In Vitro Comparative Assessment Of The Effect Of Gutta-Fusion Obturation On The Push Out Bond Strenght Of Three Types Of Sealers

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ABSTARCT

Background: The bond strength of the root canal sealers to dentin is very important property for maintaining the integrity and the seal of root canal filling. The aim of this study was to evaluate and compare the push-out bond strength of root filled with total fill Bioceramic, AH Plus and Gutta-flow®2 sealers using GuttaFusion®obturation system versus single cone obturation technique.

Materials and method: sixty of mandibular premolars teeth with straight roots were used in this study, these roots were instrumented using Reciproc system, instrumentation were done with copious irrigation of 3 mL 5.25% sodium hypochlorite solution (NaOCl) during all the steps of preparation, and smear layer will be removed with 1 ml of 17% EDTA kept in the canal for 1 min, roots were randomly divided into two groups according to the obturation technique (thirty teeth for each group):

Group I: Single Reciproc Gutta percha cone obturation technique, Group II: Gutta fusion obturation technique, then each group divided into three subgroup according to the type of sealer, AH subgroup: AH Plus sealer, BC subgroup: bioceramic sealer and GF subgroup: Gutta flow 2 sealer. The roots then stored in moist environment at 37°C for one week, the roots were embedded in clear acrylic resin and each root sectioned into three levels apical, middle and cervical. The bond strength was measured using computerized universal testing machine each section fixed in the machine so that the load applied from apical to cervical direction at 0.5mm/min. speed and the computer show the higher bond force before dislodgment of the filling material. These forces were divided by the surface area to obtain the bond strength in MPa.

Results: Statistical analysis was performed and the result showed a highly significant differences between the three types of sealers when the same obturation technique were used, also there is highly significant differences between two groups with two different obturation technique.

Conclusion: This study showed that the push out bond strength of AH plus sealer was higher than bioceramic sealer and Gutta flow 2 sealer respectively when the same obturation technique was used. The push out bond strength was affected by the obturation technique and Gutta fusion obturation technique showed higher bond strength than single cone obturation technique when the same type of sealer was used.

Key words: push-out test, bond strength, endodontic sealers, Gutta fusion. **(J Bagh Coll Dentistry 2017; 29(4):13-19)**

INTRODUCTION

Successful root canal treatment depends on thorough debridement of the root canal system, the elimination of pathogenic microorganisms and finally, complete sealing of the canal space to prevent ingress of the bacteria from the oral environment and spread to the apical tissue [1].

Many obturation systems were proposed for endodontic treatment to approach the good sealing ability and adhesion to dentin. An ideal root canal sealer should adhere firmly to both dentin and core filling materials[2].

In order to obtain a fluid tight or a fluid impervious seal a sealer should exhibit certain properties like insolubility, low shrinkage, bacteriostatic, hermetically sealing [3].

The adhesive properties of endodontic sealers are important as gutta-percha does not bond to root dentin and is used in conjunction with a root canal sealer.

The risk of filling detachment from dentin during restorative procedures or the masticatory function is minimized if the bond strength of endodontic sealers to dentin is good, thus making it an important property of filling materials [4].

Adhesion depends on a multitude of interacting factors including the surface energy of the adherent (dentin or core materials), surface tension of the adhesive (sealer), the adhesive ability to wet the surfaces and the cleanliness of the adherend surface [5]. Resistance to the dislodgement of materials applied to root canal dentine is generally evaluated by push-out tests(6).

Moreover, the push-out test has been used to evaluate the bond strength of root filling materials in root canals[4, 7].

MATERIALS AND METHOD

Sample preparation

Sixty freshly extracted straight mature fully developed mandibular premolars with straight single roots and close apices were used in this study. The age of patients range between (18-48) years but the reason of extraction and gender was not considered.

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After extraction, all teeth were stored in distilled water. Any periodontal remnants or soft tissues were ml periodontal curette and root surfaces were verified with magnified eye lens.

After the length of root was determined by digital caliper and marker to 15 mm from apex to cemento-enamel junction, the root was sectioned perpendicular to its long axis by using diamond disc in a straight handpiece with water coolant to facilitate straight line access for canal preparation and filling procedure, also to eliminate the variables in access preparation and get flat reference point for measurement as in figure 1 [8].

