EFFECTS OF SELF-ETCH ADHESIVES ON MICROLEAKAGE OF FISSURE SEALANTS

ABSTRACT

Background and Aim: The aim of this study was to evaluate the microleakage of fissure sealants placed with different adhesive systems.

Materials and Methods: Forty-eight extracted sound human mandibular molars were randomly assigned into four groups according to the mode of fissure sealant application; group I- acid etching; group II- acid etching followed by etch-and-rinse adhesive (Single Bond); group III- two-step self-etch adhesive (Adper SE Plus); group IV- one-step self-etch (Adper Easy One). After adhesive application, the fissure sealant was placed over the occlusal fissures and polymerized. The teeth were stored in distilled water, thermocycled (5/55°C, 1000X) and then stained. The teeth were sectioned longitudinally and viewed under a stereomicroscope for dye penetration. The data were analyzed with Kruskal-Wallis and Dunn tests.

Results: Group I in which fissure sealant was applied followed by acid etching without an adhesive system exhibited the higher microleakage when compared to the other groups (II, III, IV) (p<0.05). No significant differences were observed between rest of groups (Group II, III and IV) where an adhesive application were performed prior to sealant application (p>0.05).

Conclusions: The use of adhesive system before application of fissure sealant decreased microleakage.

Key words: Self-etch Adhesive, Fissure Sealant, Microleakage

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INTRODUCTION

Occlusal pit and fissures are the most susceptible areas for caries initiation. Inaccessible morphology of these areas prevents them from being cleaned properly thereby increasing the potential for plaque accumulation. It is known that sealants form a mechanical barrier for microorganisms and plaque with obstruction of retentive pit and fissures.1-2 Application of fissure sealant have been shown to be an effective method of preventing caries development.3-4 The use of an adhesive system prior to sealant application has been suggested.5,6 Fissure sealants used in conjunction with an adhesive system prior to its placement usually result in enhanced retention.5,7 On the other hand there are also controversial findings regarding the use of adhesive systems.8,9 Current dentin adhesives are classified as etch-and-rinse and self-etch adhesives depending on the acid etch process.10 Self-etch adhesives were developed to overcome the problems associated with the use of etch-and-rinse adhesives. As these systems do not require separate acid etching step, technique sensitivity especially in moisture control is lessened. Recently one-step self-etch adhesives have been introduced that combine the conditioner, primer, and adhesive resin into a single application. It can be assumed that one-step self-etch adhesives might be advantageous with shortening the treatment time and complexity. It’s known that retention is the main determinant in maintaining a sealant’s caries-preventive effect.2,11 Improper isolation and contamination of enamel surface during sealant application would compromise its effectiveness and retention. So rapid application of sealants have great importance for clinicians. Therefore self-etch adhesives especially one-step self-etch adhesives might be a good choice that may aid ease of placement with reduced steps and chair time and less technique sensitivity especially in the pediatric population’s sealant applications. However there are conflicting results about the effectiveness of self-etch adhesives on enamel especially to intact enamel. Aprismatic layer on intact enamel is less conductive to bonding due to crystals unidirectional orientation and density and its highly mineralized structure.12,13 As self-etch adhesives are not acidic as the phosphoric acid used with the etch-and-rinse adhesives, several in vitro studies have reported low enamel-bond strength values for self-etch adhesives.14,15 On the other hand there are investigations that reported no differences in bond strength between self-etch and etch-and-rinse adhesives when bonded to intact enamel.16,17 The aim of this study was to compare the microleakage of an occlusal fissure sealant placed with different adhesive systems.

MATERIALS AND METHODS

Forty-eight freshly extracted non-carious human mandibular molar teeth stored in 0.5% chloramine solution at 4°C were selected for this study. The teeth were examined to ensure the absence of any enamel crazing or cracks using a binocular microscope at 20X magnification. All teeth were cleaned with pumice and water, by means of brushes and rubber cups in a low-speed handpiece and then thoroughly rinsed and air dried to remove pumice residues. The teeth were randomly divided into four groups of 12 teeth as follows:

