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The effect of different root canal irrigants on the sealing ability of Bioceramic sealer.

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Abstract

The aim of this study was to investigate the effect of different irrigants (EDTA, MTAD, CHX) on the sealing ability of new Bioceramic root canal sealer. **Material and methods:** A total of sixty extracted human single-rooted premolar teeth were used. After instrumentation, teeth were randomly divided into three main groups (n=20) according to the type of final irrigants used. In group (A) 17% EDTA was used. Group (B) irrigants was MTAD. In group (C) irrigant was 2% CHX. Each main group further subdivided into two subgroup (n=10) according to the type of sealer used. Subgroup (1) canals obturated with Bioceramic sealer. In subgroup (2) canals obturated with AH plus sealer. After incubation period for one week the roots were placed in 2% methylene blue dye and kept in incubator for 48 hours then the roots were cleared, dye penetration measured by stereomicroscopic. **Results:** statistical significant difference was found between groups ($p<0.001$). In subgroup (1) BC sealer & CHX showed the lowest mean of leakage in comparing to other type of irrigants with highly significance difference with BC sealer & EDTA. In subgroup (2) AH Plus & EDTA showed the lowest mean of apical leakage. A highly significance differences was found between subgroup (1) and subgroup (2) for all type of irrigants. ($p<0.001$).**Conclusion:** when Bioceramic sealer is used in obturation of root canal system, it is better to use it in combination with CHX irrigant to improve the apical seal.

Keywords: Endosequence bioceramic sealer, irrigants, apical leakage.

Introduction

One of the fundamental aims of root canal therapy is to hermetically seal the root canal system with obturation material, which is expected to eliminate microorganisms from the root canal system[(1)]. Bacteria have been shown to be the etiology of apical periodontitis and to be cause of endodontic failure [(2)].

Root canal filling typically involves the use of a core material, as gutta-percha dose not bond to root dentine and therefore must be used in association with a sealer to provide a bond between the core material and the root canal wall, along with filling any gaps[(3)], lateral accessory canals and irregularities at the root canal wall[(3)]. Often sealers penetrate into dentinal tubules, thereby increasing the interface between the dentinal walls and the filling material, and improving the mechanical retention of the root canal filling[4]. In addition, sealers can seal off any residual bacteria within the tubules and prevent bacterial colonization and reinfection of the root canal by occupying the tubules[5]. Good adhesion to root dentine is one of the ideal properties of a sealer[6], which potentially influences both leakage and root strength[7]. Different types of endodontic sealers based on zinc oxide, calcium hydroxide, glass ionomer, epoxy resin, silicone and methacrylate have been introduced to endodontic.

Recently, adhesive dentistry has been introduced to the field of endodontic with a specific focus on obtaining a "monoblock" in which the core material, sealing agent, and the root canal dentine form a single cohesive unit [8]. Adhesives have been used inside the root canal to bond posts and to strengthen root canal-treated teeth[8].

A new obturation sealer, EndoSequence Bioceramic (BC) sealer, has been recently introduced to the market. According to the manufacturer's description, EndoSequence BC sealer is premixed and injectable cement past. It is a hydrophilic insoluble, radiopaque and aluminum-free material based on a calcium silicate composition[9]. BC sealer is composed of calcium silicates, calcium phosphate monobasic, calcium hydroxide and zirconium oxide[9].

Root canal instrumentation usually results in an amorphous irregular smear layer covering the canal dentinal surfaces and plugging the dentinal tubules. A number of leakage studies have examined the influence of smear layer on the apical and coronal microleakage; however, there is no agreement among the researchers whether or not the removal of smear layer impacts the sealing ability[10,11]. The mechanical interlocking of the sealer plug inside the tubules following smear layer removal has been suggested to improve retention of the material[12], which might improve the sealing ability[12].On the other hand, it has been shown that the bond strength of some sealer cements to dentin was better in the presence of smear layer[11].

The smear layer is usually removed by the alternating use of Ethylenediamine tetra-acetic acid (EDTA) and Sodium hypochlorite (NaCOl). Chlorhexidine gluconate (CHX) has been suggested as alternative irrigating solution that could replace NaOCl. Moreover MTAD (mixture of tetracycline isomer, acid, and detergent), irrigate, is recommended as a final rinse after initial irrigation with 1.3%NaOCl [13].

