Evaluation of microleakage of Ionoseal filling material as a fissure sealant agent

Effat Khodadadi (DDS)¹, Behnaz Esmaeili (DDS)², Naemeh Karimian³, Soraya Khafri (PhD)⁴

1. Assistant Professor, Department of Pedodontics, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
2. Assistant Professor, Dental Materials Research Center, Department of Operative Dentistry, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
3. Dental Student, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
4. Assistant Professor, Department of Social Medicine and Health, Faculty of Medicine, Babol University of Medical Sciences, Babol-Iran.

✉️ Corresponding Author: Behnaz Esmaeili, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
Email: dr.b.esmaeili@gmail.com  Tel: +981112291408-9

Abstract

Introduction: Sealing pits and fissures was introduced as an approach to prevent occlusal caries for more than two decades. The aim of this study was to compare the microleakage of flowable resin reinforced glass ionomer (Ionoseal) with other materials used as fissure sealants.

Methods: In this in vitro study, 50 premolar teeth of human free of any caries were selected. Fissurotomy was done with fissure bur. The samples were randomly categorized into five groups (Fissurit FX, Fuji II light-cured, Grandio flow, Ionoseal). Ionoseal was assessed by using two methods: with and without etching and bonding agent prior to sealant application. After sealant placement, all surfaces of the teeth except 2 mm area around the sealant margins were covered with two layers of nail polish. The specimens were thermocycled, and they were sectioned after immersing into a 0.5 % basic fuchsine solution. The amount of microleakage was examined by stereomicroscope.

Results: The microleakage comparisons of groups indicated that Ionoseal without etching and bonding application had significantly greater microleakage than the other groups (p<0.001), while there was statistically no significant difference between the microleakage of Ionoseal and the other groups after etching and bonding application (p>0.05).

Conclusions: By considering isolation difficulties in children and observing high amount of Ionoseal microleakage (without etching and bonding application), the samples need to be etched and bonded like other resin-based materials before Ionoseal placement in order to achieve clinically desirable microleakage outcomes.

Keywords: Dental leakage, Pit and fissure sealants, Glass ionomer cements

بررسی میسان ریسنشت ماده یونوسیل به عنوان فیشورسیلانت

چکیده
مقدمه: پُضاًذى حفرات ٍ ضیارّا بیص از دٍ دِّ است کِ بِ عٌَاى یک رٍش پیطگیری از پَسیذگی ّای سطح اکلَزال هعرفی ضذُ است. هقایسِ ریسًطت flowable resin reinforced glass ionomer (یًََسیل) با سایر هَادی است کِ بِ عٌَاى فیطَرسیلاًت استفادُ هی ضًَذ.
مواد و روش ها: در ایي هطالعِ آزهایطگاّی، ٍذف ایي هطالعِ، هقایسِ ریسًطت فیطَرٍتَهی با فرز فیطَر اًجام ضذ، وًَِ ّا بِ صَرت تصادفی بِ 0 گرٍُ تقسین ضذًذ، Fissurit FX, Grandio Flow, Fuji II light-cured, Ionoseal (یًََسیل) بِ دٍ رٍش هَرد بررسی قرار گرفت: با ٍ بذٍى بِ کار بردى اچ ٍ باًذ، ّیچ تفاٍت هعٌاداری ریسًطت بالاتری ًسیت بِ سایر گرٍُ ّا دارد (p<0.001)، در حالی کِ پس از استفادُ از اچ ٍ باًذ، ّیچ تفاٍت هعٌاداری ریسًطت یًََسیل با سایر گرٍُ ّا هطاّذُ ًطذ (p>0.05).

نتیجه گیری: با توجه به سختی ایسٍلاسیَى در کَدکاى ٍ هطاّذُ ریسًطت بالای یًََسیل بذٍى استفادُ از اچ ٍ باًذ از اج و باند، هعٌاداری ریسًطت حاصل آیذ.

