Microleakage evaluation of two types of pit and fissure sealants using two different methods, (in vitro study)

Lamis A. Al-Taie B.D.S.,M.Sc.*
Bassam A. Abdul Wahab B.D.S.,M.Sc.**
Musab H. Saeed B.D.S.,M.Sc.,Ph.D.***

Abstract

Background: Clinical preventive procedures must be done after careful assessment; one of the major risk factor is the occlusal morphology of the posterior teeth. These caries free fissures must be sealed. This in vitro study evaluated the microleakage of two types of sealant materials (unfilled resin and flowable composite) on enamel surfaces prepared using two methods (acid etching with enameloplasty and acid etching alone)**.**

Material and methods: Thirty two extracted human third molar were selected and randomly assigned in to 4 groups of eight teeth each; group A, the occlusal surfaces of teeth were acid etched ,then sealed with concise white sealant; group B, they were acid etched then sealed with wave mv flowable composite ;group C, they were prepared with bur ,acid etched ,then sealed with concise white sealant ;group D, they were prepared by bur, acid etched, then sealed with wave mv flowable composite. The sealed surfaces were stored for seven days in distilled water, then specimens were thermocycled 500 cycles, immersed 24 hours in a 2% buffered methylene blue dye, then sectioned and analyzed for leakage under a stereo microscope. Chi-square test was performed to test the differences of leakage among the four groups.

Results: The results showed that there was no significant difference ($p>0.05$) in microleakage for the same material with and without bur preparation. Concise white sealant produced significantly ($p<0.05$) less microlaekage than wave flowable composite.

Conclusion: under the conditions of the present study, bur preparation (enameloplasty) followed by acid etching produces no less microlaekage than did acid etching alone. Concise white sealant (unfilled resin) demonstrated less amount of microlaekage when compared to wave mv flowable composite.

Key words: pit and fissure sealant, enameloplasty, unfilled resin, flowable composite.

Introduction

The major concern of modern dentistry, mainly for the last decades, has become focused on reducing patient's risk of caries, stimulating preventive measures and preserving tooth structure, indicating as often as possible, non invasive conservative techniques. The resin sealants undoubtedly contribute to preserve the integrity of the occlusal surface acting as an effective mechanical obstacle to plaque retention, therefore reducing the

* Assistant lecturer, Department of Conservative Dentistry, College of dentistry, University of Baghdad.
** Assistant lecturer, Department of Pediatric Dentistry, College of Dentistry, university of Unbar.
*** lecturer, Department of Conservative Dentistry, College of dentistry, University of Baghdad.

incidence of fissure caries. However the preventive benefit of this treatment rely upon the ability of the material to promote an appropriate sealing of pits, fissures or eventual anatomic defects and remain completely intact and bonded to enamel surface, thus preventing marginal microleakage and the consequent progression of carious process underneath the sealant.[1,2]

Mechanical preparation or enameloplasty was an earlier approach which involved widening to the fissures using rotary instrument. ([3])

It enhanced sealant penetration in to the deep fissures, permitted better diagnosis of underlying demineralized tissues and increased surface area for retention of the sealant. [4] For adequate retention of the sealant, it is necessary to maximize the surface area for bonding and ensure that the enamel be clean, free from salivary contamination and dry at the time of sealant placement. Micromechanical adaptation

of the sealant is achieved through porosities created by conditioning the enamel, conventionally by acid etching, before applying the sealant. [5]

Feigal 1998 [6] ,reported that the sealant loss was common in a regular events averaging between 5 to 10% each year and remarked that better sealant material, better use of bonding agents and alternative technique for the sealants would improve their overall effectiveness on all teeth.

Materials and Methods

Thirty two sound human third molars, extracted with in a six months period, their occlusal surfaces examined and they were stored in saline solution. They were cleaned with water-pumice slurry in dental prophylactic cup and carefully rinsed to remove the residual debris from pits and fissures. The apices were sealed with a light cured composite resin [7], and the teeth were randomly assigned in to four groups of eight teeth each:

Group A, the occlusal surfaces were etched with a 37% phosphoric acid gel (Scotch bond etchant gel, 3M ESPE, USA) for 30 seconds, rinsed with air\water spray for 20 seconds and gently air dried. A uniform layer of a pit and fissure sealant (Concise white sealant, 3M ESPE, USA) was applied over the treated surfaces from the central fissure upon the cusp height in order to prevent voids and air entrapment.