Many studies compare the adhesive properties of BC sealer to dentine and gutta-percha by using bond strength test [14, 15]. Al-Hamed et al.[14] found that irrigant, obturation material and the interaction between the two variables had a statistically significant effect on mean push out bond strength. However in a study conducted by Shokouhinejad et al.[15] they found no significant differences between AH plus and BC sealer in the presence and absence of the smear layer.

No previous studies compare the apical microleakage of BC sealer by using different irrigation protocol. This study was designed to compare the uses of different irrigants and their effect on the apical sealing ability of Bioceramic sealer.

Materials and Methods

Specimen preparation

A total of 60 single –rooted human teeth (mandibular premolars) were used in the present study. Teeth were intact and extracted for orthodontic reasons. Teeth with apical curvatures, resorption, more than one canal, and previous endodontically treated teeth were discarded. The teeth were kept in normal saline solution until use. Initially, the teeth were immersed in 5% NaOCl for 10 minutes to remove any organic components from the root surfaces. The crowns were removed with a diamond disc under running tap water so that the length of the roots was standardized at 13 mm. A#10 K-file (Dentsply, Maillefer) was inserted to the root canal to establish the working length 1mm short of the apical foramen. The working length was established at 12 mm, the same K-file was passed through the apical foramen of the canals during and after instrumentation to ensure patency.

The root canals were prepared with medium EndoSequence file (Brassler, Savannah, CA) for standardization and enlarged to final size 35/.06. Irrigation with 3ml of 2.5% NaCOl was performed between each file size.

The specimens were randomly divided into three groups (n:20) according to the type of final irrigation solution (5 min.) that was used:

Group A: prepared canals were irrigated by 5-mL 17% EDTA.

Group B: prepared canals were irrigated by 5-mL MTAD.

Group C: prepared canals were irrigated by 5-mL 2% CHX.

Each group was further subdivided into 2 subgroups (n:10) according to the type of sealer:

Subgroup (1): canals were obturated with EndoSequence BC gutta-percha and EndoSequence BC root canal sealer (Brassler, Savannah, CA); using single cone technique. Each canal was fitted with a single ISO size # 35, 0.06 taper BC mater cone. EndoSequence BC sealer was injected through the intracanal tip to fill the apical part of the canal, and the tip was then slowly withdrawn while injecting the sealer until complete filling of the canal. The prefitted master cone was then introduced into the canal. The cone was subsequently seared off with a hot plugger.

Subgroup (2): canals were obturated with conventional Gutta-percha (Brassler, Savannah, CA) and AH plus sealer (Dentsply, Germany); using single cone technique. Each canal was filed with a single ISO size # 35, 0.06 taper master cone. AH plus sealer was inserted to the canal with master file, and then the prefitted master cone was then introduced into the canal. The cone was subsequently seared off with a hot plugger.

After the obturation of all groups, roots were stored in gauze and placed in an incubator for one week at 37^0C and humidity of 100% to allow the sealer to set. After the stored period all surfaces of the roots except for the 3 mm of apical root were sealed using two coats of nail polish. All roots were placed in 2% methylene blue dye and kept in incubator for 48 hours. Then the roots were cleared. Clearing was proposed by Robertson et al[(16)] to allow a three dimensional visualization of the internal tooth structure. The teeth were demineralized in 5% nitric acid until a milky color was achieved. The solution was renewed every 24 h until the process ended. The specimens were then dehydrated in 80% ethanol for 12 h, followed by 1 h in 90% ethanol and 1 h in 96% ethanol. This last procedure was repeated three times. All ethanol solutions were obtained by the dilution of 100% ethanol in distilled water. The specimens were then allowed to dry naturally for 10 min and were put into glass vials with methyl salicylate (C8H8O3). After 2 h, the roots were observed under a stereomicroscope at 40x magnification (Kruss, Germany).

Statistical Analysis

Parametric analysis was performed with one way analysis ANOVA followed by LSD test between irrigants within each subgroup. Student t-test was used to evaluate significance difference between subgroup(1) and (2) of each main group.