واژگان کلیدی: نتت دنداى، پیت و فیشورسیلانت‌ها، سمان های گلاس ایسیت،
Methods

In this in vitro and experimental study, 50 premolar teeth were extracted from human for orthodontic purposes and they were free of any caries and cracks under stereomicroscopic (Menji Techno Co, LTD, 45176, Tokyo, Japan) examination.

The samples were disinfected in 0.5 % Chloramine T Trihydrate for a week. All of the teeth were cleaned with pumice prophylaxis for plaque removal a week prior to the trial. Enameloplasty was done with the 0.8 mm diameter fissure bur (DRENDELL+ZWEILING, Quezon City, Philippines) that is 0.5 mm deep along the occlusal fissure extension of the specimens. 50 premolar teeth were classified into five groups (n=10).

Group 1 (Fissurit FX sealant): At first the teeth were etched with a 37% phosphoric acid gel (Ivoclar Vivadent, Schaan, Lichtenstein) for 30 seconds, then rinsed with air water spray for 30 seconds, then rinsed with air water spray for 30 seconds, and finally dried.

After application of the Solobond M (VOCO GmbH, Cuxhaven, Germany), Fissurit FX sealant (VOCO GmbH, Cuxhaven, Germany) was applied in the fissures according to the manufacturer’s instructions and then it was light-cured by Valo LED curing unit (Ultradent products Inc, UT, USA) light curing device for 40 second at 1000mW /cm².

Group 2 (Grandio-Flow composite): All of the steps were like the first group. Grandio-Flow composite (VOCO GmbH, Cuxhaven, Germany) was placed into the fissures and then light-cured for 40 seconds.

Group 3 (Fuji II light-cured RMGI): Fuji II light-cured RMGI (GC Corporation, Tokyo, Japan) was applied to the pits and fissures according to manufacturer’s instructions (powder and liquid were mixed at a 1:2 ratio). Finally, the fissures were light-cured for 20 seconds.

Group 4 (Ionoseal flowable RMGI without etching and bonding agent application): After preparing and rinsing the surfaces of the specimens, they were completely dried. Ionoseal flowable RMGI (VOCO GmbH, Cuxhaven Germany) was applied directly from a tube or syringe, then it was light-cured for at least 20 seconds.

Group 5 (Ionoseal flowable RMGI with etching and bonding agent application): At first the teeth were etched with a 37% phosphoric acid gel for 30 seconds, then they were rinsed with air water spray for 20 seconds and finally dried.

After application of the bonding agent (Solobond M), Ionoseal was placed into the fissures and then light-cured for at least 20 seconds. Composition and manufacture of materials are shown in table 1.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Class</th>
<th>Composition</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fissurit FX</td>
<td>Resin-based fissure sealant</td>
<td>Bis-GMA, TEGDMA, UDMA, 2% NaF, BHT, benzotriazole derivative</td>
<td>VOCO GmbH, Cuxhaven, Germany</td>
</tr>
<tr>
<td>Grandio Flow</td>
<td>Light-cured flowable resin composite</td>
<td>Bis-GMA, TEGDMA, HDDMA, SiO2</td>
<td>VOCO GmbH, Cuxhaven, Germany</td>
</tr>
<tr>
<td>Fuji II LC</td>
<td>Resin-modified glass ionomer cement</td>
<td>Resin or Liquid (24%wt): PAA, HEMA, proprietary ingredient, 2,2,4 - trimethylhexamethylenedicarbonate, TEGDMA Fillers (76%wt): (flouro) alumino silicate glass</td>
<td>GC Corporation, Tokyo, Japan</td>
</tr>
<tr>
<td>Ionoseal</td>
<td>Resin-reinforced glass ionomer cement</td>
<td>Fluoroalminumsilicate, Bis-GMA, HEMA, TEDMA, champherechinon, amine</td>
<td>VOCO GmbH, Cuxhaven, Germany</td>
</tr>
<tr>
<td>SoloBond M</td>
<td>Etch- and-rinse adhesive</td>
<td>Bis-GMA, HEMA, BHT, acetone, organic acids</td>
<td>VOCO GmbH, Cuxhaven, Germany</td>
</tr>
</tbody>
</table>

The premolars were stored in 37°C-distilled water for 24 hours. The groups were subjected to thermocycling for 500 cycles at temperatures of 5°C and 55°C with a dwell time of 30 seconds.