Group B, the occlusal surfaces were etched, rinsed, and air dried, then the flowable composite (Wave mv, SDI, Australia) was applied according to manufacturers.

Group C, the pit and fissures were prepared (0.5 mm depth) [8], with a diamond flamed shaped bur (Komet # 8833, Gebr. Brasseler Co.Lemgo, Germany), the occlusal surfaces were acid etched, rinsed, and gently air dried, then the Concise, white sealant was applied.

Group D, the pit and fissures were prepared (0.5 mm depth) with bur, the occlusal surfaces were acid etched, rinsed, and air dried, then the Wave mv flowable composite was applied.

The sealant materials were polymerized for 20 seconds using a visible light curing unit (3H instrument CO. LTD, Germany, ISO 9002).The sealed samples were stored in distilled water for 7 days at 37˚C and then thermocycled for 500 cycles between 5˚C and 55˚C water baths, dowel time was 30 minute, with a 3 second transfer time between baths[7]. In the preparation for dye penetration test, the specimens were dried superficially, entirely sealed with two layers of nail varnish excepting an area which is in the center of the occlusal surface 5 mm (width), and 1 mm window around the enamel ⁄sealant interface. The teeth were immersed in a 2% buffered

methylene blue solution for 24 hours at room temperature to allow dye penetration in to any possible gaps between the enamel and the sealant. All samples were embedded in a self curing acrylic resin (Subiton, Polvo, Argentina), to prevent chipping of the material as shown in fig (1). The teeth were then cross sectioned in a bucco-lingual plane through the sealant and each section examined at 4X magnification using a stereomicroscope.

The scoring criteria for the amount of dye penetration were accordingly [9], as follows:

Score 0 = no dye penetration.

Score 1 = dye penetration restricted to the outer half of the sealant.

Score 2 = dye penetration in to the inner half of the sealant.

Score 3 = dye penetration in to the base of the fissure.

Examples of the scoring are illustrated in fig 2,3,4,5.

The Pearson Chi-square analysis, for purposes of comparing groups overall.

RESULTS

The data of this study are demonstrated in table (1) & figure (6).

Chi-square test was performed to test the difference of leakage between Group (A) and Group (C) and between group (B) and group (D) , as shown in table (2) :

Since there is no significant difference in micro leakage for the same material with and with out bur preparation the readings were pooled together.

The results of the dye penetration for the two materials combine with and with out bur preparation presented in table (3).

To see the difference between the combine groups Chi-square test were done as shown in table (4).

Table (1): Score of dye penetration in all groups.

Groups / Score of dye penetration	A	B	C	D
0	7	0	5	o
1	1	6	3	4
2	0	1	0	3
3	0	1	0	1
Mean	0.125	1.375	1	1.625
S.D	0.3535	0.7440	0.6667	0.8333

Group A: - Concise white sealant with out preparation , Group B: - Wave mv with out preparation
Group C: - Concise white sealant with preparation , Group D: - Wave mv with preparation

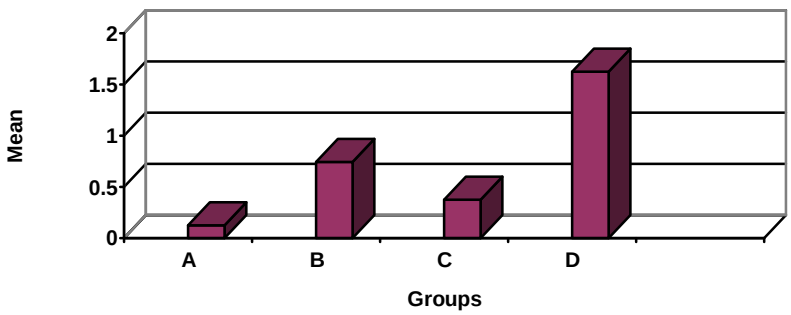

Fig. (6): Diagram showing the mean of dye penetration in all groups.

