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Tensile Bond Strength of Self-adhesive Flowable Composite as Pit and Fissure Sealant Bonded to the Enamel Surface in Comparison with Fissure Sealants (in vitro study)

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الخلاصة

الاهداف: تهدف الدراسة لمقارنة قوة رابطة الشد بين حشوة مائع ذاتية اللصق المركبة وثلاثة انواع من سداد الحفر والاخاديد (Prevent, Angie and Conseal). **المواد وطرائق العمل**: نفذت الدراسة التجريبية باستخدام ٤٠ سن من الاسنان الضواحك العلوية الاولى السليمة والتي خلعت لأسباب علاج التقويم , تم فصل التيجان عن الجذور وتم تنظيف وتلميع سطح المينا الدهليزي للحصول على سطح مينا جاهز للاختبار. قسمت الاسنان بصوة عشوائية الى اربع مجاميع معتمدة على نوع المادة مستخدمة ، في كل مجموعة عشر عينات , المجموعة الاولى: لفحص قوة رابطة الشد , (Vertise flow) المجوعة الثانية: لفحص قوة رابطة الشد , (Prevent) المجموعة الثالثة: لفحص قوة رابطة الشد , (Angie)المجموعة الرابعة: لفحص قوة رابطة الشد . (Conseal) تم تخريش سطح المينا بواسطة هلام حامض الفوسفوريك لمدة ١٥ ثانيه ثم غسل بالماء وجفف بالهواء وبعدها تم تثبيت انبوبة بلاستكية شفافة على سطح المينا وملئت بالمواد المراد فحصها (حشوة مركبه مائعة ذاتية الصق وحشوات سداد الحفر والاخاديد) , ثم وضع برغي جاهز مربوط براسه سلك تقويم مبروم قياس ٠,٠٠١٢ انج وضع الجزء المسنن من البرغي داخل الانبوبة في الكمية الاخيرة وصلب بالضوء. تم الاحتفاظ بالعينات في الماء المقطر تحت درجة حرارة الغرفة. تم قياس قوة رابطة الشد بوساطة جهاز الاختبار الشامل .(CHINA (GT-C04-2, GESTER, القيم تم تحليلها احصائيا باستخدام اختبارات one way Anova and Duncan. **النتائج** : يوجد اختلاف معنوي في قوة الرابطة الشد بين المجاميع (p<٠,٠٥ , قوة الرابطة لشد في Vertise Flow)كانت اعلى قيمة من حشوات سدادات الحفر والاخاديد (Prevent) , ثم (Angie) و .(Conseal) **الاستنتاجات**: القوة الرابطة لشد حشوة مائع ذاتية اللصق المركبة افضل من سدادات الحفر والاخاديد بسبب وجود مواد رابطة (Optibond) ومخدشه في داخل المادة.

ABSTRACT

Aims: The aims of this study to compare the tensile bond strength (TBS) of self-adhesive Flowable composite with conventional fissure sealants. **Materials and Methods** : an experimental study was carried out using forty non-carious upper first premolars that were collected of orthodontic extracted teeth. The crowns separated from the roots and the buccal surface were cleaned and polished to obtain a clean enamel surface. The samples were randomly divided into 4 main groups according to the types of resin material (n:10 for each group). Group I: testing TBS for Vertise Flow, Group II: testing TBS for Prevent, Group III: testing TBS for Angie, Group IV: testing TBS for Conseal. A translucent plastic tube was fixed after acid etching application on enamel surface for 15 seconds followed by water rinsed and air dryness, the tube filled incrementally with flowable resin and fissure sealant then ready small post screws with twisted orthodontic wire gauge 0.012 inch which placed inside the tube until the serrations of the screws were embedded in the last increment and light-cured. The Samples were stored in the distilled water at room temperature for 24 hours. Tensile bond strength was measured using a universal testing machine (Electronic Elastic Strength Tester GT-C04-2, GESTER, CHINA).The values were statistically analyzed using one way ANOVA and Duncan tests. **Results** : A significant difference in the tensile bond strength were observed among all groups ($p<0.05$). Vertise Flow showed higher tensile bond strength value than fissure sealants followed by Prevent , Angie and Conseal. **Conclusions**: The tensile bond strength of Vertise Flow better than the fissure sealant due to the presence bond (Optibond) with etchant properties..

Key words: Self-adhesive flowable composite, Fissure sealant, Tensile bond.

