

## A comparative study to evaluate the shear bond strength of different resin sealers to dentin (An in vitro study)

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### ABSTRACT

**Background:** One of the major problems in endodontics is micro-leakage of root canal fillings which might contribute to the failure of endodontic treatment. To avoid this problem, a variety of sealers have been tested. The objective of this, in vitro, study was to evaluate the shear bond strength of four resin based sealers (AH plus, silver free AH26, RealSeal SE and Perma Evolution permanent root canal filling material) to dentin.

**Materials and Methods:** Forty non-carious extracted lower premolars were used. The 2mm of the occlusal surfaces of teeth were sectioned, to expose the dentin surface. The exposed dentin surfaces of teeth were washed with 5ml of 2.5% NaOCl solution followed by 5ml of 17 % EDTA then rinsed by deionized water to remove the smear layer. The teeth were divided into four groups according to the type of sealer used: Group A: silver free AH26, Group B: AH plus., Group C: RealSeal SE, Group D: Perma Evolution. Polyethylene tube cylinders (4mm internal diameter & 5mm length) were fixed on the dentin surfaces. Then freshly mixed sealers were poured into the tubes and allowed to bench set for two hours and were stored at 100% humidity and 37°C for one week. With an Instron machine, the shear bond strength between the tested sealers and the dentin, in Mpa, was measured. Statistical analysis was carried out using the one-way ANOVA and Student's t-tests.

**Results:** Perma Evolution scored the highest mean value of sheer bond strength, being 3.343 Mpa followed by the AH plus (2.786 Mpa) and AH26 (2.149 Mpa). While the RealSeal scored the lowest mean value of sheer bond strength, which was (1.831 Mpa). ANOVA test results showed a highly statistically significant difference. Student's t test results revealed significant differences between all the compared groups, except one paired group had a non-significant difference in the shear bond strength which was between the AH plus and Perma Evolution groups ( $P>0.05$ ).

**Conclusions:** The results of this study pointed to Perma Evolution which scored the highest sheer bond strength between the tested sealers.

**Key words:** Sheer bond strength, Perma Evolution, endodontic sealers. (J Bagh Coll Dentistry 2014; 26(1):49-52).

### INTRODUCTION

It is well known that the main objective of root canal treatment is the complete seal of the prepared canal system with a root canal sealer in conjunction with a suitable core material. Root canal sealers are intended to fill the irregularities between the dentinal walls and the core material, as well as, the accessory and lateral canals <sup>(1)</sup>. The three dimensional root canal obturation and the adequate coronal restoration are important barriers that prevent the infection or reinfection of the periapex. It has been established that micro-leakage of root canal fillings might contribute to the failure of endodontic treatment. To avoid this problem, a variety of sealers has been tested in combination with gutta-percha for root canal obturation <sup>(2)</sup>. Gutta-percha is the most commonly used root canal obturation material, but the resin filling materials have been steadily gained popularity and are now accepted as root canal filling materials <sup>(3)</sup>.

Sealers based on epoxy resins afford very good physical properties and ensure adequate biological performance. An acceptable apical sealing has been found with epoxy resin based sealers <sup>(2)</sup>. The sealers used in this study are silver free AH26, AH plus (Dentsply, Germany), RealSeal SE

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(Epiphany TM, Pentron Clinical Technologies, Wallingford, CT, USA) and Perma Evolution (permanent root canal filling material based on epoxy resin, Becht, Germany); it fulfills the requirements of EN ISO 6876:2002 for dental root canal sealing materials with working time of 15 minutes and a setting time of 24 hours <sup>(4)</sup>.

The purpose of the study was to evaluate the shear bond strength of four resin based sealers (AH plus, silver free AH26, RealSeal SE and Perma Evolution, the new permanent root canal filling material) to dentin.

### MATERIALS AND METHODS

Forty non-carious extracted lower premolars, obtained from the orthodontic department, College of Dentistry, University of Baghdad, were used in this study. To facilitate the grasping and control of the samples, acrylic blocks were constructed using cold-cure acrylic resin, which was mixed and poured into a stainless steel cylindrical mould lubricated with Vaseline.

