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Research Article

Effect of Dabbing Motion During Etching on Microleakage of Fissure Sealants: An *In vitro* Study

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Abstract

Introduction: The present study evaluated the effect of dabbing motion, which is a slow motion perpendicular to the tooth surface during tooth etching, on the microleakage of fissure sealants.

Methods: Thirty extracted sound premolar teeth were randomly assigned to two groups (n=15). In the case group, 37% phosphoric acid was applied on the occlusal surfaces of teeth with a dabbing motion; however, in the control group, the dabbing motion was not used. Clinpro fissure sealant was applied in both groups according to manufacturer's instructions and light-cured for 40 seconds at a light intensity of 500 mW/cm^2. Microleakage was evaluated quantitatively under a stereomicroscope in terms of dye penetration at sealant–tooth interface. Mann-Whitney test was used to compare the two groups. Statistical significance were set at P<0.05.

Results: The mean microleakage values in the case and control groups were 0.9 and 1.4 mm, respectively, with a significant difference between the two groups (P= 0.040).

Conclusion: The results showed that dabbing motion can decrease microleakage of fissure sealants; therefore, it can affect the clinical success of fissure sealants.

Keywords: Dabbing Motion; Microleakage; Fissure sealant; Etching; Tooth

Introduction

Pit and fissure caries is the most common type of caries in children and adolescent [1]. It is not possible to clean deep and narrow I-shaped and K-shaped pit and fissures and these surfaces are the most susceptible areas to the incidence of caries and a source of concern for dentists [2]. The occlusal surface comparises only 12.5% of the tooth surface; however, more than two-thirds of caries in children occur on this surface, especially during the eruption of the first permanent molar tooth when the enamel is still immature and the child and the parents are not usually aware of the eruption of this tooth [3].

The fissure sealant technique, which was introduced by Cueto and Bunocore in 1967, has had an established preventive effect on pit and fissure caries [4]. Fissure sealants prevent accumulation of microbial plaque and foodstuff in the fissures and result in remineralization of incipient caries and buffering of the acids produced by cariogenic bacteria [5].

Microleakage results in the penetration of bacteria, liquids, molecules and ions into the tooth–covering material interfaces, including fissure sealants [6]. The effect of fissure sealants on prevention of caries depends to a great degree on the retention and adaptation between the sealant material and the enamel and the sealing capacity of margins [2,7]. A poor seal leads to marginal microleakage, bacterial invasion and initiation and progression of caries beneath the sealant [2]. The ideal characteristics of a sealant include biocompatibility, retention and resistance to wear [3].

Since the time fissure sealants were introduced, etching has been one of the necessary steps in fissure sealant therapy [8]. Various techniques have been suggested for etching the enamel surface. Use of phosphoric acid is an acceptable and standard technique for creating surface roughness on the enamel, and currently application of 37% phosphoric acid for 15 seconds is the most commonly used etching technique. Etching results in the creation of microscopic porosities through selective removal of hydroxyapatite and penetration of the sealant into these porosities, improving retention and penetration; this gives rise to the formation of resin tags with an approximate length of 6–12 μm [3,8].

The dabbing or rubbing motion during etching had no effect on the shear bond strength of composite resin to enamel surface; however, significant differences were observed in the etching pattern under an electron microscope [9]. In one study, the rubbing motion on the enamel surface during etching had a deleterious effect on the bond strength between the composite resin and enamel [10].

Preparation of enamel with a bur and air abrasion improved the penetration and adaptation of the sealant and decreased microleakage. On the other hand, there was no significant difference between conventional acid etching alone and acid etching in association with preparation of enamel with a bur [11].

Two in vitro studies compared the microleakage of fissure sealants with the use of acid-etch and self-etch techniques; the results showed no significant differences between the two techniques [12,13]. However, another in vitro study showed significantly higher microleakage in the self-etch group compared to the acid-etch group [14]. Clinical studies have evaluated the success rates of fissure sealants in the two acid-etch and self-etch techniques during 6–24-month periods and some have reported higher success rats in the acid-etch group, with others reporting no significant differences between the two groups. However, a shorter clinical chair time has been reported in the self-etch group [15-17].

The present study was undertaken based on the discrepancies between the results of previous studies and the importance of the etching process in the longevity and efficacy of fissure sealants, which might affect the most important factor in the success of a restorative material, i.e. minimum microleakage. This in vitro study aimed to evaluated the effect of dabbling motion on the microleakage of fissure sealants so that its results would be used for more effective clinical use of sealants.

Material and Methods

Thirty sound and caries-free premolar teeth were selected for the purpose of this study and stored in 1% normal saline solution for up to 3 months before initiation of the study. The inclusion criteria consisted of no carious lesions, no cracks (the presence of cracks was evaluated under the unit headlight and with the use of a light-curing unit), no signs of fluorosis, extraction for orthodontic reasons and submitting an informed consent form.

