

Marginal Microleakage of Conventional Fissure Sealants and Self-Adhering Flowable Composite as Fissure Sealant in Permanent Teeth

Sara Rahimian-Imam¹, Nahid Ramazani²✉, Mohammad Reza Fayazi³

¹Assistant Professor, Children and Adolescents Health Research Center, Oral and Dental Disease Research Center, Department of Pediatric Dentistry, School of Dentistry, Zahedan University of Medical Sciences, Zahedan, Iran

²Associate Professor, Children and Adolescents Health Research Center, Oral and Dental Disease Research Center, Department of Pediatric Dentistry, School of Dentistry, Zahedan University of Medical Sciences, Zahedan, Iran

³Dentist, Zahedan, Iran

Abstract

Objectives: Application of sealants is a safe and effective way to prevent occlusal caries in the posterior teeth. A successful sealant therapy depends on good isolation. Decreased steps of adhesive application may enable proper isolation and use of self-adhering flowable composites for sealant therapy. This study sought to compare the marginal microleakage of fissure sealants and self-adhering flowable composites in permanent teeth.

Materials and Methods: This in vitro, experimental study was conducted on 60 extracted human premolar teeth. The teeth were divided randomly into two groups of 30. In the first group, fissure sealant (Clinpro, 3M ESPE, USA) was placed on the teeth. In the second group, self-adhering flowable composite (Vertise Flow, Kerr, USA) was applied as the sealant. Then, both groups were immersed in 0.5% fuchsin dye solution for 24 hours. Sectioned samples were observed with a stereomicroscope for the extent of dye penetration. Data were analyzed using SPSS 21 and the Mann-Whitney test ($P < 0.05$).

Results: Microleakage in the fissure sealant group was significantly higher than that in the self-adhering flowable composite group ($P < 0.001$).

Conclusion: Microleakage was less using self-adhering flowable composite compared to conventional fissure sealant; therefore, self-adhering flowable composite can be used as a suitable fissure sealant in permanent teeth.

Keywords: Flowable Composite; Pit and Fissure Sealants; Dental Leakage

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2015; Vol. 12, No. 6)

✉ Corresponding author:

N. Ramazani, Department of Pediatric Dentistry, Dental School, Zahedan University of Medical Sciences, Zahedan, Iran

Ramazani_nahid@yahoo.com

Received: 28 February 2015

Accepted: 26 April 2015

INTRODUCTION

Sealant therapy is a safe and effective intervention for prevention of dental caries, particularly occlusal caries in the posterior teeth [1]. Some researchers consider it as the most effective method of caries prevention [2].

Occlusal grooves in the posterior teeth are highly susceptible to decay. By the use of sealant materials, a physical barrier is placed to prevent the onset of dental caries. No method has been introduced to ensure the outcome of sealant therapy [3]. A variety of factors play

a role in success/failure of sealant therapy such as microleakage at the sealant/tooth interface, debonding of sealant, presence of caries in deep grooves and its extension after sealing the groove, and the expertise of the clinician. The most important factor responsible for failure of sealant therapy is the microleakage at the tooth/sealant interface [4]. In pediatric dentistry, isolation during the process of sealant placement is difficult to achieve. Inadequate isolation increases the risk of microleakage and subsequent treatment failure. Therefore, use of bonding agents such as self-etching and self-adhering systems has become popular due to easier application and fewer working steps.

This issue is of great importance especially in pediatric dentistry, because of the poor cooperation of children. In a study conducted by Bektas et al, in 2013, the amount of marginal microleakage was not significantly different between the teeth filled with self-adhering flowable composite and those filled with the conventional flowable composite [5]. The researchers used dye penetration method to assess marginal microleakage and susceptibility to decay [5]. Dye penetration is a widely used technique, which is inexpensive and non-toxic and detects even small amounts of leakage [6]. This study aimed to compare the microleakage of self-adhering flowable composite and conventional fissure sealant.

MATERIALS AND METHODS

In this in vitro study, 60 healthy premolar teeth without caries, restorations, cracks or defects were extracted due to orthodontic reasons and randomly divided into two groups of 30. Occlusal surfaces of all teeth were cleaned with a brush and the teeth were immersed in distilled water at 4°C until the experiment. Samples were divided into 2 groups as follows:

Clinpro group: Samples in this group (Clinpro fissure sealant, 3M ESPE, St. Paul, MN, USA) were first thoroughly rinsed with water.