Then the teeth were embedded in a freshly mixed acrylic resin using a dental surveyor to position the long axis of the tooth parallel to that of the stainless steel mould leaving only 2 mm of the occlusal surface that projected above the acrylic level <sup>(5)</sup>. The 2mm of the occlusal surfaces of teeth were sectioned, using a diamond disc bur with a straight handpiece and water coolant, to

expose the dentin surface. The exposed dentin surfaces of teeth were washed with 5ml of 2.5% NaOCl solution followed by 5ml of 17 % EDTA then rinsed by deionized water to remove the smear layer <sup>(6)</sup>. The forty samples were divided into four groups, (10 specimens each), according to the type of the sealer used:

- Group A: silver free AH26
- Group B: AH plus.
- Group C: RealSeal SE.
- Group D: Perma Evolution.

An adhesive Teflon tape with a hole respect to the diameter of the polyethylene tube cylinder's (4mm internal diameter) was fixed on the dentin surfaces leaving a predetermined contact area. The 5mm length of polyethylene tube was fixed to the dentin surface. The freshly mixed sealers were carefully poured into the tubes, that held in contact with the exposed dentin perpendicular to its surface then a glass cover slide placed over the sealer filled tubes, with a 400 g weight <sup>(7)</sup>. All the sealer filled cylinders were allowed to bench set for two hours to ensure that the initial setting reaction was taken place), then the specimens were stored at 100% humidity and 37°C for one <sup>(8)</sup>.

The shear bond strength between the tested sealers and the dentin were measured with the universal testing machine (Instron machine), a knife edge rod, with a cross head speed of 0.5mm/min, was used to load the specimens until bond failure. The chisel end of the rod was positioned as close as possible to the interface between the dentin surface and the tested sealer; then the specimens were stressed to failure. The force was recorded in kilograms which have been transferred to Newton's; then divided by the surface area (12.56 mm<sup>2</sup>) to obtain the shear bond strength, calculated in Mpa <sup>(6)</sup>.

$$SBS = F/S.A$$

$$S.A = r^2 \cdot \pi$$

$$\pi = 3.14$$

SBS - Shear Bond Strength.

F - Force.

S.A- Surface Area.

R - Radius = 2mm.

The recorded results were statistically analyzed by:

1. Descriptive statistics which included the mean, SD, minimum and maximum values of the shear bond strength in Mpa.
2. Inferential statistics (the difference among groups were examined by the analysis of variance test (ANOVA) and

the difference between each two groups was examined by the student's t-test).

## RESULTS

The summary of the mean and the standard deviation (SD) with the minimum, maximum values of the sheer bond strength of the different resin sealers (AH plus, silver free AH26, RealSeal SE and Perma Evolution permanent root canal filling material) to dentin are compiled in Table 1 and Figure 1.

**Table 1: Descriptive statistics results of shear bond strength of sealers to dentin in MPa.**

Tested Groups	Min.	Max.	Mean	S.D.
A	1.671	2.547	2.149	0.303
B	2.468	3.025	2.786	0.165
C	1.433	2.229	1.831	0.241
D	2.229	4.458	3.343	0.715

A=AH26, B=AH plus, C=Real Seal, D=Perma Evolution

From the results which are shown in Table 1 and Figure 1, it is clear that the Perma Evolution scored the highest mean value of sheer bond strength, being 3.343 Mpa followed by the AH plus (2.786 Mpa) and AH26 (2.149 Mpa). While the RealSeal scored the lowest mean value of sheer bond strength, which was (1.831 Mpa).

Statistical analysis of the data by using the analysis of variance (ANOVA) test was done. The results showed that there was a highly statistically significant difference (P < 0.000) between all the groups which were tested in this research, Table 2.

**Table 2: The ANOVA test results.**

S.O.V	SS	Df	MS	F-test	P-value
Between	8.154	3	2.718	13.194	0.000 HS*
Within	4.132	20	0.206		
Total	12.286	23			

\* Highly Significant.

Since the ANOVA test results showed a highly significant difference the Student's t-test was performed regarding the shear bond strength of the tested sealers to dentin, Table 3.

**Table 3. Student's t-test results**

Compared Groups	T-test	P-value	Sig
A vs. B	3.191	0.024	S*
A vs. C	3.381	0.020	S
A vs. D	3.630	0.015	S
B vs. C	5.946	0.002	S
B vs. D	1.996	0.102	NS**
C vs. D	5.451	0.003	S

\*P<0.05 Significant, \*\*P>0.05 Non Significant

The results, concerning the shear bond strength of the used sealers to dentin, revealed significant differences between all the compared groups ( $P < 0.05$ ); except one paired group had a non-significant difference in the shear bond strength which was between the AH plus and Perma Evolution groups ( $P > 0.05$ ).

