected by MIH undergo dental treatment nearly 10 times more often compared with molars without MIH [7].

As a result of the previous, it is very important to start an enhanced preventive program as soon as MIH teeth erupt [2, 8]. In addition to other preventive approaches (e.g., fluoride varnishes, casein products, etc.,) resin sealant treatment for MIH molars is considered a valuable and effective preventive measure [8]. Fissure sealants should be placed before breakdown occurs and when the tooth is fully erupted

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and moisture control is adequate. In such cases of not adequate isolation during eruption, glass ionomer cements (GIC) can be considered as an interim preventive option [1, 2, 8]. An early diagnosis combined with the evaluation of the severity of the condition and the patients' dental age and expectations will facilitate proper timing for sealant placement.

The few clinical studies in the literature have shown that for intact hypomineralized molars, resin-based fissure sealants with adhesive application prior to placement are recommended, and for patients with spontaneous hypersensitivity of posterior teeth, sealants and professional application of fluoride varnishes are reported as the appropriate preventive approach [2, 3, 8].

11.2 Clinical Procedure

11.2.1 Isolation

Adequate isolation is the most critical aspect of fissure sealant application. If the enamel porosity created by the etching procedure is filled by any kind of liquid, the formation of resin tags in the enamel is blocked or reduced and the resin is poorly retained. Salivary contamination, during and after acid etching, also allows the precipitation of glycoproteins onto the enamel surface, greatly decreasing the bond strength of the fissure sealant [9]. If this occurs, re-etching is needed [10, 11]. The use of rubber dam is obviously the safest way of securing optimal moisture control, but in young and newly erupted teeth, this is usually not practical as it demands the use of local analgesia for the clamp placement. Additionally, there is sufficient evidence that careful isolation with cotton rolls gives similar retention results compared to rubber dam [9, 12]. The maintenance of a dry field can therefore usually be achieved using cotton rolls and isolation shields, in combination with a thoughtful use of the water spray and suction. However, the isolation procedure may occasionally be extremely challenging, particularly in the partially erupted teeth or in those children with poor cooperation.

11.2.2 Pretreatment

11.2.2.1 Mechanical Cleaning and Etching

Before etching, teeth should be cleaned with a bristle brush in a slow handpiece to remove any plaque or debris from the surface. Although mechanical cleaning of fissures using a round bur no. ¼ in a slow handpiece has shown conflicting results of better sealant retention in sound molars [13], its use in MIH molars might considerably enhance the retention rates of sealants. Removal of possibly defective enamel from the fissures allows better flow of the adhesive to their bottom, thus increasing sealant retention [12, 14]. Recently, the study of Hasanuddin et al. on fissure sealants in permanent molars with dental fluorosis, a defect with some structural similarities with MIH, reported higher retention rates for resin-based sealants when mechanical fissures preparation was included prior to the conventional etch and seal technique [15].

Following any type of occlusal surface cleaning, enamel is then etched with 37% phosphoric acid as usual. SEM studies have shown that regardless of the etching time, exposure of hypomineralized enamel to phosphoric acid fails to produce similar etching patterns seen in sound enamel [16]. This microstructural difference was attributed to the excess proteins in the hypomineralized enamel [4]. However, it needs to be stressed that most of the in vitro studies examine defective enamel and not the areas adjacent to the enamel defect, which have been shown to be less defective [17, 18]. Therefore, etching patterns in less defective areas might be closer to those of sound enamel, and this is probably the reason for increased retention rates when adhesives are used as it is shown below. Finally, previous findings in a classic study by Seow and Amaratunge in Amelogenesis Imperfecta hypomineralized variants reported that the etching patterns in these types of AI may occasionally resemble those of normal enamel despite the presence of hypomineralization abnormalities and morphological changes at the crystallite level [19].

11.2.2.2 Deproteinization

Few studies suggest that application of 5% sodium hypochlorite (NaOCl) for 60 s after etching (deproteinization) enhanced enamel bonding in teeth affected by MIH by removing excess protein content from the tooth surface [20–22]. The above studies looked at shear bond strength and success rates of composite restorations when NaOCl is applied following etching of the hypomineralized enamel. However, differences in both materials and methods used in the studies do not allow clear conclusions.

Kraemer et al. in a recent in vivo study showed that following etching, additional pretreatment of affected enamel with NaOCl did not enhance enamel bonding, while previously Gandhi et al. showed that when NaOCl is used before etching, there seems to be no difference compared to the conventional etch and bond technique [23, 24]. Crombie et al. also showed failure of pretreatment with NaOCl to promote deeper penetration of resin infiltrant materials into the hypomineralized enamel [25].

As only a few studies have been conducted in this area with conflicting results, it is difficult to draw definitive conclusions. Even if some of them support deproteinization for the placement of composite restorations on teeth with hypomineralized enamel, there are no studies investigating the use of deproteinization for sealant application [26]. Hence, further high-quality in vivo and in vitro studies are needed in this area.