Table (2): Chi-square test between the groups

Type of Groups	X^2	d.f	Sig.
Group A & Group C	0.0160	3	N.S.
Group B & Group D	0.0112	3	N.S.

N.S. = Not Significant for (P > 0.05).

Table (3): Combine groups " same material with & with out bur preparation"

Groups / Score of dye penetration	A+C	B+D
0	12	0
1	4	10
2	0	4
3	0	2
Mean	0.25	1.5
S.D	0.4472	0.7302

Group A +C: - Concise white sealant with & with out preparation
Group B + D: - Wave mv with & with out preparation

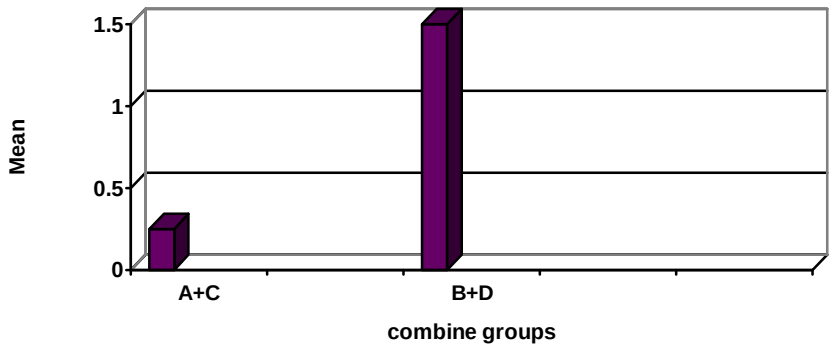

Fig (7): Diagram showing the mean of dye penetration in the combine groups.

Table (4): Chi-square test between the combine groups.

Type of Groups	X^2	d.f	Sig.
(A+C) & (B+ D)	14.2857	15	S

S.: Significant (P < 0.05). N.S.: Not Significant (P > 0.05).

H.S.: Highly Significant (P < 0.001).

Discussion

Microleakage is considered as one of the major problems in restoring teeth with different kinds of restorative materials. The factors which affect the microleakage include: polymerization shrinkage of the resin, coefficient of thermal expansion, the composition of the material itself, wetability of composite resin, and the presence and absence of an adhesive between tooth substances and the restorative materials [10, 11].

The need for surface cleaning and the method of cleaning pits and fissures prior to sealant placement may seen to be controversial. Raadal et al [12], suggests that careful removal of plaque and pellicle is done by the use of pumice or polishing instruments in order to obtain optimal acid etch pattern of the enamel, while another [13] claimed that the effect of acid etching alone is sufficient for surface cleaning. The literature is extensive on the efficiency of different cleaning procedures on bonding, including the use of rotary burs in order to remove superficial enamel and open the fissures with bur, which has given superior retention in one study[3],but in other studies it provides no additional benefit[14].

In the present study, we found that the use of bur before acid etching did not lead to significantly less microleakage .purposeful removal of enamel or enameloplasty just to wide the base of the fissure in a sound tooth structure is an invasive technique which disturbs the equilibrium of fissure system and exposes the tooth to un necessary cutting. This agrees with Mentes[7], and Chan et al [15] , but disagrees with Hatibovic et al[16], who found that the use of bur with acid etching gives superior result.

Virtually all contemporary compositions of pit and fissure sealants are unfilled and based on difunctional monomers (BIS-GMA), may be diluted with lower molecular weight species (TEGDMA) to reduce viscosity, the addition of filler particles to the sealant appears to have a little effect on clinical results[17] ; filled and unfilled sealants penetrate the fissures equally well[18] .