## DISCUSSION

Three-dimensional sealing of the root canal systems is one of the important goals of endodontic therapy by preventing the reinfection of the canal and, therefore; preserving the healthy status of the periapical tissues.

Since the appropriate selection of a sealer may influence the final clinical outcome; the biological and mechanical properties of different endodontic sealers have been extensively investigated. The root canal sealers are subject to International Standards and national regulations regarding their physical properties, but there is no consensus among researchers on adhesion testing, in other words, these tests are not standardized<sup>(9)</sup>.

The methods to measure shear strength are the simplest, most effective and reproducible. They were developed to evaluate and measure the bonding of dentin to endodontic sealers. Although various types of sealers have been used, the development of adhesive, resin-based filling material with better properties could increase the rate of endodontic success<sup>(10)</sup>.

In this study, flat surfaces of dentin were used to measure the shear bond strength of the selected sealers to the dentin; the advantage of using flat surfaces is the ease of specimen standardization, which allows comparing the bond strength of root canal sealers to dentin. The load was applied perpendicular to the direction of the dentin tubules, since it simulates the real forces that act inside the root canal system.

In the present study, the mean shear bond strength of the three evaluated sealers to dentin ranged from 1.433 to 4.458 MPa; Perma Evolution being the best with a mean shear bond strength of  $3.343 \pm 0.715$  Mpa. The ingredients of this new permanent root filling material are 4-[2-(4-hydroxyphenyl)propan-2-yl]phenol-Epichlorodineresin, Alkylglycidyl ether, diphenylolpropan-diglycidyl ether, Polyalkoxyalkylamine-copolymer, 5-amino-1,3,3-trimethylcyclohexanemethylamin, Aqua, Barium sulfate, tri-calciumphosphate, nanodispers silicon dioxide, polyhexamethylene biguanides-hydrochloride. Therefore, the permanent root filling material Perma Evolution combines epoxide chemical characteristics. It comes with integrated microcapsules containing a new

reactive adhesive to make the two-component material more resilient and tight. Fine cracks caused by physical strength are reliably sealed even after the material has set; consequently, for the mentioned reasons it might have the highest mean of shear bond strength among the tested materials<sup>(4)</sup>.

The next highest adhesion scores were obtained with AH Plus which agrees with the results reported by Haragushiku et al.<sup>(11)</sup>; when root dentin was treated with Er:YAG laser and 17% EDTAC.

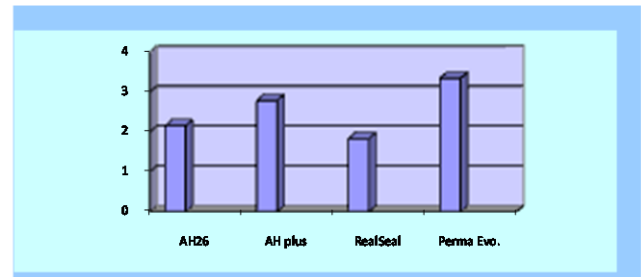
The resin-based sealers possess different adhesive behaviors, since they depend on the type of treatment of root canal walls. AH Plus sealer showed the higher bond strength in smear layer removed surfaces; since pretreatment with EDTA/NaOCl affected bond strength of them. During chemomechanical preparation of root canals, smear layer is formed on the dentin walls. Treatment of the intra-radicular dentin with chemicals that remove the smear layer, such as, ethylene-diamine-tetra-acetic acid (EDTA) and sodium hypochlorite, may affect bond strength. It is important to emphasize that due to its resin nature, flow and long setting time, AH Plus sealer penetrates deeper into the surface microirregularities, as well inside the lateral root canals<sup>(12)</sup>.

As a conclusion; Perma Evolution being the best; since having the highest mean of shear bond strength of  $3.343 \pm 0.715$  Mpa. This permanent root filling material combines epoxide chemical characteristics because it contains a new reactive adhesive which makes the two-component material more resilient and tight. Fine cracks caused by physical strength are reliably sealed even after the material has set.

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**Figure 1: The Mean values of shear bond strength of the tested sealers to dentin in MPa.**