Figure 1: Crown sectioning

The patency of canals was verified by insertion of No. 10 K file followed by 15 into canal until it was visualized at apical foramen.

The roots were instrumented by Rotary Reciproc (NiTi) system by using an electric device (VDW gold, VDW GmbH, Munich, Germany) according to manufacturer's instructions and completed in a crown-down manner using a gentle in-and-out motion up to R40 size.

The smear layer of the root canals was removed using standardized protocol of irrigation (3mL of 5.25% NaOCl followed by 1ml of 17% EDTA 1 min and the final rinse with 3mL distilled water) [9]. The delivered with needle gauge 27. Placed within apical third passively without bending and washed after each file.

The roots were randomly divided into two groups (n=30) according to types of obturation technique used:

GROUP I. Single cone Reciproc obturation technique.

GROUP II. Gutta-fusion obturation technique

Then each group was subdivided into three subgroups (n=10) according to

The type of sealer used;

Subgroups:

AH: The root canal were obturated using AH plus sealer

GF: The root canal were obturated using Gutta-flow®2 sealer

BC: The root canal were obturated using Total fill sealer

After the storage period, the roots were embedded in clear acrylic resin. After complete curing of the acrylic mold, the metal mold was open. The Excess acrylic was cut off using diamond disk (0.7mm) mounted on straight hand piece.

And engine with a rotation speed regulator, the hand piece was fixed in a Cutting device. The root was cut horizontally the cuts with flow of cold water (19-25°C) to minimize smearing [10]. To get three Sections of 2 mm in thickness coronal, middle and apical, the cuts were made at **2,6,10** mm from coronal reference point respectively as in figure 2

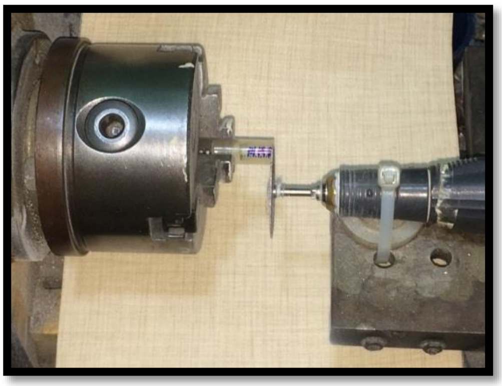

Figure 2: root sectioning

Push out bond strength test

Push-out test was performed by applying a compressive load to the apical aspect of each slice via a cylindrical plunger mounted on Universal Testing Machine managed by computer software figure

Samples were examined using Nikon camera with macro lens 105 mm and pictures of both sides of each section are taken and measurements calculated using Image J software analysis program.

The circumstance of both apical and coronal side of the section at each level was calculated. The area under load was calculated by ½ * (circumference of coronal aspect + circumference of apical aspect) *thickness [1]. The obturated area of the section at each level was measured from the apical side to determine the size of punch pin. Three different sizes of punch pins were used, 0.7 mm, 0.5mm, and 0.4mm diameter for the coronal, middle and apical slices respectively. The punch pins should provide almost complete coverage over the main cone without touching the canal walls and sealer [1, 11].

The sections were placed above the acrylic base with its apical direction upward and the coronal direction downwards because the load should be applied to the apical aspect of the root section and in a coronal direction. The root filling in each section subjected to loading using a universal testing machine.

Loading was performed on microcomputer electrical control universal testing machine at a speed of 0.5 mm / min in an apical-coronal direction until the first dislodgment of obturating material and a sudden drop along the load deflection. The punch was positioned so that it only contacted the core filling material and avoided contact with the sealing agent and root canal walls [11].

The maximum failure load was recorded in Newton (N) and was used to calculate the push-out value in MPa from force (N) divided by area in mm [1].

$$\text{The failure load (12)} = \frac{Force\ (n)}{Area\ (\text{mm}^2)}$$

Failure mode analysis

After the push-out bond strength test, both sides of the sample including the main cone and sealer plug were examined under light microscopy (ST 60 series, China) to determine the mode of failure. Each sample was evaluated at 2X magnification (2X equivalent to 20 X), Each sample was evaluated and placed into one of 3 failure modes (1): Type I: adhesive failure, either at the sealer-dentin (S/D) or between the sealer-core (S/C) interfaces, Type II: cohesive failure, within the filling material (core material), Type III: mixed failure, which contains both adhesive and cohesive failures.