- **Group I:** The occlusal fissures were acid etched using 34.5% phosphoric acid gel (Vococid, Voco, Cuxhaven, Germany) for 30 seconds. Then, the teeth were rinsed with air/water spray for 10s and gently air dried with an oil-free air stream until a uniform chalky white appearance was obtained.
- **Group II:** After the occlusal fissures were acid etched as mentioned in group I, an etch-and-rinse adhesive Single Bond was applied in two consecutive coats, air thinned gently for 5s and light cured for 10s with Quartz-tungsten-halogen light (Hilux, Benlioglu, Ankara, Turkey) with a light output of 550mW/cm².
- **Group III:** The teeth were dried lightly. Liquid A of two-step self-etch adhesive, Adper SE Plus was applied to all fissures with a brush tip. Then Liquid B was scrubbed into the entire wetted surface with another brush tip for 20s and air dried thoroughly for 10s to evaporate water. A second coat of Liquid B was applied, air thinned lightly and then light-cured for 10s with Quartz-tungsten-halogen light.
- **Group IV:** One-step self-etch adhesive, Adper Easy One was applied to all fissures for a total of 20 seconds. The adhesive was dried for 5 seconds and then light cured for 10 seconds with Quartz-tungsten-halogen light. In all groups, the occlusal fissures were sealed with resin-based sealant, Fissurit FX (Voco, Cuxhaven, Germany). It was carefully applied from the central fissure up towards the cusps in order to prevent voids, air entrapment or bubbles and then light-cured for 20 seconds using a Quartz-tungsten-halogen light-curing unit. The adhesives and fissure sealant was placed by a single operator according to the manufacturer’s instructions (Table 1). The specimens were stored in distilled water in room temperature for 24 hours. They were then thermocycled for 1000 cycles in.
water baths between 5 and 55°C with a dwell time of one minute at each temperature. After thermocycling, the root apices were sealed with a layer of resin composite and all the surfaces of the teeth were covered with two layers of nail varnish, except for a 1.0-mm-wide zone adjacent to the margins of the fissure sealants. Then the specimens were immersed in a 0.5 % basic fuchsin solution for 24 hours. Following dye exposure, teeth were washed and rinsed with distilled water, dried and embedded in self-curing acrylic resin. Afterwards, each tooth was sectioned with a water-cooled diamond disc in a mesiodistal plane through the sealant. Each section was then examined using a stereomicroscope at X40 magnification. The degree of microleakage was blindly scored by two independent examiners, using a grade scale:

0 = No dye penetration
1 = Dye penetration restricted to the outer half of the sealant
2 = Dye penetration restricted to the inner half of the sealant
3 = Dye penetration to the underlying fissure

To determine the significant differences between the groups, the data was analyzed using Kruskal-Wallis non-parametric ANOVA test. Inter-group comparisons were made using the Dunn test.

RESULTS

There were significant differences between the groups (p=0.0017). Group I, in which fissure sealant was applied followed by acid etching without an adhesive system application demonstrated the highest leakage, while the other three groups showed significantly less leakage than Group I (Group I vs II, p=0.001; Group I vs III, p=0.003 Group I vs IV, p=0.0002). No significant differences were observed between the rest of groups (Group II, III and IV) where an adhesive application were performed prior to sealant application (p>0.05) (Table 2).

DISCUSSION

The results of this study indicated that all adhesive systems performed similarly with respect to total microleakage scores. Regardless of adhesive systems, microleakage was decreased when an adhesive system was applied. The use of an adhesive under a sealant is still under debate. Since this is an additional step, it might be thought as time-consuming and not cost-effective. Mascarenhas et al.9 conducted a clinical trial that tested the use of a primer and bonding agent to increase the retention of a fissure sealant. They found no differences in sealant retention and caries in teeth sealed with or without primer and bond. They concluded that if a proper technique is used in sealant placement, primer and bond does not enhance sealant retention. In five year clinical follow-up of the same study, no difference was observed between teeth sealed with primer and bond and teeth sealed without primer and bond. Moreover caries prevention was not enhanced in teeth sealed with primer and bond sealant compared with those sealed with sealant alone.18 Boksman et al.8 evaluated whether the clinical effectiveness of pit and fissure sealants was increased when a bonding agent was used prior to the placement of the sealant. At the 2 year, they found that bonding agent did not increase the long-term retention rate. However

Table 1. Adhesive systems used in the study

<table>
<thead>
<tr>
<th>Adhesive Systems</th>
<th>Composition</th>
</tr>
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<tbody>
<tr>
<td>Single Bond</td>
<td>Bis-GMA, DMA, HEMA, water, ethanol, PAA, photoinitiator</td>
</tr>
<tr>
<td>(etch-and-rinse adhesive)</td>
<td></td>
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<tr>
<td>3M ESPE, St. Paul, MN, USA</td>
<td></td>
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<tr>
<td>Batch # 2007036</td>
<td></td>
</tr>
<tr>
<td>Adper SE Plus</td>
<td>Liquid A: Water, HEMA, Surfactant, Pink Colorant Liquid B: UDMA, TEGDMA, TMPTMA, HEMA, MHP, Bonded zirconia nanofiller, camphorquinone</td>
</tr>
<tr>
<td>(two-step self-etch adhesive)</td>
<td></td>
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<tr>
<td>3M ESPE, St. Paul, MN, USA</td>
<td></td>
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<tr>
<td>Batch # 70-2010-5421-3</td>
<td></td>
</tr>
<tr>
<td>Adper Easy One</td>
<td>HEMA, Bis-GMA, methacrylated phosphoric esters, 16hexanediol dimethacrylate, methacrylate functionalized polyalkenoic acid, finely dispersed bonded silica filler with 7 nm primary particle size, ethanol, water, camphorquinone, stabilizers</td>
</tr>
<tr>
<td>(one-step self-etch adhesive)</td>
<td></td>
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<tr>
<td>3M ESPE, St. Paul, MN, USA</td>
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<td>Batch # 318383</td>
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</table>
Microleakage of fissure sealants