11.2.2.3 Adhesion/Bonding

For hypomineralized enamel which during treatment undergoes chemical, mechanical and morphological alterations, adhesion is a key factor for the success of any resin restoration or sealant application [5, 26]. The literature on adhesion in hypomineralized enamel is still limited, especially regarding its use in sealants [14, 23, 26].

Bonding to hypomineralized enamel of MIH-affected teeth is very challenging [8, 27]. The enamel-resin adhesive interface has been found to be weaker in

MIH-affected first permanent molars, compared to sound teeth, possibly because of limited interprismatic enamel dissolution, higher porosity, greater organic content and lower microtag formation in affected enamel [4, 16, 21, 28]. However, in vitro research has shown that adhesion to hypomineralized enamel although less effective is still possible, as the enamel surrounding clinically defective lesions is less affected [4, 17, 18]. The use of modern adhesive systems may further enhance bonding to the hypomineralized enamel, increasing the success rates of composite resin restorations and sealants to MIH teeth.

Results regarding the use of an adhesive prior to fissure sealant in MIH molars are conflicting [29]. In one of the first studies on fissure sealant retention following adhesives application, it was clearly shown that these factors helped substantially in sealant retention in cases of molars with enamel "alterations" as they were described that time [30]. Lygidakis et al. reported that fissure sealants applied using a fifth-generation adhesive after the etchant had a higher retention rate than those applied without it and that by using adhesives, sealant retention rate in MIH molars approached that of sound teeth (Table 11.1) [8, 14]. A possible explanation for this result would be that the currently available single-bottle adhesives have a great ability to flow deeply into capillary-like spaces of the etched enamel surface and promote an optimal resin tag penetration and enhanced adhesion. The hydrophilic monomers present in the contemporary bonding agents increase the surface wetting and resin penetration [26].

The type of adhesive used for bonding to hypomineralized enamel may also play a role. William et al. suggested that self-etching adhesives have superior bond strength to hypomineralized enamel compared with all-etch single-bottle adhesives possibly attributed to omitting of rinsing, thus eliminating the interference of residual water on the bond [16]. However, the hydrophilic properties of acetone included

Table 11.1 Clinical trials on resin-based sealants (RBS) retention on MIH-affected teeth

Authors (year)	Participants (no. of teeth)	Intervention	Materials/ technique used	Follow-up (months)	Results
Kotsanos et al. (2005)	I: 35 treatment II: 90 control	I: RBS on MIH teeth II: RBS on control teeth	N/A	I: 33 II: 55	I: 77.1% retention II: 82.3% retention
Lygidakis et al. (2009)	I: 47 treatment II: 47 control	I: RBS on MIH teeth with use of fifth-generation adhesive II: RBS on MIH teeth without the use of adhesive	Mechanical fissure cleaning using a round bur no. ¼ Fissurit® One-step®	48	I: 70% fully sealed, 30% partially sealed II: 26% fully sealed, 45% partially sealed, 29% failed
Fragelli et al. (2017)	I: 16 treatment II: 25 control	I: RBS on MIH teeth II: RBS on control teeth	Fissurit®	18	I: 72% retention II: 62% retention

in some of the single-bottle adhesives systems may play the same role for removing the residual water from the etched enamel, increasing the available for bonding enamel surface [2, 14]. Finally, the recent study by Kraemer et al. showed that a two-step self-etch adhesive revealed lower values of microtensile bond strength compared with two- and three-step etch-and-rinse adhesives, while the systematic review of Ekambaram and Yiu further concluded that there is no sufficient evidence to prove that self-etch dental adhesives bond better to hypomineralized enamel [23, 26].

11.2.3 Sealant Application

The selected pit and fissure sealants are applied and photopolymerized according to the manufacturer's instructions [14]. The surface is checked for deficiencies, and sealant is added if needed. Regarding the type of sealant used, Hasanuddin et al. evaluated the retention of fissure sealants in permanent molars with dental fluorosis, defect with some structural similarities with MIH, reporting significantly higher sealant retention when applying resin based than when using glass ionomer sealants [15]. However, the Cochrane Database systematic review by Ahovuo-Saloranta et al. concludes that, regarding sound molars, "the relative effectiveness of different types of sealants is unknown, due to very low-quality evidence" [1]. There is no evidence concerning the use of different types of sealants in MIH-affected teeth.

11.3 Success Rates

The effectiveness of resin-based sealants is related to their retention, which in normal teeth appears high in many studies. At 12 and 24 months follow-up, resin sealants are retained completely on average in 80% of cases. After 48–54 months, most studies reported 70% retention of sealants [1]. On the contrary, in MIH molars, enamel alterations leading to inferior enamel-sealant bond strength result to lower retention rates, as confirmed by the systematic review of Elhennawy and Schwendicke [31].

There is conflicting evidence however on the success rate of resin-based sealants on molars with MIH compared to sound molars, as to date there are only three studies evaluating the retention of resin-based sealants [29]. Kotsanos et al. and Fragelli et al. compared success rate of sealants on MIH-affected molars with sealants on sound molars, while Lygidakis et al. compared sealants on MIH, with or without the use of fifth-generation adhesives (Table 11.1) [14, 32, 33].