RESULTS

The bond strength values for each groups are given in Table 1. The mean bond strength for AH Plus sealer in Group II was maximum (2.73 ± 0.41 MPa) among the three sealers and between the two groups. The mean strength of Gutta flow 2 sealer was lower in Group 1 (0.48 ± 0.19MPa).

Table 1: Descriptive Statistics for bond strength according to groups and sealers to determine whether the group effect, sealer effect and their interaction are statistically significant, two-way analysis of variance (ANOVA) was performed with the results shown in Table 2. The analysis revealed that the group effect was statistically highly significant (P ≤ 0.01), the sealer effect was also highly significant (P ≤ 0.01). Further, the interaction effect of group and sealer was Non significant (P value = 0.938).

Groups	Sealer	Mean				±SD			
		Site				Site			
		Apical	Middle	Coronal	Total	Apical	Middle	Coronal	Total
GI	AH	1.97	2.45	2.77	2.40	0.22	0.22	0.17	0.39
	GF	0.26	0.49	0.69	0.48	0.04	0.07	0.11	0.19
	BC	0.65	0.86	0.87	0.80	0.08	0.23	0.21	0.21
	Total	0.96	1.27	1.44	1.22	0.76	0.88	0.97	0.89
G II	AH	2.23	2.90	3.06	2.73	0.21	0.14	0.22	0.41
	GF	0.78	0.81	0.92	0.83	0.07	0.10	0.08	0.10
	BC	1.00	1.15	1.33	1.16	0.17	0.16	0.15	0.21
	Total	1.34	1.62	1.77	1.57	0.67	0.94	0.96	0.87
Total	AH	2.10	2.67	2.92	2.56	0.25	0.29	0.24	0.43
	GF	0.52	0.65	0.80	0.66	0.27	0.18	0.15	0.23
	BC	0.83	1.00	1.10	0.98	0.22	0.24	0.30	0.28
	Total	1.15	1.44	1.61	1.40	0.73	0.92	0.97	0.90

Table 2 :Two-way ANOVA for bond strength

Source	Type III Sum of Squares	df	Mean Square	F	P-value	Sig.
Corrected Model	130.692[a]	5	26.138	345.778	.000**	H.S.
Intercept	352.548	1	352.548	4663.772	.000**	H.S.
Groups	5.523	1	5.523	73.062	.000**	H.S.
Sealer	125.159	2	62.580	827.850	.000**	H.S.
Groups * Sealer	.010	2	0.005	0.064	0.938	N.S.
Error	13.153	174	0.076			
Total	496.393	180				
Corrected Total	143.845	179				

Failure analysis showed the predominant failure mode to the adhesive mode of failure was predominant in AH sealer when obturated with single cone however in the other groups, the mixed failure was the predominant failure mode. The cohesive type of bond failure occur less frequently.

DISCUSSION

The stability of a filling depends upon the bond of the sealer to Gutta- percha and dentin. An ideal endodontic sealer should adhere firmly both to dentin and gutta-percha. The sealers vary markedly in their adhesion to dentin and gutta-percha[13].

Adhesion of root canal filling material to dentinal walls is important in both Static and dynamic situations. In a static situation, it should eliminate any space that allows the percolation of fluids between the filling and the wall. In a dynamic situation, it is needed to resist dislodgement of the filling during Subsequent manipulation [3].

In the present study, the bond strength performance of single matched-taper gutta-percha cone techniques of reciprocating NiTi systems with different sealers was evaluated and compared with that of the carrier based obturator technique. The results demonstrated that the bond strength of the filling material to the root canal is dependent on both the filling technique and the sealer. The highest bond strength values were observed when the carrier based obturator technique was used when compared with single cone technique.

The bond strength of root canal sealers to dentine is important for maintaining the integrity of sealing in root canal filling. Bond-strength testing has become a popular method for determining the effectiveness of adhesion between endodontic materials and tooth structure [14].

In this study, the epoxy resin-based AH Plus sealer was chosen as a reference. It has higher bond strength than most other sealers [4, 11].

