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Evaluation of the Effect of Irrigating Solutions on Push out Bond Strength of Bio-ceramic and Resin Based Endodontic Sealers

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ABSTRACT

Purpose: This study was designed to evaluate the impact of irrigating solutions on push out bond strength of Bio- ceramic and resin based endodontic sealers. **Materials and Methods**: sixty extracted human teeth with single root and single canal were prepared with RACE FKG rotary files (#35, 0.06) taper. The specimens were divided into two experimental groups according to the final rinse used (30 samples each): Group (I) irrigated with 17%EDTA, Group (II) irrigated with 2% Chlorohexidinedigluconate (CHX). Each group was subdivided into two subgroups according to the sealer used (15 samples each). Total Fill Bio-ceramic sealer, and AH Plus Sealer The specimens were obturated by single cone gutta-percha with vertical condensation technique. **Results:** Final irrigation with EDTA resulted in the highest bond strength of bio-ceramic sealer to dentin of the root which was statistically different from irrigation with chlorohexidinedigluconate (CHX). Bond strength values were as follows: EDTA>CHX. **Conclusion**: The type of final irrigation affects the adhesion of Total Fill Bio-ceramic and AH plus sealers to root canal dentin.

KEYWORDS

Bio-ceramic sealer,
AH Plus sealer, EDTA, CHX,
Bond strength

INTRODUCTION

Endodontic treatments stand on root canal system debridement with killing of pathogenic organisms and complete sealing of canal space(1). Root canal sealer should make a good connection between the core material and the dentin wall, as it is found that gutta-percha does not bond directly to dentin surface (2). Many types of endodontic sealers are nowadays introduced to endodontic; those sealers are composed

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of zinc oxide, calcium hydroxide, glass ionomer, epoxy resin, silicon and methacrylate. Recently the adhesive dentistry has improved the endodontic with achieving a monoblock in which the three agents of core material with sealer and root canal form one strong element. Also, adhesives are used inside root canal to strengthen root canal treated teeth [(3)].

New sealers are involved into market such as obturation sealer and Endosequence Bioceramic (BC) sealer. Bio-ceramic sealer is available in flowable cement past form which is a radiopaque hydrophilic insoluble material. It is consisting of zirconium oxides, calcium hydroxide and calcium phosphate [(4,5)]. Removing of smear layer id an important technique that is used to provide a tight contact of calcium silicates endodontic sealers to radicular dentin

Three-dimensional root canal obturation is a great factor to accomplishment of root canal therapy [(6)]. Most endodontic filling methods use variant forms of gutta-percha with mixture of smallest quantity of root canal filling material that is important to make the contact between sealers and dentin surface more gap-free and provide fluid tight seal with making more resistance to displacement of root canal [(7,8)] Removing of smear layer is an important technique that is used to provide a tight contact of endodontic sealers to radicular dentin [(9, 10)].

Adhesion would be enhanced by using chelating solutions due to increasing the interface area between sealer and dentin of the root canal [(11)], which make good adaptation by enhancing numbers of dentinal tubules and removed the smear layer [(12)]. On the other hand, chelating solutions may remove useful inorganic elements such as calcium ions with partial demineralization of dentin surface that may interfere with bonding effectiveness of endodontic sealers [(13)].

Ethylenediamine tetra acetic acid (EDTA) is one of important chelating solutions that used as a chelating agent in endodontics. It can detach smear layer. The final rinse of EDTA can enhance dentinal tubules and increasing the numbers of lateral canals to be filled. EDAT is a weak acid and may cause protein denaturing that will increase the dental permeability to intra canal medication and make the bond between dentin and endodontic cement easer [(14-17)]. Chlorhexidine (CHX) is another common endodontic irrigant, it is recommended due to its antimicrobial effect via binding to hydroxyapatite [(18)] and producing antimicrobial activity similar to NaOCl[(19)]. Also, there is no tissue solubility which is considered a weak point [(20)].