Kotsanos et al. performed a retrospective study evaluating 35 teeth with MIH, 52.2 (±34) months after application of resin-based sealants and compared them with 90 resin-based sealants on unaffected molars, which were evaluated after 53.5 (±25.1) months. From the MIH group, 22.9% of the sealants needed retreatment, while on the control group, 17.7% needed retreatment. Sealants in MIH molars were found to need retreatment almost 2 years earlier than sealants in the control group and were three times more at failure risk compared to those on control teeth [32]. The characteristics of that study were the inclusion of the sealed MIH molars within a larger-scale study including all types of restorations on affected molars, the diversity of follow-up period of affected and control teeth and the absence of technique and materials details. Considering however the period this study was performed, most possible treatment approach would have been the "standard" etch and seal technique.

Fragelli et al. in a prospective study evaluated 41 MIH molars 18 months after application of fluoridated resin-based sealants using rubber dam. All molar teeth had mild defects with white, yellow, and brown opacities and received a weekly application of fluoride varnish for a month before application of the sealants. Sealants were applied with a "standard" etch and seal technique and revealed a retention rate of 62% on sound molars and 72% on molars with MIH, presenting no statistical difference. During the follow-up period, from the 13 sealant failures observed, only 2 were associated with caries, both in the MIH-affected group [33]. Findings regarding caries highlight the greater risk of developing carious lesions in patients with MIH [34]. It was concluded that sealant application may be an effective approach to preventing carious lesions in MIH-affected first permanent molars [33]. The characteristics of that study was the pretreatment of the molars with four weekly applications of fluoride varnish, the use of rubber dam for isolation during treatment of sealed molars and the use of the "standard" etch and seal technique.

Lygidakis et al. in a double-blind split mouth study evaluated prospectively 94 molars with mild MIH, 4 years after application of a fluoridated resin-based sealant using cotton roll isolation, mechanical cleaning of the fissures and with or without the use of adhesive prior to sealant placement. In the end of the study period, treated molars were recorded as fully sealed, partially sealed and with sealant lost. When the resin-based sealant was applied without the adhesive, 26% molars remained fully sealed and 45% partly sealed after 4 years, while total sealant loss was seen in 29% of the molars. When resin-based sealant was applied using the fifth-generation adhesive prior to sealant placement, then the retention rate was significantly better at 70% fully sealed and 30% partly sealed molars, without any case of total sealant loss [14]. The later 4-year results are compatible with those described previously for the retention rate of light-cured resin-based sealant to sound molars using the "standard" etch and seal technique [1, 9]. It seems safe to speculate that the use of single-bottled adhesives increases substantially the retention rates of sealants in MIH molars. A possible explanation has been given above in the section of "adhesion/bonding".

Previous studies in sound molars have also shown that sealant retention can be improved if a clinician applies a bonding agent that contains both an adhesive and a primer between the previously acid-etched enamel surface and the sealant material. A recent thorough systematic review and meta-analysis that evaluated five clinical studies from 2009 to 2016 has concluded that fifth- and sixth-generation adhesive systems beneath fissure sealants had "a significant positive effect on retention rates." Regarding the type of adhesive used, it was concluded that the use of etch-and-rinse systems is preferable to that of self-etching systems. The authors speculated that the better results with these adhesive systems can be attributed to the wetting quality of monomers such as hydroxyethylmethacrylate or to the newer functional monomers such as 10-MDP, which favour the diffusion process and improve adhesion to either dry or moist enamel. In addition, in the case of difficult isolation, the volatile solvents of adhesive systems such as ethanol or acetone can displace the trapped water to promote adhesion of sealant to the tooth [35].

Further research is needed on the use of sealants for MIH-affected first permanent molars for the (a) application at different stages of eruption, (b) use of different sealant materials and (c) use of etch-bond-seal technique. In addition, methodology of the studies should aim for high internal and external validity and longer follow-up periods, while split mouth design appears a very good method to compare interventions, such as sealants or restorations on MIH teeth, with a control in the same patient. This way, any outcomes (success or failures) obtained would most likely be a result of the tested intervention and not of the patient-related confounding factors [26].

11.4 Conclusions

- Fissure sealants should be placed in fully erupted MIH permanent molars, before breakdown occurs, and when moisture control is adequate. In cases of inadequate isolation during eruption, glass ionomer cements can be considered as an interim preventive option.
- Implementing the evidence presented above, the following clinical options should be considered for enhancing sealant retention in the hypomineralized enamel of MIH molars:
  – The use of mechanical cleaning of fissures using a round bur no. ¼ and a bristle brush in a slow handpiece.
  – The application of fifth- or sixth-generation adhesive systems according to the manufacturer's instructions, following enamel etching (i.e. etch-bond-seal technique).
  – Conflicting research results on enamel deproteinization with NaOCl does not support at present its regular use.

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