The Effect of Ultrasonic Activation of Two Different Sealers on the Fracture Resistance of Obturated Root Canals

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Abstract

The aim of the current study is to evaluate the effect of ultrasonic activation of two sealers: EndoSequence BC and AH Plus on the fracture resistance of obturated roots.

Materials and Method: Forty eight mandibular first premolars were decoronated to a length of 13 mm from the apex. The roots were divided into two groups (24 samples) to be obturated with gutta percha using either EndoSequence BC(Group I) or AH Plus (Group II) sealers. Each group was further subdivided into two subgroups (n=12). Subgroups IA and IIA were obturated without ultrasonic activation of the sealers. Subgroups IB and IIB were obturated with ultrasonic activation of the sealers. The activation of the sealers was performed using size 15 ultrasonic K-file for a total of 20 seconds 2 mm short of the working length. The samples were subjected to fracture resistance test using a universal testing machine at a across head spead of 0.5 mm/min. The data were analyzed using One way ANOVA and Tukey tests at a significant level of 0.05.

Results: The fracture resistance mean values of the EndoSequence BC subgroups with and without activation were significantly higher than those of AH Plus sealer ($P<0.05$).

Conclusion: The ultrasonic activation of both sealers did not enhance the fracture resistance of obturated roots.

Keywords: *Bioceramic, Epoxy resin based sealer, Ultrasonic.*

Introduction

During endodontic therapy, the tooth structure can be compromised increasing the possibility of root fracture due to: removal of supporting tooth structure by access opening and instrumentation, pressure during obturation and dehydration of dentin.[1,2] The standard obturation material that has been used for years in root canal therapy is gutta percha. However, one of the disadvantages of gutta percha as a filling material is that it does not bond or adhere to the dentinal walls of the root canal resulting in an incomplete sealing of the canal space. It has been shown that the use of sealers with an ability to bond to the root canal dentin will strengthen the remaining tooth structure, thus increasing the root resistance to fracture.[3,4] Nowadays, numerous sealers have been introduced into the market that are supposed to adhere to the root canal dentin such as: methacrylate resin-based sealers, epoxy resin-based sealers, mineral trioxide aggregate (MTA) based sealer and calcium silicate-based sealer. The adhesion and the mechanical interlocking of the sealer can strengthen the remaining tooth structure.[4] Bolleset al., in 2013[5] and Macedo et al., in 2014[6] stated that the use of ultrasonic activation to the endodontic sealers during obturation can increase sealer pressure against the root canal walls allowing better penetration into accessory canals, isthmus, and dentinal tubules, with formation of a greater number, density and extension of tags.[7,8] Thus, increasing the adhesion and mechanical interlocking of the filling material.[9,10]

Endosequence BC sealer is a calcium silicate-based endodontic sealer, with a self-adhesive nature. It has nano-particles permit it to flow readily into the canal's irregularities and dentinal tubules. In addition, no shrinkage occurs on setting, resulting in a gap-free

interface between the gutta-percha, sealer and dentin.[11] AH Plus sealer, on the other hand, is an epoxy resin-based sealer characterized by very good mechanical properties, easy handling, potential for better wettability of the dentin and gutta-percha surfaces and self-adhesive property.[12]

Topcuoglu et al., in 2013[13]and Yendrembam et al., in 2019[14] evaluated the fracture resistance of teeth filled with AH Plus and Endosequence bioceramic root canal sealers in vitro. They concluded that both sealers were capable of increasing the force to fracture in single-rooted endodontically treated premolars. Guimarães et al., in 2014[7]; Wiesse et al., in 2018 [8] and Sachin et al., 2018[15]evaluated the influence of ultrasonic vibrations on the penetration depth of both sealers using confocal microscopy. They concluded that the ultrasonic activation was linked with higher bond strength values, greater intratubular penetration and better interfacial adaptation to root dentin and less existence of gaps and voids than no activation technique. However, the effect of ultrasonic activation to Endosequence BC and AH Plus sealers on fracture resistance of obturated roots has not been cleared yet. Therefore, this study was conducted to evaluate the effect of ultrasonic activation of Endosequence BC and AH Plus sealers in the assessment of fracture resistance of endodontically treated roots.