MATERIALS AND METHODS

Teeth selection and preparation

Sixty extracted human teeth with completely formed single roots and single root canal were used. The tissue debris that attached to the root surface was removed by using NaOCl 5.25 % and the hard deposits were removed by ultrasonic scaler. All teeth were sectioned at the cemento enamel junction (CEJ) by a carborundum disk that was mounted in low speed hand piece under coolant system to standardize the length of the specimen to 15 mm. Then, size #10 k-file was inserted in the root canal until it was just visible from the apex, then 1 mm was subtracted from this length to establish the working length. The root canal was instrumented using RACE rotatory system (FKG Dentire swiss dental product) in the following sequence size 25, 30 and 35 by endodontic motor with speed of 300-600 rpm and torque 1-1.5 with packing motions back and forth. The canals were irrigated with 2 ml of 2.6% sodium hypochlorite between each file size.

Specimens grouping:

The specimens were divided into two experimental groups according to the final rinse used (30 samples each), Group (I) irrigated with 17%EDTA, Group (II) irrigated with 2% Chlorohexidinedigluconate (CHX). Each group was subdivided into two subgroups according to the sealer used (15 samples each). Total Fill Bio-ceramic sealer, and AH Plus Sealer. The specimens were obturated by single cone gutta-percha. The final irrigating solution was done with 5 ml of each solution for 1 minute, dispensed through a 30 gauge irrigating needle, then all specimens were irrigated with 5 ml distilled water and dried with paper points.

Specimen obturation:

The root canals were obturated by gutta-percha points (#35, 0.06 taper) using single cone technique with either Total Fill Bio-ceramic sealer or AH Plus sealer. Cone fitness radiograph was taken to ensure proper master cone length. Obturation was done by introducing the sealer into the canal by the master cone that coating with it then inserted in the canal to the full working length. After obturation, periapical radiograph was taken to ensure proper obturation. The specimens were stored at 37˚C in 100% humidity for 48 hrs to allow complete setting of sealer.

Specimens preparation for push-out bond strength:

Isomet 4000 saw was used (Buehler, USA) to cut the samples perpendicular to the long axis of the roots under water coolant that is 2mm thickness slices and then were gained from the coronal root for assessment of push out bond strength. Coronal and apical aspects of each sample were photographed and checked by using stereomicroscope (Nikon MA100 Japan) to make sure that the dentin cracks are absent and to confirm that the canal space was filled by sealer. Filling material was loaded with a, 9mm diameter stainless plunger which was mounted on the upper part by a universal testing machine (Instron, England). Samples were arranged in apical to coronal direction to prevent any constriction interference. Then, the tests were conducted at head speed of 0.5 min-1 using a 500N load cell. The uppermost value was taken as the push out bond strength. Push out force was applied until bond failure occurs that manifested by extrusion of the obturating substance from the coronal surface. Area under load was calculated by the following calculation:

Area= circumference of restoration × thickness of the section (2mm) .

$$\textbf{Push out bond strength (MPa)} = \frac{\text{Force (N)}}{\text{area in mm2}}$$

Statistical analysis:

By using SPSS Statistics Version 20 for Windows, (Kolmogorov-Smirnov and Shapiro-Wilk tests) was used to check data division and normality. Then, data was presented as mean and standard deviation (SD), Kruskal-Wallis test was used to contrast different groups in non-parametric data. Independent t test was used to compare 2 groups and used Two-ways analysis of variance (ANOVA) test to check significance of values. $P \leq 0.05$ is considered statistically significant result

RESULTS

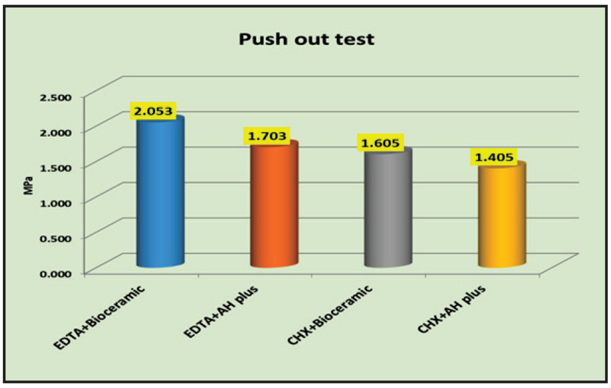
1. Comparison between the tested sealers in the mean push out bond strength:

In group I (EDTA): The highest mean value was recorded in the EDTA + bio ceramics group. Unpaired t test revealed that difference was statistically significant group II (CHX): The highest mean value was recorded in the CHX +bio ceramics group. Unpaired t test revealed that difference was not statistically significant

2. Comparison between the tested irrigants in the mean push out bond strength:

In subgroup (a) (Bio-ceramic sealer), The highest mean value was recorded in the EDTA + Bio-ceramics group. There was a statistically significant difference (p=0.0015).