Results

The means and standard deviations (SD) for all groups of this study have been shown in (table -1). CHX & BC sealer showed the lowest mean of microleakage (1.262 mm), followed by EDTA & AH Plus (1.333mm), MTDA & BC (1.55mm), CHX & AH Plus (1.967mm) in increasing order. The highest mean of leakage showed by MTAD& AH Plus (2.22mm) and EDTA& BC (2.541mm), (fig. 1).

ANOVA test revealed a significant difference among groups in both subgroup (1) and (2), (table-2). LSD test used to compare the apical leakage for each subgroup. In subgroup (1), group (A1) showed a highly significance differences with groups (B1) and (C1) ($p<0.001$), while group (B1) showed a non significance differences with group (C1) ($P>0.05$). Also in subgroup (2), group (A2) showed a highly significance differences with groups (B2) and (C2) ($p<0.001$), while group (B2) showed a non significance differences with group (C2) ($P>0.05$).

Student-t test showed a highly significance differences between subgroup (1) and subgroup (2) for all type of irrigants ($p<0.001$).

Discussion

Achieving an adequate apical seal is an important goal in endodontics to prevent bacteria and their by- products from apical percolation. In this regard, removal of the smear layer is one of the factors that can affect coronal and apical microleakage and thus compromise the long term success of endodontic treatment [13]. The ability of root-canal sealers to adhere to dentin and gutta-percha is expected to result in superior sealing ability, which in turn should reduce leakage in clinical situations [17].

In subgroup (1) when BC sealer used with CHX irrigant the apical leakage decrease and showed the lowest mean of dye penetration, with significance difference with EDTA&BC group and non significance difference with MTAD&BC group. Koch et el. [18], suggested that when bioceramic sealer is introduced into a root canal, it absorbs water from the dentinal tubules. Then the setting reaction is initiated and it produces a composite of calcium silicate hydrogel and hydroxyapatite. The calcium silicate hydrogel forms a chemical bond with the hydroxyapatite because of the hydroxy-group. The hydroxyapatite formation in the sealer is a continuous crystal growth process of hydroxyapatite on the dentinal walls. Therefore, both of the compounds form a strong chemical bonding with the dentin hydroxyapatite. When CHX used as irrigant and due to the presence of surface surfactant in CHX composition, which increases the dentin surface energy, its wettability, and also increases the reaction of polycarboxylic group of the glass ionomer due to enhancing the cationic charging of the dentin surface [19], properties that are required for the adhesion of Bioceramic gutta-percha, due to it hydrophilic nature. On the contrary when CHX irrigant used with

AH Plus the apical leakage increased, this could be related due to the hydrophobic nature of AH plus sealer, where the increased wettability due to the presence of surface surfactant in CHX would not be beneficial to its action [20].

In subgroup (2) when AH Plus sealer was used with EDTA the apical leakage decreased, with a significance differences with both MTAD&AH Plus group CHX&AH Plus group. One of the advantages of resin-based sealers is that they cannot only lock into open dentinal tubules but also adhere to the exposed dentinal surfaces. This characteristic of resin-based sealers is similar to the adherence capacity of composites to the dentin and enamel of teeth [11].

Pretreatment with EDTA chelating agent might have altered the surface energy of dentin which significantly decreased the wetting ability of dentinal wall. Thereby providing a suitable dentin substrate for the adhesion of materials of a hydrophobic nature as the resinous AH Plus. Furthermore, the effective removal of the smear layer by EDTA allowed for the extension of the resin into the opened dentinal tubules, creating efficient micromechanical retention [21]. This results in agreement with Farhad et al.[22] who found that the use of EDTA irrigation would improve the adhesion and reduce the microleakage of resin. On the contrary in this study, the decreased wetting ability of dentin surface treated with 17% EDTA prohibited the adhesion of materials hydrophilic in nature, which correlates with BC sealer group.