Materials and Methods

Freshly extracted forty eight single rooted mandibular first premolars were collected after extraction for orthodontic reason from patients with age ranged from (20-30) years old.[16] The teeth were cleaned from calculus and tissues manually using cumine.[17]Then, the teeth were stored at room temperature in 0.1 % thymol solution for 48 hs to prevent dehydration and bacterial growth. The teeth were decoronated at a length of 13 mm from the anatomical apex for standardization and to achieve a stable reference during working length determination and instrumentation. The working length was established to be 1 placing a K-file size 10 (Dentsply , Switzerland) into the canal until observing it at the apical foramen.[13]

For root canal instrumentation, the canals were first irrigated with 1 ml of 2.5 % NaOCl for 1 minute. Then, K-file size 15 was introduced to the full working length to obtain a reproducible glide path. The canals were instrumented using ProTaper Next system (Dentsply Maillefer Endodontics, Switzerland) by the following sequence: X1(17/0.04), X2(25/0.06), X3 (30/0.07) and X4 (40/0.06). For standardization, each canal was irrigated with a total amount of 5 ml of 2.5% NaOCl. Then, a 3 ml of EDTA 17% was applied for 1 minute, then a final irrigation was applied with 10 ml of distilled water. [13,19] Each canal was dried with two paper points size 40/0.06.[20]

The roots were randomly divided into two groups (n=24) according to the types of root canal sealers: EndoSequence BC Sealer (Group I) and AH Plus sealer (Group II). Each group was subdivided into two subgroups (n=12): Group IA and Group II A were obturated without sealer activation and Group I B and Group II B were obturated with sealer activation.

For Group IA, a master guttapercha cone X4 (40/0.06) (Dentsply Maillefer) was inserted into the canal to full working length (12 mm) with a good tug-back. EndoSequence BC Sealer was introduced into the root canal by its intracanal tip. The tip was placed into the coronal one third of the canal and the sealer was released while slowly withdrawing the tip from the canal.[13]Then, the master cone was reinserted and the excess of guttapercha was cut off with a guttapercha cutter at the level of canal orifice.[20]

For Group IB, the samples were treated as in Group IA except that after the application of the sealer, activation of the sealer was performed using an ultrasonic K-file size 15 in a piezoelectric ultrasonic handpiece (SatelecActeon) at 6 mode power.[15]Then, the file was activated 2 mm short of the working length, with 2-3 mm back and forth movements in a bucco-lingual and in a mesio-distal direction of the root canal for a total of 20 seconds.[15]

For Group IIA, the roots were obturated in a similar way using AH plus sealer which was manipulated according to the manufacturer's instructions. The two pastes were mixed to get a homogenous creamy consistency and the master cone was coated with the sealer and slowly inserted into the canal until the working length was reached.[14,22] According to the manufacturer instructions, the canal walls were coated with AH Plus sealer through a simultaneously rotating movement of

the master cone in a counter clockwise direction four times per a canal. The excess of guttapercha was cut off with a guttapercha cutter at the level of canal orifice.[20]

For Group IIB, the samples were obturated with ultrasonic activation of AH Plus sealer which was performed in a similar way as in Group IB using the ultrasonic handpiece.

After obturation of the roots of each group, the samples were radiographed to ensure the quality of obturation.[13] The samples were stored in an incubator for 1 week at 37°C and 100% relative humidity to permit fully set of the sealers.[20]All the procedure was performed by one operator for standardization.

In order to assess the fracture resistance test, the roots were fixed in a cylindrical acrylic block (20 mm height and 20 mm diameter) using a cold-cured acrylic resin to simulate the alveolar bone. While a periodontal ligament simulation was performed by coating the root surface with a thin layer of light-body addition silicon. Then, the roots were embedded into the acrylic resin exposing 2 mm of the coronal parts of the roots. [14, 20]Fracture resistance test was performed for all roots using an Instron testing machine. A spreader-like metal tip (0.8 mm in diameter) was positioned at the center of each canal orifice and a vertical force was exerted at a across head speed of 0.5 mm/min until fracture. [20] The fracture force was recorded in Newton.[20]

All of the analyses were performed using SPSS 21 software (IBM-SPSS Inc., Chicago, IL, USA). One-way analysis of variance (ANOVA) and post hoc Tukey tests were used to determine the significance difference between the subgroups at $P<0.05$.

Results

The results of the descriptive statistics are shown in Figure 1. One way ANOVA test showed that there was a significant difference between EndoSequence BC sealer and AH Plus sealer with and without activation (P=0.000). However, the results of Tukey's test for multiple comparisons between the groups (Table 1) showed non-significant differences neither between the subgroups of EndoSeqence BC Sealer (Group IA & Group IB), nor between the subgroups of AH Plus sealer (Group IIA &Group IIB) as $P > 0.05$.

