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Original Article

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

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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 flow able 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

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بررسی میزان ریزنشت ماده یونوسیل به عنوان فیشورسیلانت

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چکیده

مقدمه: پوشاندن حفرات و شیارها بیش از دو دهه است که به عنوان یک روش پیشگیری از پوسیدگی های سطح اکلوزال معرفی شده است. هدف این مطالعه، مقایسه ریزنشت flowable resin reinforced glass ionomer (یونوسیل) با سایر موادی است که به عنوان فیشورسیلانت استفاده می شوند.

مواد و روش ها: در این مطالعه آزمایشگاهی، ۵۰ عدد دندان پرمولر انسانی،عاری از پوسیدگی انتخاب شدند. فیشوروتومی با فرز فیشور انجام شد. نمونه ها به صورت تصادفی به ۵ گروه تقسیم شدند:(Fissurit FX, Grandio Flow, Fuji II light-cured, Ionoseal) یونوسیل به دو روش مورد بررسی قرار گرفت: با و بدون به کار بردن اچ و باند قبل از قرار دادن سیلانت ها. پس از قرار دادن سیلانت ها، تمامی سطوح دندان ها به جز ۲ میلی متری اطراف سیلانت ها، با ۲ لایه لاک ناخن پوشانده شدند. نمونه ها تحت سیکل حرارتی قرار گرفته و پس از غوطه ورسازی در محلول فوشین بازی ۰/۵٪، برش خوردند. میزان ریزنشت با استفاده استرئومیکروسکوپ مورد ارزیابی قرار گرفت.

یافته ها: مقایسه ریزنشت گروه ها بیانگر آن بود که یونوسیل بدون استفاده از اچ و باند، به صورت معناداری ریزنشت بالاتری نسبت به سایر گروه ها دارد ($p<0.001$)، در حالی که پس از استفاده از اچ و باند، هیچ تفاوت معناداری بین ریزنشت یونوسیل با سایر گروه ها مشاهده نشد ($p>0.05$).

نتیجه گیری با توجه به سختی ایزولاسیون در کودکان و مشاهده ریزنشت بالای یونوسیل بدون استفاده از اچ و باند، نمونه هاقبل از قرار دادن این ماده نیز، همانند مواد رزینی، نیاز به اچ و باند دارند تا نتایج مطلوب کلینیکی از لحاظ ریزنشت حاصل آید.

واژگان کلیدی: نشت دندانی، پیت وفیشور سیلانت ها، سمان های گلاس آینومر

Introduction

The anatomical pits and fissures of the teeth have been identified as predisposal areas for the beginning of dental caries.[1] Therefore, fissure sealing is a useful method for caries control on occlusal surfaces.[2] An efficient marginal seal, retention and integrity can cause pit and fissure sealant success during long time spans.[3] Three classes of materials are used as pit and fissure sealants: glass ionomer, resin and polyacid-modified resins.[4]

Fissure sealing with glass ionomer cement was put forward by Mclean and Wilson for the first time in 1974.The most important use of the glass ionomer application as a pit and fissure sealant is the fluoride release that causes increased ability of the fissures for demineralization.[5]

In vitro microleakage studies can assess the capability of restorative materials for the marginal sealing.[2] A study done by Pradi et al. (2006) evaluated the microleakage of various materials and their findings showed similar marginal sealing in all groups (flowable composite resin, flowable compomer, resin-modified glass ionomer (RMGI) and unfilled resin based sealant).[2] In another study (2011),Prabhakar et al. compared viscosity and the microleakage of fissure sealants and they reported better sealing ability of flowable composite than RMGI and compomer.[6]

The use of flowable restorative systems has grown in dentistry, mostly due to their efficient properties such as easy handling, low modulus of elasticity and low viscosity.[7]

By the technological advancement in dentistry materials, the flowable glass ionomeris used because its placement is easier than that of powder glass ionomerfor children. So, this study evaluated the microleakage of flowable RMGI in comparison with the other materials used as fissure sealants.

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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.[1] 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 20 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.

Table1. Characteristics of the materials used

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

Bis-GMA: Bis-glycidyl methacrylate, TEGDMA: Triethyleneglycoldimethacrylate, UDMA: Urethane dimethacrylate, NaF: Sodium Fluoride, BHT: Butylatedhydroxytoluene, HDDMA: 1,6- Hexanedioldimethacrylate, PAA: Polyacrylic acid, HEMA: 2-Hydroxyethyl methacrylate, TEDMA: Triethylenedimethacrylate.

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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 fuchsine 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 prestudy(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

MateriaMaterials	Scores N(%)			
	0	1	2	3
1.Fissurit FX	6(60)	3(30)	0(0)	1(10)
2.Grandio Flow	1(10)	6(60)	2(20)	1(10)
3.Fuji II LC	2(20)	4(40)	2(20)	2(20)
4.Ionoseal (without etching and bonding agent)	0(0)	0(0)	0(0)	10(100)
5.Ionoseal(with etching and bonding agent)	3(30)	4(40)	2(20)	1(10)

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

Compared groups	P-value	Inference
I,II, III, IV	<0.001	Significant
I, II,III	0.08	Not significant
I,II, III, V	0.152	Not significant
IV, V	0.007	Significant

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

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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 el. 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

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this material from among different groups to reach convenience in the isolation situation.

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