

Comparison of Tensile Bond Strength between Fissure Sealants Placed After Rubber Cup Polishing and Air Polishing of Enamel Surface (An in vitro study)

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الخلاصة

الاهداف: تهدف الدراسة الى مقارنة القوة الرابطة لشد بين الحشوات المستخدمة في سداد الحفر والاخايد باستخدام طريقه جهاز التلميع الهوائي (Air Polisher) وطريقة التلميع بواسطة فرشاة المطاطي (Rubber cup). **المواد وطرائق العمل:** نفذت الدراسة التجريبية باستخدام 40 سن من الاسنان الضواك العلوية الاولى السليمة والتي خلعت لأسباب علاج التقويم, تم فصل التيجان عن الجذور ثم وزعت الاسنان بصورة عشوائية على مجموعتين مكونتين من عشرين سنا اعتمادا على نوع الحشوة المستخدمة (Prevent or Angie), قسمت كل مجموعة الى مجموعتين فرعيتين مكونة من عشرة اسنان معتمدة على طريقة تنظيف سطح المينا قبل تطبيق المادة, اما بطريقة الفرشاة المطاطية مع ملاط الخفاف (Rubber cup with pumice slurry) او طريقة تلميع الهوائي (Air polisher). **المجموعة الاولى** I a : Prevent and Rubber cup (PRC) **المجموعة الاولى** II a : Angie and Rubber Cup (ARC) **المجموعة الثانية** I b : Prevent and Air polisher (PAP) **المجموعة الثانية** II b : Angie and Air polisher (AAP). تم تخريش سطح المينا بواسطة هلام حامض الفوسفوريك لمدة 20 ثانية ثم غسل بالماء لمدة 20 ثانية وجفف بالهواء للحصول على سطح ابيض تباشيري متناسق وبعدها تم تثبيت انبوية بلاستيكية شفافة على سطح المينا وملئت بالمواد المراد فحصها بصورة تدريجية , ثم وضع برغي جاهز مربوط براسه سلك تقويم مبروم قياس 0.12, 0.1 انج مع وضع الجزء المسنن من البرغي داخل الانبوية في الكمية الاخيرة وصلب بالضوء , تم الاحتفاظ بالعينات في الماء المقطر تحت درجة حرارة الغرفة لمدة 24 ساعه. تم قياس قوة رابطة الشد بواسطة جهاز الاختبار الشامل (CHINA GT-C04-2, GESTER) القيم تم تحليلها احصائيا باستخدام اختبار Independent sample t-Test. **النتائج:** لا يوجد اختلاف معنوي بين الطريقتين المستخدمتين في المجاميع ($p>0.05$). **الاستنتاجات:** طريقة تنظيف الاسنان باستخدام التلميع الهوائي سهلة ومفيدة ولكن لا يوجد اختلاف معنوي بينها وبين طريقة الفرشاة المطاطية مع ملاط الخفاف.

ABSTRACT

Aims: study aims is to compare the tensile bond strength between fissure sealants placed after rubber cup pumice polishing and air polishing of the enamel surface. **Materials and Methods:** An experimental study was carried out using 40 non-carious upper first premolars extracted for an orthodontic reason, the crowns were separated from the roots, the teeth were randomly divided into 2 main groups consisting of 20 crowns depending on the sealant material used (Prevent or Angie), the teeth were subdivided into two subgroups of 10 teeth depending upon whether rubber cup with pumice slurry polishing or air polishing. Group Ia: Prevent Rubber cup (PRC). Group Ib : Prevent Air polisher (PAP), Group IIa: Angie Rubber cup (ARC). Group IIb: Angie Air polisher (AAP). Each tooth in this study was etched with a 37% semi-gel phosphoric acid for 15 seconds on the buccal surface, rinsed thoroughly for 20 seconds, and dried with the air stream to get an uniformly white, chalky-similar appearance. A translucent plastic tube was fixed on an etched enamel surface and filled incrementally with a fissure sealant then ready small post screws with twisted orthodontic wire gauge 0.012 inches which placed inside the tube until the serrations of screws were embedded in the last increment and light-cured. Samples were kept in the distilled water at room temperature for 24 hours. Tensile bond strength was measured by using the universal testing machine (GESTER, GT-C04-2, CHINA) and the values were statistically analyzed using Independent sample t-test. Results: A non-significant difference in tensile bond strength was detected between two methods used in the groups ($p>0.05$). **Conclusions:** The air polishing method is easy and useful but, there were no significant differences on the tensile bond strength of material in comparison with a rubber cup and pumice

Key words: Fissure sealant, Air polisher, Rubber cup, Tensile bond strength.