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INTRODUCTION

Pits and fissures are represented as malformations in cuspal odontogenesis, and considered as the main reason for developing occlusal caries. The complexity morphology of occlusal pits and fissures makes them favorable place for the stagnation of microbes and food residues[1]. The most caries-susceptible permanent tooth during the mixed dentition stage is the period of the first permanent molar eruption which has the long eruption phase as the enamel is immature during this period[2]. The retaining plaque nature of pits and fissures make them difficult to clean, thus triggering them to be more prone to carious lesion than areas of smooth surfaces and possibly not to be protected by fluoride therapy[3]. Newer methods in the field of dental cariology have focused on the importance of prevention of disease from the treatment of disease. One of the most commonly used preventive dental methods, it is the application of pits and fissures sealant which acts as physical prevention. The clinical efficiency of fissure sealants is depending on their retention and the retention level of a pit and fissure sealant depends on the micro-mechanical bond between the enamel surface and sealant material[4]. The most widely used fissure sealants are glass ionomer and resin-based fissure sealants. Conventional resin-based fissure sealants are not self-adhering so that, the surface area of teeth must be modified or etched by acids[5]. Resin dependent fissure sealants have disadvantages a totally dry area is necessary for the development of a strong bond, also the application is very method sensitive microleakage, time-consuming , fracture toughness, weak bond and wear[6]. The conventional fissure sealant may need bond placement before sealant application to improve bonding strength, it is known that enamel bonding is accomplished by the formation of resin tags in etched enamel to create micromechanical interlocking[23][12]. To get rid of these problems, a self-adhering resin(SAR) based fissure sealants were developed. The resin in these fissure sealants is a self-adhesive flowable composite that's used in the restoration of small Class one caries , Class five carious lesion, and non-carious lesions and the application is simple and non-difficult, and the surface area may do not need previ-

ous acid etching or bond placement with high enamel bonding property[7][19].

The aim of this study is to compare the tensile bond strength (TBS) of self-adhesive Flowable composite with conventional fissure sealants. The null hypothesis test was that there were non-significant differences in the bond strength between tested materials.

MATERIALS AND METHODS

The study was approved by Research Ethics Committee board (University of Mosul, College of Dentistry, REC reference No. POP/Ib.18/8/20).

Sample collection and preparation :

A total of forty non-carious extracted upper premolars, from young persons (14-18 years) which were extracted for orthodontic purposes, Inclusion criteria were teeth must not contain caries, restoration and hypo-mineralization, then teeth were collected and carefully cleaned by water and toothbrush to remove deposits of calculus, plaque, or debris and stored in 2% thymol until the experiment (a maximum of one month) the teeth were rinsed completely in the tap water and examined under a ×20 magnifier to reject those with structural faults and were kept in the distilled water at room temperature for a maximum of one week[8]. The teeth samples were divided randomly into 4 main groups (n:10). The root portion was separated and removed using diamond disc bur with water whereas the coronal portion was conserved, so we choose the flattest area of the buccal of each tooth was tested [9]. Each tooth specimen was inserted in an acrylic block , which has been prepared by pouring acrylic in the mold of the polyvinyl cube (trunk tray cable) , the flattest area of the buccal crown portion made parallel with acrylic level, when the cold cure acrylic resin set for all specimens, they were arranged into study groups, figure (1).

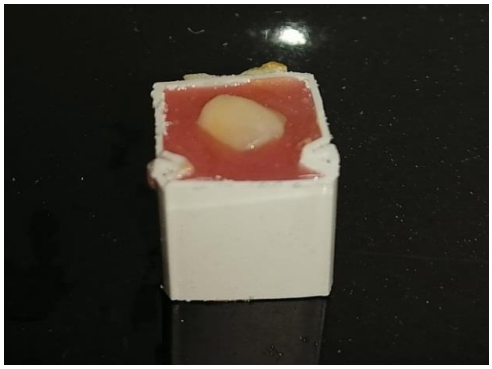

Figure (1) : Tooth specimen embedded in acrylic block

Samples Grouping:

The teeth samples were at randomly selected and divided into 4 groups according to the materials used:

Group I Vertise Flow (VF): its self-adhesive flowable composite

Group II Prevent (p) : its ionomer-based fissure sealant

Group III Angie (A) : its resin with fluoride-based fissure sealant

Group IV (Conseal) (C): its resin-based fissure sealant

The materials and their compositions as shown in the table (1).