The root apexes were sealed with epoxy resin for assessment of microleakage. The whole surfaces of teeth except the 2 mm area around the sealant margins were covered with two layers of nail polish. [2]

Then, the samples were immersed in 0.5 % basic fuchsin solution for 24 hours. [8] After that, the wax and nail polish were removed and the samples were rinsed and mounted on acrylic resin blocks. All the 50 specimens were sectioned longitudinally in buccolingual direction with a double-faced diamond disc.

The sections were then examined under a stereomicroscope to evaluate the microleakage rate by using the magnification of 40x. [2]

Four criteria ranked scale were applied to score the dye penetration depth according to pre-study(2):
0=no dye penetration
1=dye penetration limited to the outer half of the sealant
2=dye penetration extending to the inner half of the sealant
3=dye penetration extending to the underlying fissure

For the comparison of the microleakage among different groups, Chi-Square test and Kruskal-Wallis test were used in current study at a significance level of α=0.05.

**Results**

Microleakage scores of different materials are shown in table 2. Comparing with other groups, the majority of the sealed specimens using Fissurit FX revealed no dye penetration (score=0). Most of the sealed specimens with Grandio flow and Fuji II light-cured (Fuji II LC) demonstrated dye penetration limited to the outer half of the sealant (score=1), all of the samples related to Ionoseal (without etching and bonding agent application) showed dye penetration extending to the underlying fissure (score=3). So, the results indicated significantly greater microleakage of Ionoseal in comparison with the other materials (p<0.001) and there was no statistically significant difference among 3 other groups (p>0.05).

**Table 2. Microleakage scores of different materials**

<table>
<thead>
<tr>
<th>Material</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fissurit FX</td>
<td>6(60)</td>
<td>3(30)</td>
<td>0(0)</td>
<td>1(10)</td>
</tr>
<tr>
<td>Grandio Flow</td>
<td>1(10)</td>
<td>6(60)</td>
<td>2(20)</td>
<td>1(10)</td>
</tr>
<tr>
<td>Fuji II LC</td>
<td>2(20)</td>
<td>4(40)</td>
<td>2(20)</td>
<td>2(20)</td>
</tr>
<tr>
<td>Ionoseal (without etching and bonding agent)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>10(100)</td>
</tr>
<tr>
<td>Ionoseal (with etching and bonding agent)</td>
<td>3(30)</td>
<td>4(40)</td>
<td>2(20)</td>
<td>1(10)</td>
</tr>
</tbody>
</table>

After etching and bonding agent application in Ionoseal samples, their microleakage rate improved noticeably and the majority of the specimens were scored 1. Therefore, there was no statistically significant difference among the various groups (p>0.05). P-values for comparison among different groups are shown in table 3.

**Table 3. P values for comparison among the different groups**

<table>
<thead>
<tr>
<th>Compared groups</th>
<th>P-value</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, II, III, IV</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td>I, II, III</td>
<td>0.08</td>
<td>Not significant</td>
</tr>
<tr>
<td>I, II, III, V</td>
<td>0.152</td>
<td>Not significant</td>
</tr>
<tr>
<td>IV, V</td>
<td>0.007</td>
<td>Significant</td>
</tr>
</tbody>
</table>

**Discussion**

Having used Ionoseal based on its manufacturer's instructions (without etching and bonding agent application), the results showed significantly greater microleakage of Ionoseal than the other groups. The necessary contents of RMGIs are like those of conventional glass ionomers (CGIs) that an aqueous polycarboxylic acid reacts to an acid-base setting with
fluoroalumionosilicate glass. The RMGIs possess some methacrylate contents like resin composites.\(^9\) Probably it is possible for RMGIs to bond to enamel similar to CGIs, via a common chemically based bonding mechanism; it also holds micromechanical-bonding mechanism like the one in resin composites.\(^10\) Thus due to the existence of micromechanical bonding, it is regular to observe better sealing results after etching and bonding agent application.