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INTRODUCTION

The recent dentistry has focused on preventive approaches and conservative methods to apply less-invasive techniques to the dental structure(1). Pit and fissure caries occur mostly on the occlusal, buccal surfaces and palatal grooves of posterior teeth(2). The anatomical depth and morphological shape for pits and fissures enhance the caries possibility due to enable plaque accumulation. The deep fissures become more difficult to scrub or cleaning by toothbrush and consequently hold more plaque deposits and trap more food fragments that are represented a good environment for bacterial growth(3). Fissure sealants are one of the main prevention measures for reducing the risk, and the occurrence of caries in the fissure area, also avoiding the need for more invasive dental procedures(4). A variety of factors play a role in the failure of sealant treatment such as bad isolation, micro-leakage, sealant detachment, presence of caries in a deep grooves and its extension after sealing the fissures, incomplete removal of fissure stains and the skill of the dentist. The cleaning of fissures is an important procedure before sealant application and

there is some difficulty to remove stains and debris in a deep area of fissures especially by rubber cup with pumice slurry. The air-polishing technique is almost painless, requires no anesthetic injection, and creates no vibration and without heat, making it a good choice for children who may be scared of the needle, and noise with the vibration of a traditional rubber cup (5). The air-polishing device is more effective than rubber cup polishing when cleaning the fissure area before etching for sealant placement (6).

The study aims to compare the tensile bond strength (TBS) of two different types of fissure sealants placed after rubber cup pumice polishing and air polishing of the enamel surface. The null theory test was that there were no statistically significant differences in the tensile bond strength of tested materials between two methods of enamel surface cleaning.

MATERIALS AND METHODS

Sample collection and preparation :

The study was approved by Research Ethics Committee board (University of Mosul, College of Dentistry, REC reference No. POP/Ib.5/9/20).

Forty non-carious upper premolars which were extracted from young persons (16- 18 years old), for orthodontic purposes were chosen. Inclusion criteria were teeth must not contain caries, restoration, and hypo-mineralization, the teeth were collected and carefully cleaned 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 carefully in running tap water and examined under a 20X magnifier to reject those with structural faults and were stored in distilled water at room temperature for a maximum of one week^(v).

The root portions were separated and removed using diamond disc bur (MANI, CHINA) with water whereas the coronal portion was conserved, the flattest area of the buccal of each tooth was chosen to be tested⁽⁸⁾. Each tooth was implanted in the block of acrylic, which was prepared by pouring acrylic in the mold of the polyvinyl cube (trunk tray cable), the flattest area of the buccal crown portion was exposed and placed parallel with acrylic level, when the cold cure acrylic resin set for all specimens, they were arranged into study groups, figure (1).

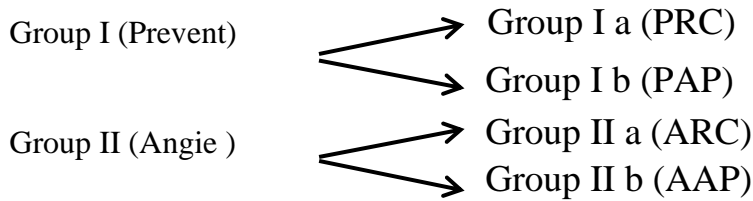


Figure (1) : Teeth samples prepared

Samples Grouping:

The samples were randomly selected and divided into 2 main groups. The main group was further subdivided

into two subgroups of ten teeth depending upon whether rubber cup with pumice polishing(RC) or air polishing(AP), the materials and their compositions shown in the table (1).



PRC: Prevent with Rubber cup, PAP: Prevent with Air polisher
 ARC: Angie with Rubber cup, AAP: Angie with Air Polisher

Table (1): The tested materials and their compositions

Material	Brand name (manufacturer)	Shade	Batch	Composition
Pit and Fissure sealant	Angie Angelus company Brazil (Resin-based)	white	101128	Methacrylate monomers 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 (Glassionomer based)	white	80119	Bis-GMA, Sodium Fluoride Modified Urethane, Tegdma, Barium, Aluminum, ionomer, Tetra-Acrylic Ester, Phosphoric acid, , N-Methyl diethanolamine, Borosilicate and Camphorquinone

Bonding procedure:

After dividing the prepared samples randomly into multi-groups, the flattest area on the buccal surface of each tooth was treated and tested for each group. The enamel buccal surfaces of one subgroup were exposed to conventional enamel conditioning through the use of slow speed handpiece brushing by non-fluoridated pumice for 15 seconds.⁽⁹⁾ The other subgroup was subjected to enamel conditioning by air polisher device using calcium carbonate powders with an average particle diameter of 54 µm. for (15) seconds through setting or installing the air polisher de-

vice on fabricated wood stand for holding the device to confirm standardization procedure, the distance between the nozzle tip and tested enamel surface with nozzle tip 0.5cm perpendicular on the enamel surface (air pressure: 2.5–3 bar according to manufacturer instruction) with water stream, steady sweeping motion along the surface to achieve a uniform, frosty appearance^(10,11), figure (2). The etching gel applied with 37% phosphoric acid gel for 15 seconds and washed with water spray for 20 seconds and dried with air carefully to get a chalky-white enamel, the bonding places were determined fixed by at-

tachment a piece of separating tape
"adhesive tape" with a circular hole in
the middle with 3mm in diameter⁽¹²⁾.