They were then air-dried for 10 seconds and etched for 30 seconds using phosphoric acid (Denfil Etchant Vericom Co., Georggi, Korea). After thorough rinsing and drying, one-layer of bonding agent (Tetric N-Bond, Ivoclar/Vivadent, Schaan, Liechtenstein) was applied to the etched surface and light-cured using Coltolux light-curing unit (Coltene AG, Altstatten, Switzerland). Fissure sealant was then gently placed on the area. Sealant was carefully directed to the grooves to penetrate deep into the grooves and prevent void formation. Light curing was performed for 40 seconds by the same light-curing unit [7].

Vertise Flow group: According to the manufacturer's instructions, self-adhering flowable composite (Vertise Flow, Kerr, USA) does not require any acid etching or bonding protocol prior to application. Self-adhering flowable composite was placed on the grooves using a microbrush for 20 seconds. This layer did not exceed 0.5 mm in thickness. Light curing was performed using Coltolux light-curing unit (Coltene AG, Altstatten, Switzerland) for 40 seconds [7,8].

During the experiment, samples were stored in distilled water at room temperature. After 24 hours of storage in distilled water at 37 ° C (incubator), all samples were separately placed into thin lace-like fabrics with two different colors (for each group) and subjected to 500 thermal cycles between 5°C and 55°C. Duration of exposure at each temperature was 20 seconds. After thermocycling, all samples were prepared for immersion in dye solution as follows:

Teeth apices and the furcation area were well sealed with self-cured glass ionomer. Then, the crown and root surfaces of the teeth were covered with two layers of nail varnish. A 2mm margin around the fissure sealant was not coated.

By doing so, microleakage from areas other than the fissure sealant margin was prevented. After complete drying of nail varnish, the teeth in each group were separately immersed

in 0.5% Fuchsin dye solution (Merck, Biesterfeld International GmbH, Bavaria, Germany) at room temperature for 24 hours [7]. Next, samples were rinsed and the varnish was cleaned with a scalpel for easy cut. After drying, specimens were mounted in acrylic blocks made of transparent acrylic resin. Samples were numbered and sectioned in a buccolingual direction along the longitudinal axis using a cutting machine (TL-3000, Vafaei Industrial Co., Tehran, Iran). The tooth was divided into mesial and distal halves under water coolant to prevent thermal damage. All the above-mentioned procedures were performed by a pediatric dentist. Then, only the mesial halves (coded) were evaluated under a stereomicroscope (Zeiss, Germany) at $\times 40$ magnification to assess the degree of microleakage. Samples were examined under a stereomicroscope by an examiner blinded to the type of material used for sealant therapy. The amount of microleakage at the tooth/ sealant interface was rated as follows:

Score 0 = no dye penetration.

Score I = dye penetration restricted to occlusal half of the tooth/sealant interface

Score II = dye penetration restricted to gingival half of the tooth/sealant interface

Score III = dye penetration up to the depth of the groove and beneath the sealant [7]. Data were analyzed using SPSS 21 and the Mann-Whitney test. Level of significance was set at 0.05.

RESULTS

In the self-adhering composite group, 76.7% of specimens demonstrated score 0 and 23.3% showed score I of dye penetration. In conventional fissure sealant group, 20.0%, 33.3%, 16.7% and 30.0% of specimens demonstrated score 0, score I, score II and score III of dye penetration, respectively (Table 1). According to the Mann-Whitney U test, microleakage was found to be significantly less in the self-adhering group when compared to the conventional fissure sealant group ($P < 0.001$).

DISCUSSION

This comparative study was conducted to evaluate the marginal microleakage of conventional fissure sealant and self-adhering flowable composite in permanent teeth. A reduction in microleakage was noted when using self-adhering flowable composite compared to fissure sealant material. Microleakage is a significant problem in operative dentistry and can lead to secondary caries, pulpal injuries, post-operative tooth hypersensitivity, marginal discoloration and fracture of restorations [8].

Bond strength and marginal leakage of restorative materials are usually investigated in vitro. A perfect restorative material should provide high bond strength and minimal leakage [8]. Marginal seal is important for the success of sealants, because penetration of microorganisms beneath the sealants initiates carious lesions [9].

Table 1. Frequency distribution of microleakage scores in the two groups

		Microleakage				Total
		No leakage	Score I	Score II	Score III	
		N (%)	N (%)	N (%)	N (%)	
Type of sealant	Self-adhering composite	23 (76.7)	7 (23.3)	0	0	30 (100)
	Fissure Sealant	6 (20)	10 (33.3)	5 (16.7)	9 (30)	30 (100)
	Total	29 (48.3)	17 (28.3)	5 (8.3)	9 (15)	60 (100)

Ganesh and Shobha believe that the primary factor affecting the performance and durability of a sealant is its marginal adaptation to the enamel, which provides a good seal and minimizes microleakage [10]. One solution is to use adhesives or self-etching sealants, which do not need rinsing and thus, decrease the risk of contamination [11]. Clinical and laboratory evaluation of microleakage can be performed; but in vitro studies are easier and more widely used. Various methods are used to evaluate microleakage in vitro such as chemical markers, radioactive isotopes, penetration of bacteria, neutron activation analysis, scanning electron microscopy, creating artificial caries, electrical conductivity and dye penetration methods [6]. Dye penetration is a widely used technique, which is inexpensive and non-toxic and detects even small amounts of leakage [6]. In comparison with bacterial penetration, dye penetration method is more accurate because the dye particle diameters are less than those of bacteria and they are the same size as the bacterial endotoxins [12].