In another clinical study it has been demonstrated that adhesives enhance the sealant retention. Concur with this result, in a one-year clinical study, the use of adhesives increased the success rate of sealants. Our results are in line with many in vitro studies that found less microleakage when a bonding agent was applied prior to the sealant placement. In an in vitro study, the microleakage of a sealant after using three different techniques for conditioning the surface to be sealed were evaluated. Marginal leakage was lowest when the tooth was conditioned with phosphoric acid and subsequent application of an adhesive, prior to sealant. Higher leakage scores were observed when the surface was conditioned using a self-etching adhesive, and when was conditioned with 37% phosphoric acid. On the other hand contrary to our findings, Perry and Rueggeberg observed lower incidence of microleakage in sealants used with conventional acid etching of enamel than did use of an acidic primer resin. In most of the studies self-etch adhesives has been shown to result in low enamel bond strengths than etch-and-rinse adhesives. The application of self-etch adhesives especially to an intact enamel surface remains a controversial issue. It has been stated that the self-etch adhesives do not etch aprismatic enamel efficiently and unground enamel presents a challenge for this type of adhesives. On the other hand some authors consider that self-etch adhesives could provide a satisfactory alternative to the conventional acid-etching. An in vitro study by Hannig et al. investigated the microleakage and internal seal of fissure sealants placed by the use of self-etching priming agents in comparison to phosphoric acid etching of enamel. They found that the fissure sealing ability of self-etching primer is less effective as compared to acid-etching. Cehreli and Gungor evaluated the effect of long-term water storage on the microleakage of a fissure sealant applied with or without different bonding agents. The use of etch-and-rinse adhesives resulted in significantly less microleakage compared to that achieved with self-etching adhesives or acid etching alone. The sealants placed without a prior bonding agent showed the greatest amount of leakage after four years.

In another study an antibacterial self-etching system gave bond enamel bond strengths that appeared to similar to those of an etch-and-rinse adhesive. However another self-etch adhesive Clearfil SE Bond led to a statistically lower enamel bond strength value than the antibacterial self-etch and etch-and-rinse groups. They attributed this result to their different contents. The results that we obtained could be related with the composition and mechanical properties of the adhesives used in this study. Bonding procedure relies on resin tag formation in the etched enamel surface, that creates micro-mechanical interlocking. Moreover the depth of hydroxyapatite removed during self-etch application might depend on the type and concentration of acidic monomers. The pH of Adper SE Plus is 0.4 and it’s high acidity might cause similar bond values with etch-and-

<table>
<thead>
<tr>
<th>Groups</th>
<th>Microleakage scores</th>
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<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Group I</td>
<td></td>
</tr>
<tr>
<td>Only acid-etch</td>
<td>2</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
</tr>
<tr>
<td>Single Bond</td>
<td>9</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
</tr>
<tr>
<td>Adper SE Plus</td>
<td>8</td>
</tr>
<tr>
<td>Group IV</td>
<td></td>
</tr>
<tr>
<td>Adper Easy One</td>
<td>10</td>
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</table>
rinse adhesive, Single Bond. On the other hand the pH of Adper Easy One is 2.7. However this adhesive includes phosphoric esters, that etch the surfaces of enamel to allow for the micromechanical bonding of a restorative material. Moreover, the phosphoric esters and the Vitrebond™ Copolymer in Adper Easy Bond Self-Etch Adhesive form a chemical bond to the hydroxyapatite by forming a complex with the calcium ions.

In most of the clinical studies use of self-etch adhesives provided less retention than the standard acid-etch technique. In a retrospective study comparing the retention of sealants placed with a self-etching primer and phosphoric acid etching, poorer retention rates were observed with the use of self-etching primer. Similar results were obtained by Burbridge et al. who also found superior results in retention rates of sealants placed with etch-and-rinse adhesive than did a one-step self-etch adhesive. In a recent clinical study the retention rates of a nanofilled occlusal fissure sealant placed with the use of an etch-and-rinse or a self-etch adhesive were compared over 24 months. Fissure sealants placed with etch-and-rinse adhesive showed better retention rates than those placed with self-etch adhesive. The studies mentioned above studies concluded that the fissure sealants placed by using traditional acid-etching followed by an adhesive system remains as the best clinical technique in terms of retention and caries prevention. On the other hand the result of our study support the findings of a clinical study of Feigal and Quelhas. They evaluated the 2-year clinical sealant success when using a one-step self-etch adhesive Prompt-L-Pop prior to sealant application. They found no difference with the phosphoric acid etch method without the use of any bonding agent and self-etch adhesive.

All tested adhesives in the present study were equally effective in preventing microleakage but in vitro studies cannot incorporate all factors. Adequate isolation is one of the main factors that directly relates with sealants’ retention. It’s known that moisture contamination was the most frequently cited reason for sealant failure. By conducting this study under in vitro conditions, isolation problem is totally eliminated. The reason why we obtained similar leakage scores might be related with this factor. However most reliable conclusions about the effectiveness of self-etch adhesives could be obtained in the oral environment with long-term clinical studies.

**REFERENCES**

Microleakage of fissure sealants