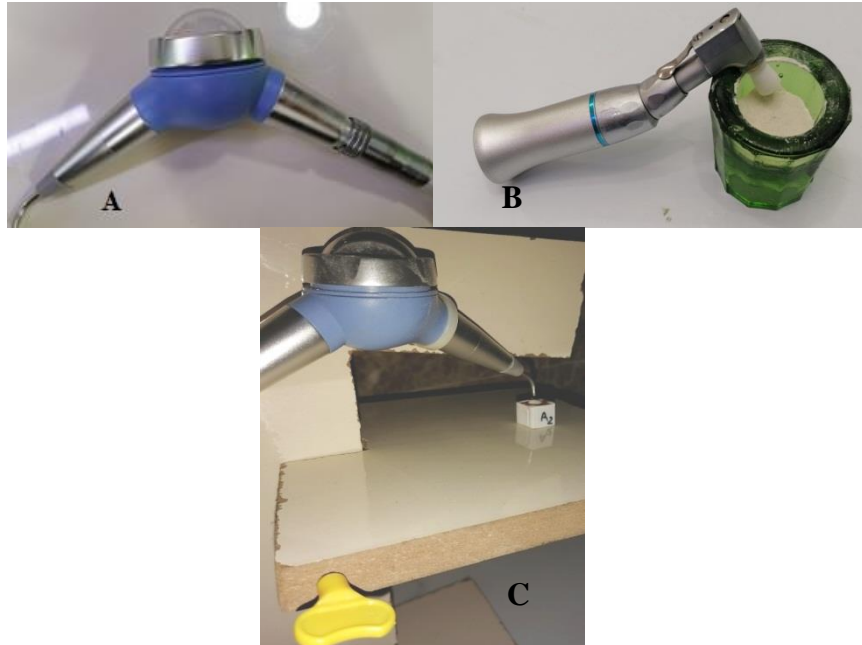


Figure (2): Air polisher device (A), Slow speed handpiece with pumice (B) Fabricated wood stand with air polisher and sample (c).

A polyvinyl tube with a 3 mm diameter (internal diameter) and a depth of 5mm was positioned on the buccal surface and stabilized. The sealant was condensed to a thickness of 2 mm and it was light-cured for 20 seconds with intensity (420-480nm) by LED light cure device (COXO, CHINA), then an additional 2 mm of sealant was placed over it. The 0.012 gauge stainless steel orthodontic wire of length 15 cm which

was twisted at one end and with a ring formed at the other side was adapted with a 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 the screw were covered and then light cure was applied. After complete curing, the polyvinyl tubes or hollows tube was removed^(13,14), figure (3).

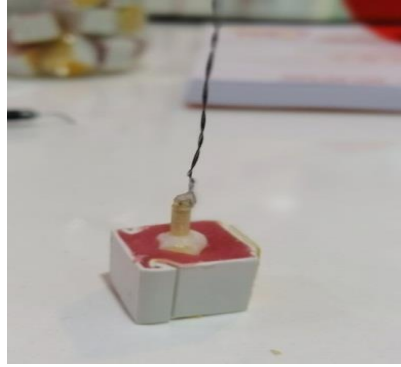


Figure (3): Sample prepared with cylindrical shaped sealant

All the teeth samples were placed for 24 hours in the distilled water to avoid dehydration and examined for bond strength using of the universal testing machine (GESTER, *GT-C04-2*, CHINA)^(15.16). Each sample was connected between two clasps of the machine. The teeth samples were fixed in such a situation that the load was applied perpendicular to the sealant mass at a speed (1 mm/min), figure (4).

$$\text{Area} = \pi r^2$$

$$\pi = 3.14 \quad r = \text{radius}$$

The moment at which the sealant mass was broken from the enamel surface considered the breakage load and it denoted the tensile stress.

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

Where the load in Newton's (N) and area of the bonding surface in mm² was obtained with the following formula:

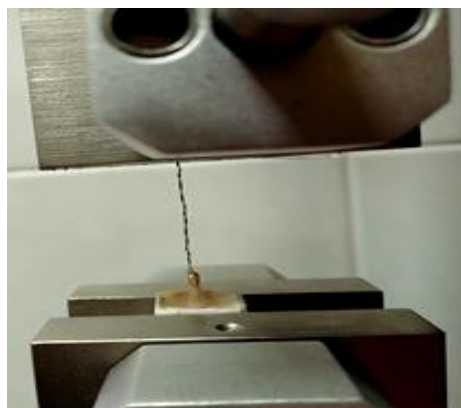


Figure (4): Sample testing using Universal testing machine.