MTAD is acidic and has a pH of 2.15, it contains doxycycline and citric acid among its constituents which results in the removal of the smear layer and demineralization of the underlying dentin [17]. MTAD increased dentin surface energy, wettability, reduced surface tension, and increased dentin penetration, hence increasing intertubular dentin permeability as well as the exposure of collagen matrix and intertubular fluid [23], which could have negatively affected the adhesion of the hydrophobic AH plus sealer. On the other hand, final irrigation with MTAD with BC sealer provided a good dentinal surface treatment for the adhesion of the bioceramic sealer, due to its hydrophilic nature. A highly significance difference was found between the main groups for the three type of irrigants. Zhang et al.[24] found a non significant difference between BC sealer and AH Plus sealer when EDTA used as irrigant. Zhang et al.[24] in their study used EDTA for one min. in this study the irrigant used for 5 min. further more they used lateral condensation technique not single cone technique that result in better adaptation of both sealer.

In conclusion: according to the condition of this study, CXH irrigant improved the sealing ability of bioceramic sealer, while EDTA decreased the sealing ability of bioceramic sealer.

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Table (1): Descriptive statistics for all groups in (mm)

Groups		**Mean**	**SD**	**Min.**	**Max.**
Group (A)	**Subgroup(A1) (EDTA&BC)**	2.541	0.493	1.90	3.30
	Subgroup(A2) (EDTA&AH)	1.333	0.406	0.85	2.10
Group (B)	**Subgroup(B1) (MTAD&BC)**	1.55	0.419	1.0	2.0
	Subgroup(B2) (MTAD&AH)	2.22	0.511	1.51	3.00
Group (C)	**Subgroup(C1) (CHX&BC)**	1.262	0.392	0.90	1.90
	Subgroup(C2) (CHX&AH)	1.967	0.421	1.51	2.61

Table (2): ANOVA test

Subgroup (1)			
	F-test	**P-value**	**Sig.**
Between groups	23.514	0.000	*HS
Subgroup (2)			
	F-test	P-value	Sig.
Between groups	10.394	0.000	*HS

Table (3): LSD test for multiple comparison in subgroup (1)

	P-value	Sig
A1&B1	.000	HS
A1&C1	.000	HS
B1&C1	.153	*NS

*NS: Non significant (P>0.05)

Table (4): LSD test for multiple comparison in subgroup (2)

	P-value	Sig
A2&B2	.000	HS
A2&C2	.000	HS
B2&C2	.218	NS

Table (5): Student -t test

Groups	t-test	P-value	Sig.
A1&A2	5.97	0.000	HS
B1&B2	3.21	0.0052	HS
C1&C2	3.87	0.0012	HS

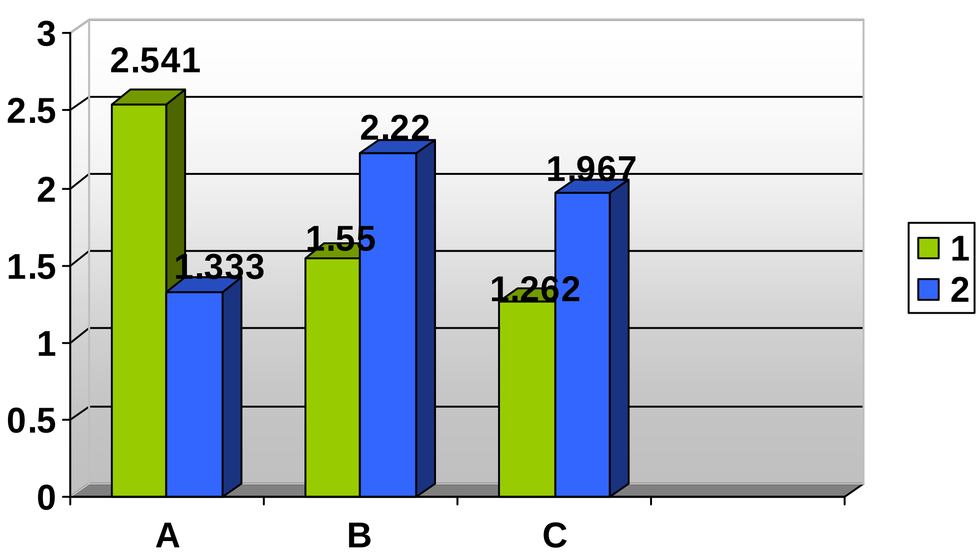

Figure-(1): Bar chart for the mean of microleakage for all groups.