The epoxy resin-based AH Plus sealer was chosen also due to its excellent properties, such as low solubility, small expansion, and it's very good sealing ability, its looked as a (Gold Standard) [15].

In this study epoxy resin-based AH plus sealer showed superior dentin Push out bond strength among the tested sealers, this is agreed with [16] who test that there are differences in bond strength between endodontic sealers to either dentin or gutta-percha.

The result of this study Agree with [17] who compare the bond strength of different root canal obturation sealer (AH plus, bioceramic sealer and GuttaFlow 2 sealer) and single cone obturation technique were used and they found that AH Plus group has the highest mean values at all levels in comparison with other groups followed by BC group, then GuttaFlow2 group.

The result of our study agree with [18] who compared the bond strength of Epoxy resin based and UDMA based sealers and to assess the relative bond strengths between Dentin-Sealer and Sealer-main cone, by testing canals filled with and without a main cone.

Also agree with [19] who compare push-out bond strength of four obturation systems; Gutta-percha/AH Plus, GuttaFlow, RealSeal and EndoREZ system to root canal dentin.

The findings of this study regardless of the filling technique used, agree with [20] who found that AH Plus presented higher push-out bond strength values than Epiphany SE.

The probable reasons of higher push out strength for AH Plus and gutta-percha could be:

- Formation of a covalent bond by an open epoxide ring to any exposed amino groups in collagen.
- Very low shrinkage while setting.
- Long term dimensional stability.
- Inherent volumetric expansion of AH Plus may have contributed to the superior bond strength of AH Plus

- Epoxy-based resin sealer penetrates deeper into the dentinal tubules and micro-irregularities due to its flowability and long-term polymerization time, which might contribute to enhancing the mechanical interlocking between the sealer and dentin(21).

The result of this study disagreed with [22] who found a non-significant difference in the push-out bond strength between AH Plus and BC sealer. May be duo to different type of manufacture of bioceramic sealer that were used by them also may be difference in method of measurement in which measured the push out bond strength of AH plus and Bioceramic sealer at middle third only.

The bioceramic sealer showed push out bond strength lower than AH plus this could be explained by:

[23]who found that the lower value achieved when bioceramic sealer used with Gutta percha can be attributed to the BC sealer as it does not bond with the gutta-percha cones, but if Bioceramic cones or ActiV GP cones were used, the bond strength might have increased.

Also BC Sealer is, described by its manufacturer as an insoluble, radiopaque, aluminum-free material that requires the presence of water to set and harden. So in our study we obturated dry canals [17].

Silicon based Gutta-Flow sealer showed the least shear bond strength to dentin among the tested groups, this result is in agreement with (5)and [13] who showed that there is little opportunity for polydimethylsiloxane to react with dentin. This may be due to the poor wetting

Of Gutta Flow on the dentin surface because of the presence of silicone, which

Possibly produces high surface tension forces, making the spreading of these materials more difficult [24].

The use of single-cone techniques resulted in low bond strength values. Anatomical variations of the root canal often result in an insufficient adaptation of larger master cones to the root canal[25].

Carrier coated with Gutta percha based thermal obturation techniques had been used in this study, producing a more homogeneous mass of gutta-percha while using very little sealer and appears to provide better canal sealing ability due to heat induced softening, aiding in better flow. This in turn may reduce leakage along root fillings [26].

The manufacturer's claim a better seal and a good adaptability because of increased flowability and the fact that this material slightly expands on setting [27].

Agree with [20] who found that the highest mean values were obtained when MicroSeal and Obtura II were used with AH Plus, and this group was different from the lateral-compaction groups ,These results could be due to the improved flow of warm gutta-percha [28], that, along with vertical compaction (performed to finish the filling procedure), resulted in high volume of a compact and homogeneous mass of gutta-percha and minimal volume of sealer. This is generally associated with higher material retention [29]. Nevertheless, the cold lateral-compaction technique does not allow complete filling of the root canal system irregularities, resulting in absence of sealer and/or gutta-percha in some canal areas and reduced filling bond strength [30] .

Gutta fusion obturators show higher bond strength value than single Reciproc Gutta percha cone could be explained by root canal sealers commonly exhibit thixotropic behavior, whereas their viscosity is reduced (increasing flow) under increased pressure. [31] evaluated the rheological properties of root canal sealers demonstrated a reduction in the viscosity of the AH Plus sealer at a constant shear rate with time (thixotropic behavior).