Table (1) : The tested materials

Material	Brand name (manufacturer)	Shade	Batch	Composition
Pit and Fissure sealant	CONSEAL SDI company AUSTIRALIA	white	3153	urethane dimethacrylate base 7 % filled with a submicron filler size of 0.04 microns to withstand surface wear
Pit and Fissure sealant	Angie Angelus company Brazil	white	101128	Methacrylate monomers such as Bis-GMA and TEGDMA, Acid Methacrylate monomers, Stabilizers, Camphor-Quinone, Co-initiators and Aluminum fluoride silicate glass filler
Pit and Fissure sealant	Prevent FGM company Brazil	white	80119	Bis-GMA, Modified Urethane, Tegdma, Barium, Aluminum, Borosilicate, ionomer, Tetra-Acrylic Ester, Phosphoric acid, Sodium Fluoride, N-Methyl diethanolamine and Camphorquinone
Self-adhering Flowable composite	Vertise-flow Kerr company Italy	white	34402	GPDM, prepolymerized filler, 1-μm barium glass filler, nanosized colloidal silica, nanosized Ytterbium fluoride

Bonding procedure:

After dividing the prepared samples randomly into multi-groups ,the flattest area on the buccal surface of each tooth was tested for each group which will be subjected to conventional enamel conditioning through the use of slow speed handpiece brushing by non-fluoridated pumice for 10 seconds.[10] Then etching gel applied at concentration 37% phosphoric acid gel for 15 seconds then washed with air/water spray for 20 seconds and dryness with air carefully to obtain a chalky-white enamel, after that the bonding places were fixed by attaching a part of insulating tape "adhesive tape" with a round puncture in the middle with 3mm in diameter[11], figure (2).

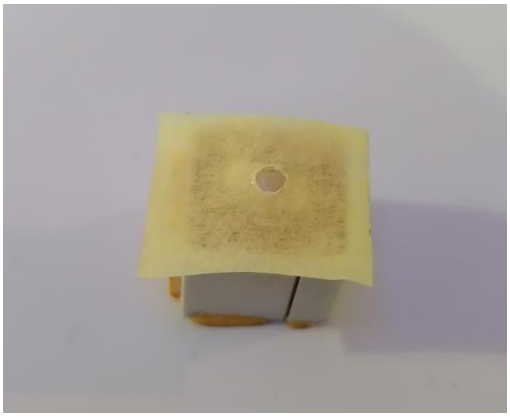

Figure (2): specimen attached by adhesive tape and the circular hole

A polyvinyl tube with a diameter of 3 mm (internal diameter) and a depth or height of 5mm was retained on the buccal surface. The sealant material was poured to 2 mm of material thickness and it was light cured for 20 seconds with intensity (420-480nm) by led light-cured device (LED, COXO), an additional 2 mm of sealant was poured over it, figure (3). The 0.012 gauge stainless steel orthodontic wire of length 15 cm which was twisted at one side and with a circle formed on the other end was adapted with small ready-made post screw after fixation of twisted wire with screw head, it was placed inside the uncured sealant material until all serrations of screw covered then light cure application, after that, the polyvinyl tubes or hollows tube was eliminated from the cured sealant[12,13].

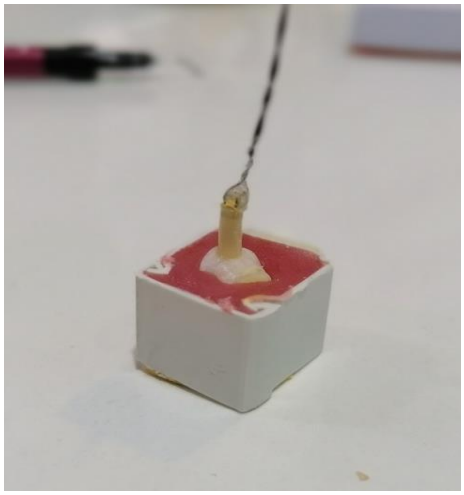

Figure (3): Cylindrical shaped sealant with screw bonded on the buccal surface

All the teeth samples were placed for 24 hours in the distilled water to avoid dehydration and examined for tensile bond strength through using a universal testing machine (UTM)[14,15]. Each sample was connected between two grasps of the UTM. The teeth samples were fixed in such a situation that the load was applied at the right angle or perpendicular to the sealant mass at a speed (1 mm/min), figure (4).

Area = πr^2

π= 3.14 r = radius

The point at which the sealant plug snapped from the enamel surface considered the breaking load and it denoted the tensile stress

Bond strength in Mega-Pascal (MPa) = load /area (N/mm2)

where the load in Newteon's(N) and area of the bonding surface in mm^2 was obtained with the following formula:

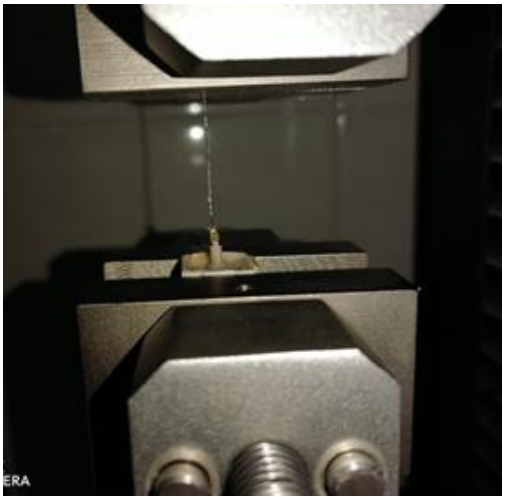

Figure (4): Sample testing using UTM

STATISTICAL ANALYSIS

Values are analyzed statistically by using software program "IBM SPSS- version 22" to obtain :

1. Descriptive Analysis: was used to observe the mean, standard deviation of Values.
2. Test of normality
3. Analysis of Variance (one way ANOVA test) used to determine the presence or absence of a significant difference among different groups at 0.05 level of significance.
4. Duncan's test was used to determine the presence significant difference between the groups.
5. All analysis was performed at 5% of significance.

RESULTS

- Mean and standard deviation (SD) of tensile bond strength as shown the in table (2).

Table (2): Means and Standard deviations of tested materials

Groups	Mean	Standard deviation
Vertise	14.24	1.89
Prevent	11.98	1.62
Angie	9.72	1.29
Conseal	9.31	0.99

- Test of normality

The significance values of Kolmogorov-Smirnov obtained by normality test are more than 0.05 so that, the distribution of all groups results are normally distributed, a parametric test used to analyze the values obtained from present study throughout using One Way ANOVA and Duncan tests as shown in the table (3).

Table (3) : Test of normality

Materials	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Vertise	.161	10	.200*	.953	10	.703
Prevent	.229	10	.146	.890	10	.168
Angie	.161	10	.200*	.952	10	.689
Conseal	.170	10	.200*	.953	10	.700

*This is a lower bound of the true significance

- One way ANOVA test showed significant difference found among the groups at ($p< 0.05$) table (4).

Table (4): Significance differences among groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	155.413	3	51.804	23.266	0.000
Within Groups	80.158	36	2.227		
Total	235.570	39			

- Duncan test showed that Vertise group exhibits a highest tensile bond strength values with a significant difference ($p\leq0.05$) followed by Prevent group while other remaining groups (Angie and Conseal groups) show no significant difference with lowest values as shown in the table (5).

Table (5) : The Duncan's Analysis for Determining the Significant difference among groups.

Groups	No.	Subset for alpha = 0.05		
		1	2	3
Conseal	10	9.3100		
Angie	10	9.7290		
Prevent	10		11.9860	
Vertise	10			14.2400

DISCUSSION

In the present study, an in-vitro model used to compare tensile bond strength of different fissure sealants with Vertise Flow , the values of ANOVA and Duncan revealed significant difference between them, it was found Vertise group was higher bond strength than Prevent , Angie and Conseal respectively.

Glycerol-phosphate Dimetracrylate (GPDM) is probably the most functional factor in Vertise Flow where it has proven good adhesive performance in both laboratory and clinical research.[16] Moreover, concurrence between bond strength and curing stress is decreased as the viscous elastic flow occurs at the same time as the bonding manner, This finding was supported by Juloski *et al.*, 2012 [17].

Margvelashvili *et al.* 2013 revealed Vertise Flow depends on the glycerol-phosphate dimetracrylate (GPDM) its bi-functional adhesive monomer, whose groups of acidic phosphate bond with calcium ions, also for etching the tooth structure, as the functional methacrylate groups copolymerize with the other mechanical

monomers, the cross-linking density and mechanical resistance of the material are increased , but their finding disagreed who said that the recent self-adhering flowable resin composite Vertise Flow produces same bond strength to conventional fissure sealant [18].

On the other hand, this study agrees with Owida *et al*., 2018 who concluded that Vertise Flow have significantly higher retention, bond strength and better sealing ability to pits and fissures when compared to Clinpro sealant (resin based sealant with fluoride, 3M ESPE,USA) [19]. The high bond strength of Vertise Flow due to Opti-Bond technology (All in one) that incorporating etching adhesive and priming. Regarding the mode of failure, Vertise Flow group showed significantly lower adhesive failure and higher cohesive failure than other groups and the lower tendency towards adhesive failure of the Vertise Flow may thus be attributed to its higher bond strength as concluded by Derelioglu *et al*., 2014[20]. Many modern studies have considered The substitution of sealants with flowable composites, thus allowing further preservation of primary and permanent teeth (Corona *et al*., 2005; Asselin *et al*., 2009) [21,22].

CONCLUSION

it may be concluded that Vertise Flow has significantly higher bond strength when compared to Fissure sealants due to adhesive and etchant properties of Vertise Flow.

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