Table 1. Tukey test multiple comparisons for the fracture mean values for all subgroups.

Groups		Mean Difference	S.E	Sig.
Group IA EndoSequenceBC Sealer (Without activation)	Group IB	.083	5.283	1.000 (NS)
	Group IIA	45.083	5.283	0.000 (HS)
	Group IIB	45.250	5.283	0.000 (HS)
Group IB EndoSequence BC Sealer (With activation)	Group IA	-.083	5.283	1.000 (NS)
	Group IIA	45.000	5.283	0.000 (HS)
	Group IIB	45.167	5.283	0.000 (HS)

Cont... **Table 1. Tukey test multiple comparisons for the fracture mean values for all subgroups.**

Group IIA AH Plus Sealer (Without activation)	Group IA	-45.083	5.283	0.000 (HS)
	Group IB	-45.000	5.283	0.000 (HS)
	Group IIB	.167	5.283	1.000 (NS)
Group IIB AH Pus Sealer (With activation)	Group IA	-45.250	5.283	0.000 (HS)
	Group IB	-45.167	5.283	0.000 (HS)
	Group IIA	-.167	5.283	1.000 (NS)

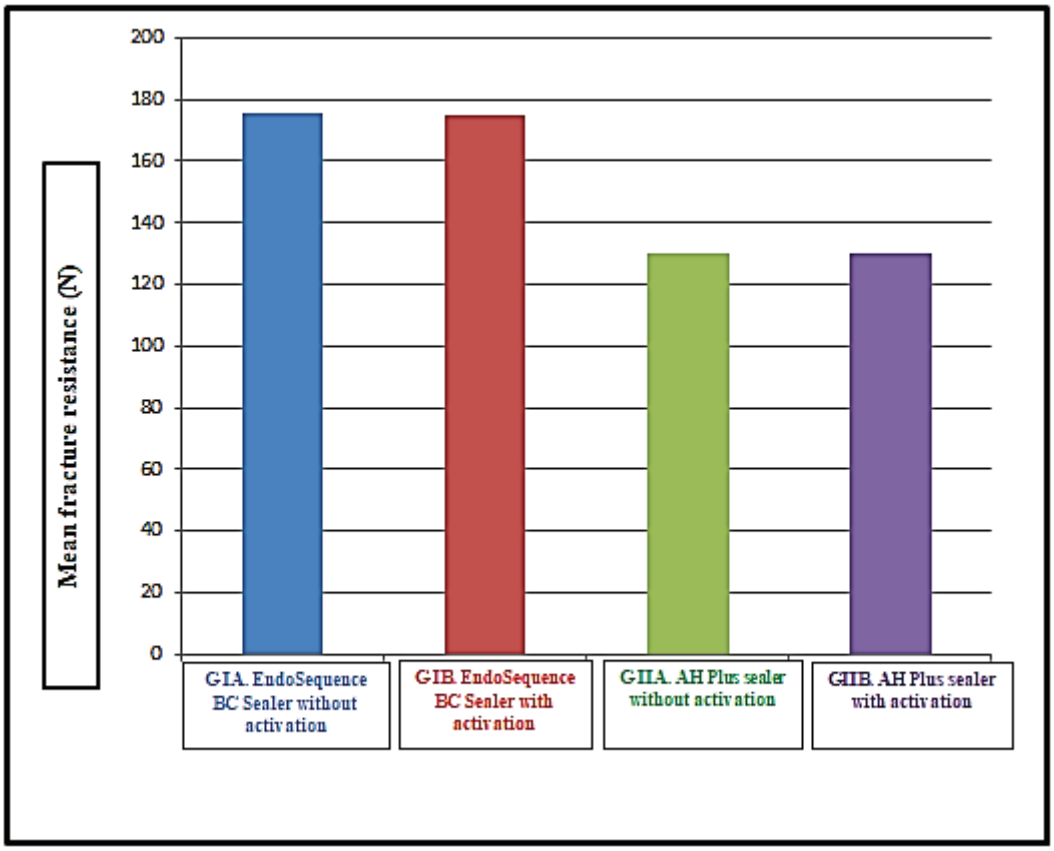

Figure 1. Bar chart graph representing the mean fracture resistance (N) of all subgroups.