After collecting the samples, the occlusal surface and central fissure were cleaned with some fluoride-free pumice slurry and polishing cups in a low-speed handpiece. Then the central fissure of each tooth was prepared with the use of a #¼ round bur (Jotta/Switzerland) up to a depth of 0.5 mm. Then the teeth were randomly assigned to two groups (n=15).

The case group

The occlusal surface was etched with 37% phosphoric acid (DiaDent, South Korea) for 20 seconds. During the etching process, the acid was gently applied to the tooth surface with the use of a microbrush in a dabbing motion (The dabbing motion is schematically shown in Figure 1).

Figure 1: The dabbing motion is schematically shown.

Then the occlusal surface was irrigated with water spray for 15 seconds, followed by irrigation with air-and-water spray for 15 seconds; finally, the occlusal surface was dried with an oil-free air stream for 10 seconds. In the next stage, Clinpro sealant (3 MESPE, USA) was applied to the fissures according to manufacturer's instructions and its excess was removed with a micro brush and the bubbles were removed with a dental explorer. Then the tooth surface was light-cured for 40 seconds with the use of a light-curing unit (Woodpecker, China) at a light intensity of 500 mW/cm2. Before light curing, the intensity of the light delivered by the unit was determined and the unit was calibrated after preparation of every 10 samples.

The control group

The procedures in this group were the same as those in the case group except for the fact that during the 20-second etching process, the dabbing motion was not used on the tooth surface.

Microleakage testing

The teeth were stored in distilled water for completion of polymerization. Then the samples in each group were separately wrapped in a thin lace piece of cloth and subjected to 500 rounds of thermocycling procedure at 55/5ºC, with 20 seconds at each temperature.

Then all the samples were prepared for immersion in a dye solution. To this end, the apex and furcation area of each tooth were sealed with sticky wax and all the tooth crown surfaces were covered with two layers of nail varnish up to 1.5 mm from the occlusal surface to prevent interferences of microleakage of other areas with that of the area in question that would result in erroneous results. After the nail varnish dried up, the teeth in each group were separately immersed in 0.5 basic fuchsine dye solution (Merck, Germany) for 24 hours [18].

After 24 hours, each sample was irrigated and sectioned in a buccolingual direction with the use of a diamond disk in a sectioning device (TC 3000, Vafaei Industries, Iran) under water spray to cool the disk and prevent damage to the fissure sealant and tooth. Then the mesial and distal cross-sections were evaluated under a stereomicroscope for the amount of microleakage. The microleakage was scored quantitatively under the stereomicroscope (TECHNICA, Germany) at ×20 magnification in terms of dye penetration at sealant–tooth interface.

Three independent observers evaluated dye penetration separately in each cross-section. The mean value for each cross-section was used to determine microleakage of that cross-section in mm.

Statistical analysis

For each mesial and distal section in each group there were 3 values in mm reported by the three independent observers, which indicated penetration of dye at sealant–tooth interface. The means and standard deviations of the value were used for statistical analyses in each group with SPSS 22. Mann-Whitney U test was used to compare the means between the two groups.

Results

Table 1 presents the means and standard deviations of the quantitative results of microleakage.

Group	Frequency	Mean (SD)
Case	20	0.9 (0.56)
Control	20	1.40 (0.74)

Table 1: Means (SD) microleakage (in mm) in the case and control groups.

Figures 2 and 3 show penetration of dye in the mesial half of one section in the case and control groups, respectively

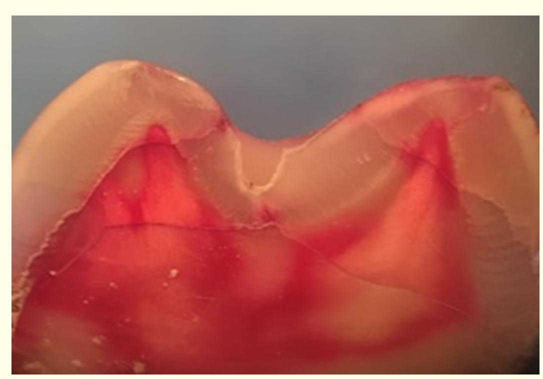

Figure 2: No penetration of dye in the mesial half of one section in the case group.

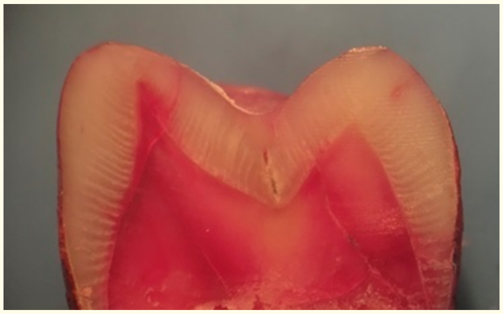

Figure 3: Penetration of dye in the mesial half of one section in the control group.