Subgroups (b) (AH Plus sealer), The highest mean value was recorded in the EDTA+AH plus group. There was a statistically significant difference (p=0.0465).



Figure(1) Column chart showing mean push-out stresses (MPa) in all groups

DISCUSSION

The ideal endodontic therapy stands on good chemical cleaning and requires complete filling of the canal space with an inert material [21].the obturating material should be in strong contact with the canal walls to make it more perfect and thus can be achieved by making the gutta-percha and the sealer into homogenous mass. The ysiochemical structure of the endodontic sealers is an important role in bond strength and tissue tolerance with antimicrobial outcome [(22,23)]. This study was designed to demonstrate the effect of EDTA and Chlorohexidine on push out bond strength AH plus Resin Based Sealer and Total Fill BC Sealer.

In this study FKG RACE rotary files were used for canal instrumentation as they have a noncutting tip and a triangular cross-section with high flexibility, fast cutting and more space for debris removal. It also had electrochemical polishing which gave resistance against fatigue and corrosion. Cutting edges with alternating matter can avoid the screwing effect and working with low torque. This instrument can create centered canal shapes with enough clean and shaped canals [(24)].

Many factors may obstruct with the adhesion to dentine surface for examples, existence or absence of smear layer, surface tension of the sealers and intramolecular surface energy of dentin [(25)]. removal of the smear layers becomes a necessity as it prevents the dissolution of irrigation solutions and sealers into canals. The most common used solution is the ethylenediamine tetra acetic acid (EDTA) which was used in the present study to remove the smear layer [(26,27)]

The results showed that, EDTA irrigation resulted in higher bond strength mean value in Total Fill BC subgroup compared to AH Plus subgroup this could be attributed to the lack of smear layer [(28).]These results were in agreement with previous study which reported the efficiency of a 1-min irrigation of 17% EDTA on smear layer cleaning [(29,30).]A significance between the EDTA and CHX in pushout bond strength mean values ,there are high values of push out bond strength among the EDTA group comparing with CHX ,thus difference may be due to existence of surfactant in CHX composition that increases the dentin surface power and the dentin wet ability which is important for adhesion of total fill sealer. CHX has no proteolytic action on collagen fibers in dentine, so it improved the cationic charging of the dentin surface which improved the reaction between material and dentine [(31).]

The difference between mean value of push out stresses was found (MPa) in both main groups (Total fill bio ceramics and AH plus sealer) and was statistically significant. The same finding was in previous study which found the highest bond strength with bio ceramic followed by resin-based sealer. also, another study found some differences, as AH-Plus and Total Fill BC Sealer provide equal bond strength to root canal walls when irrigated with EDTA and CHX and lowest value was recorded with distilled water [(32,33)].

Bond strength of Total Fill Bio-ceramic and AH Plus sealers were obtained in this study as follows (EDTA> Chlorohexidine) and Total Fill BC Sealer and AH Plus reported higher values of bond strength when irrigated with EDTA than chlorohexidine. This in agreement with previous study [(34)], which established that last rinse with EDTA resulted in highest bond strength of bio-ceramic sealer to root dentine with significant difference from irrigation with NaOCl.

The main content of dentin is hydroxyapatite, which has a hydroxy group. The setting reaction of the Total Fill BC Sealer, which is bio ceramic-based that starts with sucking water from the dentinal tubules. Calcium silicate hydrogel and hydroxyapatite compound are produced after this reaction.

AH-Plus sealer is chemically reacting with any exposed amino group in the collagen and makes a covalent bond between epoxy resin and collagen. Also, naturally acidic matter of AH-Plus sealer limits the binding to dentin. Bio ceramic-based sealers has the ability to produce bonds interface dentin with the core filling materials [35].

CONCLUSION

Concluding that the type of final irrigation affects the adhesion of total fill bio ceramic and AH-Plus sealers to root canal dentin.

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