Based on some researches such as Lodlow\(^{11}\), Cortes\(^{12}\), Birkenfeld\(^{13}\) and Pradi\(^{2}\) studies and due to the high microleakage rate (score=3) in all of the Ionoseal samples, another group of this material was examined after etching and bonding agent application.

This time, there was no statistically significant difference between Ionoseal and the other groups, the Ionosealmicroleakage rate improved noticeably. This result was in conformity with Lodlow and Cortes' findings which reported less microleakage amount and higher bond strength of RMGI after selective enamel etching, respectively.\(^{11, 12}\)

Cortes et al. claimed the cause of strong bond of resin-reinforced GIC to the etched enamel was its resin components.\(^{12}\) Moreover, both of the studies done by Cortes and Birkenfeld demonstrated a cohesive failure within the materials in the etched enamel samples. However, an adhesive failure (material-enamel interface) was discovered in un-etched teeth.\(^{12, 13}\)

This finding (after etching and bonding agent application) was also in accordance with the study carried out by Pradi et al.\(^2\)

In their study, all groups were also etched before sealant placement that the findings indicated no statistically significant difference in microleakage of RMGI (Vitremer) in comparison with other materials. But dorego et al. reported a greater microleakage of RMGI than fluoride resin-filled sealant. They connected their findings with the fact that this kind of material (RMGI) had a resin element whereas the enamel was not etched in their trial.\(^{14}\) No significant difference between microleakage of Ionoseal and flowable composite in the present study was contrary to the results obtained by Majati et al.

Their study illustrated the sealing ability of packable composite was improved more by the use of flowable composite intermediate layer than the RMGI.\(^{15}\) It is also different from the outcomes resulted in Parabhakar study that they indicated better sealing ability of flowable composite in comparison with RMGI and compomer.\(^{16}\)

In the first method (without etching and bonding agent application), two groups of RMGI (Ionoseal and Fuji II LC) showed different amounts of microleakage.

As the polymerization shrinkage is due to the existence of resin component, this shrinkage of resin-containing restorative materials might cause marginal gaps leading to microleakage, sensitivity and marginal discoloration.\(^{17}\) This shrinkage can cause stress concentration which can damage to adhesion interface.\(^{10}\) This difference of two RMGI groups indicated that the microleakage of resin modified glass ionomers depended on material.

The microleakage rate may be affected by the amount of resin content and filler particles.\(^{17}\) Finally, considering the results obtained in this research and high amount of Ionoseal microleakage without etching and bonding agent application and with regarding to this material type (RMGI), researchers can illustrate that its resin component is probably dominant to the glass one.

Hence, it is essential for this material to be used in etching and bonding similar to resin based groups to reach clinically proper microleakage results. It is suggested that the other properties of this material such as microhardness, bond strength and so on can be investigated in future studies.

Conclusions

In order to approach clinically proper microleakage results, the teeth need to be etched and bonded prior to Ionoseal placement similar to resin-based materials. Therefore, it is not preferable to use
this material from among different groups to reach convenience in the isolation situation.

Acknowledgments

The authors would like to thank Evangeline Foronda for English editing and Dental Materials Research Center of Babol University of Medical Sciences.

Funding: This study was a part of thesis and research project (Grant No: 9236333) which was supported and funded by Babol University of Medical Sciences.

Conflict of interest: There was no conflict of interest.

References


16. Prabhakar AR, Madan M, Raju OS. The marginal seal of a flowable composite, an injectable resin modified glass ionomer and a compomer in primary...