The result disagree with [32, 33] who may be to the different type of obturation technique that they were used (Calamus obturating delivery system (Dentsply-Tulsa Dental, Tulsa, OK) and System B with Obtura II instead of Guttafusion obturators).

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الخلاصة

يرتبط النجاح السريري للعلاج اللبية مباشرة إلى تقنية سد السن وخصائص ونوع السدادة . هناك عدة أنواع من تقنيات التثبيت و المواد السدادة ، ولكل منها مزايا وعيوب، ومن المهم تحديد مادة واحدة مناسبة. والغرض من هذه الدراسة هو تحديد ومقارنة فصل المادة السدادة الى الخارج بعد ملئها بالسدادات التالية(Total fill,AH plus, Gutta flow®2)باستخدام نظام الكوتا فيوجن لسد الجذر مقارنة مع مخروط ريسيبروك غوتا بيرتشا الاحادي.

ستين سن من الضواحك المقلوعة حديثا واللتي تملك قناة واحدة تم استخدامها في الدراسة الحالية.

تم قطع تيجان الاسنان وتم اعدادها بنظام الحركة الترددية لنظام الرسبروك الدوراني(في دي دبليو ,المانيا) المستدق بدرجة 0,06.

تم إزالة الطبقة االلطاخة من القنوات الجذرية باستخدام بروتوكول موحد للغسيل (3 مل بتركيز 5.25٪ من محلول هايبوكلورات الصوديوم تليها 1 مل بتركيز 17٪ من ال EDTA لمدة 1 دقيقة والغسل النهائي مع 3 مل من الماء المقطر).

ثم تم تقسيم الأسنان عشوائيا إلى مجموعتين (ثلاثون في كل مجموعة) وفقا لنوع الطريقة المستخدمة في سد الجذور; كوتا فيوجن مقابل المخروط الاحادي. كما تم تقسيم كل مجموعة إلى ثلاث مجموعات فرعية وفقا لنوع مادة السدادة المستخدمة كما يلي;

المجموعة 1 AH : كوتا بيرشا الرسبروك الاحادي مع سدادة AH plus, المجموعة 1 GF : كوتا بيرشا الرسبروك الاحادي مع سدادة GuttaFlow2,المجموعة 1 BC: كوتا بيرشا الرسبروك الاحادي مع سدادة السيراميك الحيوي Total fill, المجموعة 2 AH: كوتا فيوجن مع سدادة AH plus,المجموعة 2 GF : كوتا فيوجن مع سدادة GuttaFlow2 , مجموعة 2 كوتا فيوجن مع سدادة Total fill.

تم تخزين الجذور المحشوة لمدة سبعة أيام في الحاضنة، ثم تم اغماس الجذور براتنج الاكريليك الشفاف وكان كل جذر مقطوع إلى ثلاث شرائح بسمك 2 ملم (قمي، وسط، الاكليلية).

تم تثبيت العينة على قاعدة من الاكريلك وتم تطبيق الحمل من خلال خرم العينة باتجاه قمي-اكليلي باستخدام آلة الاختبار العالمي بسرعة 0.5 مم/ ثانية.

تم حساب قوة دفع قوة المادة للخارج متمثلة بوحدة (الميغا باسكال) من خلال قسمة الحمل على مساحة السطح بالتعاون مع برنامج الكمبيوتر image J.

تم تحليل قيم قوة الالتصاق إحصائيا باستخدام طريقة الفحص أنوفا ثنائية الاتجاه. تم فحص شرائح مع المجهرالفراغي لمراقبة حالة الفشل.

في حدود هذه الدراسة، أظهرت النتائج أن قوة دفع السد للخارج باستخدام Gutta flow®2 و Total fill كانت أقل بكثير من سدادة ال AH plus.

وأظهرت قوة دفع السدادة للخارج ان أعلى قوة في الأسنان المحشوة مع الغوتا فيوجن من تلك التي تم حشوها باستخدام مخروط ريسيبروك كوتا بيرتشا الاحادي.

أعلى متوسط لقيمة دفع قوة السدادات في استخدام سدادة AH plus و الكوتا فيوجن.