Discussion

It has been reported that during root canal treatment, there will be a reduction in the fracture resistance of the root which consequently leads to tooth extraction.[23,24] Hence, one of the essential features of any root canal filling material is their capability to reinforce and significantly strengthen the endodontically treated roots. Recently, researchers illustrated that the adhesion and the mechanical interlocking of the sealers can strengthen the remaining tooth structure, increasing its resistance

to fracture.[4]

In this study, the effect of ultrasonic activation of two dentin bonding capable sealers (EndoSequence BC sealer and AH Plus sealer) on the fracture resistance of obturated root canals was evaluated. The results showed that the mean values of fracture resistance of both subgroups of EndoSequence BC sealer with and without activation were significantly higher than AH Plus sealer subgroups. Significantly higher fracture resistance for bioceramic sealers vs AH Plus sealer were also reported by recent studies using Totall fill biocermic sealer.[25,26] Two other studies reported similar results using Endosquence bioceramic sealer.[14,27] Reasons for such a result were related to the deeper penetration of the nanoparticles of EndoSequence BC sealer into the dentinal tubules and canal irregularities. EndoSequence BC sealer has a nanoparticle size of an average of 0.2 µm, which could increase the distribution of particles into dentinal tubules particularly within the apical root area.[28] AH Plus sealer, on the other hand, and according to the manufacturer, contains calcium tungstate particles with an average size of 8 µm and zirconium oxide particles with a 1.5 µm size. The larger particles could not enter easily into the small tubules and the sealer tags would be weaker than those of bioceramic sealer.[20] Additionally, Yendrembam et al., in 2019[14] showed that EndoSequence BC sealer has a higher adhesiveness to the root dentin than AH Plus sealer. EndoSequence BC sealer create a chemical and micromechanical bonding with dentin by means of the production of hydroxyapatite during setting, in contrast to a limited adhesion of AH Plus sealer to dentin from a mild covalent bond between its open epoxide ring and the amino group in the collagen fiber.[29,30]Oltra et al., in 2017[31] reported that EndoSequence BC sealer had a significantly more residual filling material than AH Plus sealer after removal of the sealers indicating higher interlocking of EndoSequence BC sealer. Another possible reason could be related to polymerization shrinkage of AH Plus sealer associated with the use of large amounts of sealer in the canal when used with a single cone technique.[32,33] In contrast, the EndoSequence BC sealer is a hydrophilic in nature and has no shrinkage[11,34] and it expands 0.2% on setting producing a self-seal. This expansion together with the chemical and micromechanical bonding could improve the bonding of the root canal sealer to the canal walls.[35,36]

Topçuoğlu et al., in 2013[13] reported a higher, however, not significantly different fracture resistance mean value of EndoSequence BC sealer compared with AH Plus sealer. Such a difference could be related to the differences in methodologies. In this study, a spreader-like of 0.8 mm diameter metal tip with a vertical force in 0° angle, resulting in splitting stress exerted along the long axis of the root. Additionally, the roots had only 2 mm exposed above the acrylic block. This resulted in smaller stresses because of decreased bending movements and maximum stresses situated more cervically.[20, 37]

It has been reported by many studies that the activation of endodontic sealers might improve root canal sealing, predominantly in areas of difficult access for example lateral and accessory canals, isthmus, recesses, and apical deltas.[7,8] Numerous studies illustrated that the use of ultrasonic activation of these sealers cause greater dentinal sealer penetration and less presence of gaps, and increasing the adherence to the root dentin.[7,8,15,21] However, the result of this study showed that the ultrasonic activation to both sealers produced no significant effect on the fracture resistance of obturated roots. This could be explained primarily as higher penetration can be different in different levels of the root. Better penetration due to sealer activation can be seen for both sealers in the apical more constricted areas than the coronal area.[7,8] Therefore,further investigations and studies are still needed to verify the effect of sealer activations on its adhesion to root dentin at different root levels.

Conclusions

Under the circumstances of this study, the following conclusions are withdrawn:

1. EndoSequence BC sealer group showed a significantly higher fracture resistance than AH Plus sealer group with and without activation.

2. Ultrasonic activation of both EndoSequence BC and AH Plus sealers produced no significant influence on the fracture resistance of obturated roots.

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Conflict of Interest: None to declare.

Ethical Clearance: All experimental protocols were approved under the College of Dentistry and all experiments were carried out in accordance with approved guidelines.

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