Therefore, dye penetration method was used in this study to evaluate microleakage. In a study conducted by Piwowarczyk et al, in 2005, full metal crown cementation was performed using six cements of Rely, Fuji Plus, Fuji 1, zinc phosphate cement, Rely X Unicem, Panavia F and X ARC to compare marginal leakage and marginal cracks. The results indicated that Rely X Unicem self-adhesive resin cement had the lowest microleakage both in enamel and dentin, compared to other tested cements. They stated that self-adhesive cements had less microleakage due to higher consistency, smaller gap at the tooth/cement interface and lack of multiple layers (absence of poor bonding layer present in other bonding systems) [13]. In a study conducted by Vichi et al, in 2010, forty premolar teeth requiring Grade 1 repair were prepared and restored with self-adhering flowable composite. After six months, marginal discoloration and marginal adaptation were evaluated. Only two teeth had

minor defects in marginal adaptation and slight discoloration [14], which was consistent with the findings of the current study.

Radovic et al, in 2008 reviewed self-adhesive cements and stated that self-adhesive cements in vitro had weaker bond strength to enamel, despite having an acceptable bond to dentin [15]. In a study conducted by Biria et al, in 2011 microleakage of self-etch sealants and conventional sealants was compared in vitro. They found that self-etch and self-adhesive sealants had greater microleakage in enamel margin than conventional sealants. They believed that self-adhesive sealants cannot form resin micro-tags and an acceptable hybrid layer in the enamel, which result in microleakage in the long run [16]. In a study by Vichi et al, in 2013 on the properties of self-adhering flowable composites, they found that self-etch and self-adhering flowable composites had lower microleakage than conventional flowable composites [17]. One of the possible reasons explaining lower microleakage of self-etch and self-adhesive cements is higher hygroscopic expansion of these materials and their relatively low polymerization shrinkage. Acidic resins that form following the use of self-etch adhesives absorb more water than natural resins; therefore, greater hygroscopic expansion occurs [18,19]. In self-etch composites, the hygroscopic expansion compensates for the polymerization shrinkage and provides a better seal [20]. Also, improved sealing of the self-etch composites can be due to the unique polymerization/bonding process.

During the restoration process by the conventional flowable composites, after completion of the bonding process, the restorative material is placed in the cavity and curing is done. Flowable composite's polymerization stress may affect the bonding of adhesive material to tooth structure and cause debonding. But in self-adhering composites, the process of resin polymerization and bonding occur simultaneously and thus the interaction between bonding and polymerization stress is reduced.

This can positively affect the marginal adaptation of these materials [21]. In an in-vitro study conducted by Bektas et al, in 2013, a total of 30 premolar teeth were divided into three groups. In the first group, OptiBond and self-adhering composite were used. In the second group, self-adhering composite was used alone and in the third group OptiBond and conventional flowable composite were used for tooth restoration. The results indicated that when self-adhering flowable composites were used alone, a proper marginal seal was obtained. No significant difference was found between the three groups in terms of marginal microleakage [5]. In the current study, use of self-adhering composite resulted in proper marginal seal and significantly reduced microleakage. This is of particular importance especially in pediatric dentistry and permanent fissure sealant therapy, and will decrease recurrent caries in the long run. Microleakage of other types of cements and self-adhering composites needs to be compared in future studies.

CONCLUSION

By eliminating the rinsing and drying processes and by the use of isolation process alone, self-adhesive composites can be effectively used for sealant therapy not only in patients with difficult saliva control, but also in children in order to save time and decrease technique sensitivity during sealant placement.

ACKNOWLEDGMENTS

This manuscript was based on a thesis submitted to the Graduate Faculty, Faculty of Dentistry, Zahedan University of Medical Sciences, in partial fulfillment of the requirements for the M.S. degree (registration code: 6012). The authors would like to thank the Vice Chancellor for Research of Zahedan University of Medical Sciences for their financial support.

REFERENCES

1- Koh SH, Chan JT, You C. Effects of topical fluoride treatment on tensile bond strength of

pit and fissure sealants. *Gen Dent.* 1998 May-Jun; 46(3):278-80.