In the present study it was found that there is a significant reduction in the microleakage when Concise white sealant (un filled resin) was applied in comparison to flowable composite(60% by wt inorganic filler).Un filled resins are believed to undergo a volumetric shrinkage of approximately 5% during polymerization, compared to the filled resins undergoing only 1%. The addition of filler particles confers a greatly reduced coefficient of thermal expansion and a reduction in the expansion resulting form. It was believed that [19] the un filled resin has greater up take of water and consequently undergoes greater hygroscopic expansion, minimizing the effect of the high coefficient of thermal expansion, such hygroscopic expansion compensates completely and uniformly through out the sealant, eliminating the detrimental effect of thermocycling. In addition to that the rheologic property of the unfilled resin allows the sealant to spread across the enamel surface entering the enamel micropores, this improved adaptation of the material at the interface manifests as greater resin tag penetration prior to light activated polymerization. As filler content increases, the wetting characteristic of resin decreases [20]. The results of this study coincide with that of Barrie et al [21], and Yildiz[22], but disagree with that of Perez et al[23], who found that the use of concise white sealant produce significantly greater marginal microleakage when used without bonding agent .

Adequate bonding by the use of an adhesive layer beneath the sealant is important to prevent marginal microleakage, the use of flowable composite as a fissure sealant without bonding agent was seen to produce significantly greater microleakage. This may be due to the fact that bonding composite to etched enamel structure reduces the potential negative effect of a difference between the coefficient of thermal expansion of tooth structure and that of the material.

The shrinkage stresses of resin composite

During polymerization creates forces that compete with the adhesive bond, and this may disturb the bond to the cavity walls, which is one of the main causes of marginal failure and subsequent microleakage. The study was in accordance with that of Kwon, and park [24], but differs from the study of Gillet et al [26], who showed that the use of flowable composite with one bottle bonding is more efficient in sealing pits and fissures of non carious teeth. Finally, we must emphasize that the behavior of dental materials in laboratory conditions can be quite different from that registered in a clinical setting. The inherent problems in teeth selection, and the biological variations in enamel micro morphology from tooth to tooth, therefore, at best, the measurement of microleakage is a screening process prior to clinical traits.

Conclusions

1- There is no significant difference between the use of bur before acid etching and acid etching alone.
2- Concise white sealant (unfilled resin) demonstrated less amount of microleakage when compared to wave mv flowable composite.

References

1- **Jensen OE, Handelman SL**. Effect of an autopolymerization sealant on viability of microflora in occlusal dental caries. Scand J Dent Res 1980; 88:382-8.
2- **Jeronimous DJ, Till MJ, Sveen OB**. Reduced viability of microorganisms under dental sealants. ASDC J Dental Child 1975; 42:275-280.
3- **Shapira J,Eidelman E**. Six years clinical evaluation of fissure sealants placed after mechanical preparation .Pediatr Dent 1986; 8:204-5.
4- **Boj J, Xalabrade A, Gracia GF.** Microleakage of fissure sealants after enameloplasty. Pediatr Dent 1995; 17:143.
5- **Park K, Georgescu M, Scherer W, Schulman A**. Comparison of shear bond strength, facture patterns, and microleakage among un filled, filled, and fluoride releasing sealants. Pediatr Dent 1993; 15:418-421.
6- **Feigal RJ,** Sealants and preventive restorations, a review of effectiveness and clinical changes for improvement. Pediatr Dent 1998; 20:285-292.
7- **Mentus A, Gescoglu N,** An invtro study of microleakage of sealants after mechanical or air abrasion techniques with or without acid etching. EJPD 2000;1(4):151-6.
8- **Sturdevant CM, Roberson TM, Heymann HO, Sturdevant JR**. The art and science of operative dentistry. 3 rd ed. St. Louis: CV Mosby; 1995.p.412-3.
9- **Overbo RC, Raadal M.** Microleakage in fissure sealed with resin or glasss inomer cement. Scand J Dental Res 1990; 98:66-9.
10- **Craig G.R. (1997):** Restorative dental materials. 10th ed. The C.V. Mosby Co.; ch. 10.
11- **Manhart J.; Hickel R. and Weber K. (2001):** marginal quality and microleakage of adhesives class V restorations. J. Dent.; 29:123-130.
12- **Raadal M, Espelid I, Mejare I**. The caries lesion and its management in children and adolescents. Pediatric dentistry 2001:173-212.
13- **Gilpin JL**. Pit and fissure sealants: a review of literature. J Dent hygiene 1997; 71(4):150-8.
14- **Blackwood JA, Dilley DC, Roberts MW, Swift EJ**. Evaluation of pumice, fissure enameloplasty and air abrasion on sealant microlaekage. Pediatric dentistry 2002; 24(3):273-7.
15- **Chan DC, Summit JB, Gracia GT, Hilton TJ, Chung KH**. Evaluation of different methods for cleaning and preparing occlusal fissures. Oper Dent 1999; 24:331-6.
16- **Hatibovic KS, Wright GZ, Braveman I.** Microleakage of sealants after conventional bur, and air abrasion preparation of pits and fissures.Pediatr Dent 1998; 20:73-6.
17- **Waggoner WF, Siegal M**. Pit and fissure sealant application: up dating the technique. JADA 1996; 127(3): 351-361.
18- **Feigal RJ , Hitt J, Spleith C**. Retaining sealant on salivary contaminated enamel. JADA 1993; 124: 88-97.
19- **Ruyter I, Oysaed H**. composites for use in posterior teeth: composition and