Five samples in each group were excluded from the study because they were damaged during sectioning. Each group consisted of 20 mesial and distal halves after sectioning and dye penetration at sealant–tooth interface was detected in all the sections in both groups. Table 2 shows comparison of dye penetration between the case and control groups, indicating significant differences between these two groups (P=0.040), with less dye penetration in the case group compared to the control group.

Group	Frequency	P-value
Case	20	0.040
Control	20	

Table 2: Comparison of dye penetration between the case and control groups.

Discussion

Pit and fissure caries on the occlusal surface of teeth occur more frequently than that on the smooth surfaces, which is due to the retention of plaque as a result of tooth morphology. Fissure sealants provide a physical barrier, preventing accumulation of micro organisms and food particles in pits and fissures. The most effective factor in the success of a restorative material is a minimum amount of microleakage; in the present *in vitro* study, the effect of dabbing motion was shown on decreasing microleakage of fissure sealants. The authors hypothesize that during etching with the use of dabbing motion fresh acid is always placed on the enamel surface and during the whole etching period, minerals are more effectively removed from the enamel surface. Therefore, more porosities are available on the enamel surface for penetration of resin tags. No similar study is available; however, the results of studies that have evaluated microleakage of fissure sealants are available. These studies have used different techniques to decrease microleakage and some are mentioned here:

- Bates., *et al*. evaluated the effect of dabbing and rubbing motions on the enamel–composite resin bond strength. The results of this *in vitro* study showed that the dabbing and rubbing motions or absence of motion during acid-etching procedure had no significant effect on the enamel tensile bond strength [19].
- Blackwood., *et al*. evaluated the effect of pumice slurry, enameloplasty and air abrasion on the microleakage of sealants and did not report any significant difference in microleakage between the three groups [20].
- Ansari., *et al*. evaluated the effect of prophylactic paste on microleakage of pit and fissure sealants and concluded that prophylaxis had a role in increasing retention of the sealant and elimination of this step resulted in an increase in microleakage [11].
- Youssef., *et al*. evaluated microleakage with different enamel preparation techniques before application of flowable composite resin as a pit and fissure sealant and reported that preparation and treatment of enamel surface with laser alone resulted in maximum microleakage [8].
- Ghasemi., *et al*. carried out an *in vitro* study on the microleakage of conventional fissure sealants and flowable composite resins in permanent teeth and reported no significant difference in microleakage between these two groups of materials [21].
- Kamal., *et al*. carried out an *in vitro* study to compare nanoleakage and resin tag lengths in three different sealants with the use of an electron microleakage and reported significantly less nanoleakage and larger resin tags in the Vertise Flow group compared to other groups [2].
- Khodadadi., *et al*. compared microleakage of flowable resin-reinforced glass-ionomer (Uniseal) with other materials

used as fissure sealants. The results showed that Uniseal without the use of an etchant and bonding agent exhibited significantly higher microleakage compared to other groups; however, after use of an etchant and a bonding agent, there were no significant differences in microleakage between Uniseal and other groups [22].

- Rahimian-Iman., *et al*. evaluated marginal microleakage in conventional fissure sealants and self-adhering composite resins in permanent teeth and concluded that self-adhering composite resin can be used as fissure sealants in permanent teeth [23].
- Meligy., *et al*. evaluated the effects of pumice slurry, enameloplasty, dentin adhesive agents and air abrasion on the microleakage of fissure sealants and concluded that prophylaxis withy pumice slurry is still the standard technique before fissure sealant therapy [24].
- Chaitra., *et al*. carried out an *in vitro* study to evaluate microleakage of flowable composite resins as fissure sealants in molars with the use of enameloplasty, fissurotomy and conventional techniques and concluded that enameloplasty is the best technique to prepare pits and fissures [25].
- Malek., *et al*. compared microleakage of resin fissure sealants and resin-modified glass-ionomers as fissure sealant materials and reported no significant difference between them, concluding that resin-modified glass-ionomer is an appropriate material for sealing pits and fissures [26].

Further studies are necessary with long follow-up periods for teeth that have received fissure sealants using the dabbing motion; such studies might confirm the positive results of the present study.

Conclusion

Despite the limitations of the present study, the results showed that dabbing motion during acid etching for preventive fissure sealant therapy can decrease microleakage. The decrease in microleakage in the case group (with the use of dabbing motion) was significant compared to the control group (without dabbing motion).

Conflict of Interests

The authors have declared that no conflict of interest exists.

Acknowledgment

The authors declare no conflict of interest.

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Volume 3 Issue 8 August 2019