2- Del Urquía MM, Brasca N, Girardi M, Bonnin C, Ríos M. In vitro study of microleakage of fissure sealant whit different previous treatments. *Acta Odontol* 2011; 24(2); 150-4.

3- Blackwood JA, Dilley DC, Roberts MW, Swift EJ Jr. Evaluation of pumice, fissure enameloplasty and air abrasion on microleakage. *Pediatr Dent.* 2002 May-Jun;24(3):199-203.

4- Pérez-Lajarín L, Cortés-Lillo O, García-Ballesta C, Cózar-Hidalgo A. Marginal microleakage of two fissure sealants: a comparative study. *J Dent Child (Chic).* 2003 Jan-Apr; 70(1):24-8.

5- Bektas OO, Eren D, Akin EG, Akin H. Evaluation of a self-adhering flowable composite in terms of micro-shear bond strength and microleakage. *Acta Odontol Scand.* 2013 May-Jul;71(3-4):541-6.

6- Alani AH, Toh CG. Detection of microleakage around dental restorations: A review. *Oper Dent.* 1997 Jul-Aug;22(4):173-85.

7- Naga AA, Yousef M, Ramadan R, Fayeze Bahgat S, Alshawwa L. Does the use of a novel self-adhesive flowable composite reduce nanoleakage? *Clin Cosmet Investig Dent.* 2015 Mar 27;7:55-64.

8- Roberson T, Heymann HO, Swift EJ. *Sturdevant's Art and Science of Operative Dentistry.* 5th ed. Philadelphia: Mosby; 2006. 185-266.

9- Pardi V, Sinhoreti MA, Pereira AC, Ambrosano GM, Meneghim Mde C. In vitro evaluation of microleakage of different materials used as pit-and-fissure sealants. *Braz Dent J.* 2006 May; 17(1): 49-52.

10- Ganesh M, Shobha T. Comparative evaluation of the marginal sealing ability of Fuji VII and Concise as pit and fissure sealants. *J Contemp Dent Pract.* 2007 May 1;8(4):10-8.

11- Gomes-Silva JM, Torres CP, Contente MM, Oliveira MA, Palma-Dibb RG, Borsatto MC. Bond strength of a pit and-fissure sealant associated to etch-and-rinse and self-etching

- adhesive systems to saliva-contaminated enamel: individual vs. simultaneous light curing. *Braz Dent J*. 2008; 19(4):341-7.
- 12- Hansen SR, Montgomery S. Effect of restoration thickness on the sealing ability of TERM. *J Endod*. 1993 Sep;19(9):448-52.
- 13- Piwowarczyk A, Lauer HC, Sorensen JA. Microleakage of various cementing agents for full cast crowns. *Dent Mater*. 2005 May;21(5):445-53.
- 14- Vichi A, Goracci C, Ferrari M. Clinical study of the self-adhering flowable composite resin Vertise flow in class I restorations: six-month follow-up. *Int Dent SA*. 2010 Jan-Feb; 12(1):14-23.
- 15- Radovic I, Monticelli F, Goracci C, Vulicevic ZR, Ferrari M. Self-adhesive resin cements: A literature review. *J Adhes Dent*. 2008 Aug;10(4):251-8.
- 16- Biria M, Ghasemi A, Doroudgar K, Najafi Abrandabadi S. In vitro evaluation of microleakage of both self-etch and conventional sealants. *JIDA*. 2011 Autumn;23(3):182-8.
- 17- Vichi A, Margvelashvili M, Goracci C, Papacchini F, Ferrari M. Bonding and sealing ability of a new self-adhering flowable composite resin in class I restorations. *Clin Oral Investig*. 2013 Jul;17(6):1497-506.
- 18- Wei YJ, Silikas N, Zhang ZT, Watts DC. Hygroscopic dimensional changes of self-adhering and new resin-matrix composites during water sorption/desorption cycles. *Dent Mater*. 2011 Mar;27(3):259-66.
- 19- Versluis A, Tantbirojn D, Lee MS, Tu LS, DeLong R. Can hygroscopic expansion compensate polymerization shrinkage? Part I. Deformation of restored teeth. *Dent Mater*. 2011 Feb;27(2):126-33.
- 20- Davidson CL, Feilzer AJ. Polymerization shrinkage and polymerization shrinkage stress in polymer-based restoratives. *J Dent*. 1997 Nov;25(6):435-40.
- 21- Bortolotto T, Mileo A, Krejci I. Strength of the bond as a predictor of marginal performance: an in vitro evaluation of contemporary adhesives. *Dent Mater*. 2010 Mar;26(3):242-8.