conversion. J Biomed Mater Res 1987; 21:11-23.

20- **Gwinnett A, Matsui A**. A study of enamel adhesives the physical relation ship between enamel and adhesive. Arch Oral Bio I 1967; 12: 1615.

21- **Barrie AM, Stephen KW, Kay EJ**. Fissure sealant retention: a comparison of three sealant types under field conditions. Community Dent Health, 1990; 7(3):273-7.

22- **Yildiz E, Dorter C, Efes B, Koray F**. A comparative study of two fissure sealants: a two years clinical follow up. J Oral Rehabil 2004, 31(10):979-84.

23- **Perez LL, Cortes LO, Garcia BC, Cozar HA**. Marginal microlaekage of two fissure sealants: a comparative study. J Dent Child 2003; 70(1):24-8.

24- **Kwon HB, Park KT.** SEM and microleakage evaluation of three flowable composites as sealants without using bonding agent. Pediat Dent 2006; 28(1):48-53.

25- **Gillet D, Nancy J, Dupuis v, Dorignac G**. Microleakage and penetration depth of three types of materials in fissure sealant self etching primer versus etching: an invitro study. J Clin Pediatr Dent 2002; 26(2):175-8.

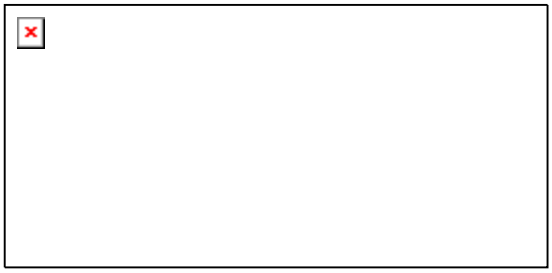

Fig (1) The tested groups were embedded in a clear acrylic blocks.

Fig (2) Section of a tooth sealed, which was scored as 0 =no dye.

Fig (3) Section of a tooth sealed, which was scored as 1=
The dye restricted to outer half of the sealant.

Fig (4) Section of a tooth sealed, which was scored as 2=
Dye Penetrated to the inner half of the sealant.

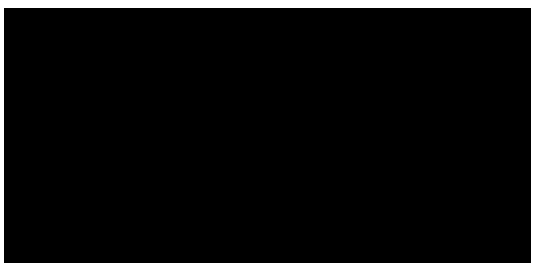

Fig (5) Section of a tooth sealed, which was scored as 3=
Dye penetrated in to the fissure.