STATISTICAL ANALYSIS

Values were analyzed using a software program "IBM SPSS- version 22" to obtain:

1. The descriptive statistics was used to observe the standard deviation and mean of the values.
2. An independent sample t-test was used to compare two groups.

RESULTS

Descriptive statistics:

Mean and standard deviation (SD) of the results are shown in Table (2).

Table (2): Mean Tensile Bond Strength For the Groups± Standard Deviation

Groups	Mean	Standard deviation
Group I a(PRC)	11.98	1.62
Group I b(PAP)	12.88	2.18
Group II a(ARC)	9.72	1.29
Group II b(AAP)	10.0	0.50

- Independent sample t-test for Prevent Air Polisher (AP) and Prevent Rubber cup (RC):

The analysis of t-test showed a non-significant difference ($p>0.05$) between Prevent Air Polisher (PAP) and Prevent Rubber Cup (PRC) as illustrated in a table (3).

Table (3): The Independent t-test analysis between Prevent Air Polisher and Prevent Rubber Cup.

t-test for Equality of Means			
Prevent (AP) and Prevent (RC)			
	t	df	Sig. (2-tailed)
Equal variance non assumed	1.04	16.64	0.31

t- Test, Non-Significant difference $P > 0 .05$

Independent sample t-test for Angie Air Polisher (AAP) and Angie Rubber cup (ARC).

The analysis of t-test showed a non-significant difference ($p>0.05$) between

Angie Air Polisher (AAP) and Angie Rubber Cup (ARC). As illustrated in table (4).

Table (4): The Independent t-test Analysis between Angie Air Polisher and Angie Rubber Cup.

Angie (AP) and Angie (RC)	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances not assumed	0.70	11.73	0.49

t- Test, Non-Significant difference $P > 0 .05$

DISCUSSION

Dental professionals should be attentive to new approaches for the inhibition of pit and fissure caries, including the introduction of recent dental materials and tools⁽¹⁷⁾. The first stage of using the sealants is to clean the occlusal surface to eliminate all debris and organic deposits from the fissures⁽¹⁸⁾. The surface can be cleaned with bristle brushes, rubber cups and air-powder polisher devices. However, the usage of rubber cups or bristle brushes is often hard, time-consuming and ineffective in totally removing stains and debris, especially from deep pit and fissure areas. As an alternative, air polishing methods, have been constantly active and powerful for eliminating stains and deposits⁽¹⁹⁾. Waggoner WF and Siegal M.(1996) recommended that the pumice

with a rubber cup or bristles used for polishing and cleaning should be fluoride-free to prevent risking the surface bond⁽²⁰⁾. The most recent suggestion appears to indicate that fluoride does not diminish retention capability^(17,21).

Wright *et al.*, (1999); Burrow *et al.*, (2001) said that the existence of a prism less layer of enamel at the entry of fissures and fissure walls diminish the etching ability of acid gel and the air polishing system eliminates this layer and improves the development of resin tags to gain improved bonding outcomes. Furthermore, deposits contamination at the fissure bases and walls cannot be reached by regular etching procedures might prevent the spreading of the sealant and its capability to come into near touch with enamel^(22,23).

In the present study the results of the independent t-test obtained from the comparison between air polisher and rubber cup with pumice slurry regarding with materials showed all of the fissure sealants there were an increase in tensile bond strength of air polisher groups but non-significant difference in the results between groups may be due to parameters that's found in air polisher device include the pressure, the nozzle geometry of different systems , type and size of powders, exposure time and distance between the nozzle tip and enamel surface all these effects on bond strength outcome, calcium carbonate (Flash Pearl, NSK) powders that used in this study are available in round particles are safe for children with a little defect on enamel surface that's constitutes to produce non-significant results.

This study didn't fully agree with the findings of Natalia *et al.*, (2016) who was made the comparison and evaluation the effect of different approaches of prophylaxis and conditioning of enamel on sealant adhesion and concluded there was higher tensile bond strength in the group treated with air polisher than non-fluoridated pumice group⁽²⁴⁾.

The previous study by Selecman *et al.*,(2007) on the influence of preparation methods, fissure shape and material features on the in vitro margin penetrability and permeability of pit and fissure sealants

which revealed no differences in the retention rate between pumice prophylaxis and air abrasion⁽¹⁹⁾

CONCLUSIONS

It can be concluded that both methods of cleaning pits and fissures using air-polishing device with calcium carbonate powders and rubber cup with pumice polishing were efficient in cleaning with no significant differences on the tensile bond strength of sealant material.

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