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# Assessment of Interfacial Adaptation of New Endodontic Sealers to Root Canal Dentin with and Without a Main Guttaperch Cone: An SEM Analysis

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## ABSTRACT

*Aim of the study: The aim of this study was to evaluate the interfacial adaptation of EndoSequence BC sealer, MTA Fillapex and Vioseal sealers to root canal Dentin with and without a main gutta-percha cone.*

*Material and Methods: Total of 60 single-rooted human teeth with single canal were selected and the crowns were removed at the CEJ level to standardize the root length (16 mm). Samples were instrumented using Protaper next NiTi rotary system up to size X5. After irrigation and smear layer removal samples were randomly divided according to the sealer used into three groups of 20 samples each, and each group was further subdivided based on obturation technique into six subgroup three group with cone and three group without cone of 10 sample each. Samples were stored for 48 hours before testing. Horizontal sections were obtained for all samples to evaluate the adaptation of sealer using Scanning electron microscope. The data were analyzed statistically by one-way Anova and Tukay's post-hoc test.*

*Result: Vioseal showed significantly least gap and better adaptation (P<0.05) followed by MTA Fillapex then EndoSequence BC when obturated with cone were as EndoSequence BC show the least gap and better adaptation followed by Vioseal then MTA Fillapex when obturated without cone. The coronal level of all group had significantly more gaps compared to middle and apical third.*

*Conclusion: All the three sealers showed different grades gap width along the whole length of root canal wall.*

**Key words:** Bio ceramic root canal sealer, Scanning electron microscope, Interfacial adaptation, Gap width

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## INTRODUCTION

Successful root canal treatment depends on the thorough debridement of the root canal system, the elimination of pathogenic organisms and finally the complete sealing of the canal space to prevent ingress of bacteria from the oral environment and spread to the periapical tissue [1]. The main causes of pulpal and periradicular pathosis are microorganisms and their byproducts in the root canal system [2]. The goal of endodontic treatment is to eliminate microorganisms from the root canal and prevent its reinfection. However, root canal systems cannot be completely cleaned and disinfected with chemomechanical preparation [3]. A three dimensionally obturated root canal system prevents percolation and microleakage of periapical exudate into the root canal space. It prevents reinfection and creates a favorable environment for healing to take place [4]. Though endodontic success requires elimination of micro-organisms through mechanical instrumentation, antibacterial irrigants, and use of antimicrobial dressings and the adequate filling of the empty space, complete sterility is achieved when these procedures are coupled with root canal sealers that have an antimicrobial effect [5].

The penetration of sealer cements into dentinal tubules is one of the desirable characteristics in the outcome, for several reasons: It increases the interface between the guttapercha and dentinal walls, thus improving the interfacial adaptation and retention of the material. The retention of the obturating materials can be improved by mechanical interlocking. The penetration of sealer cements into dentinal tubules may also entomb any residual bacteria within the tubules and the chemical components of sealer cements may exert an antibacterial effect that will be enhanced by closer approximation to the bacteria. Therefore, it is important that the percentage of the sealer/dentin interface covered by the sealer and the degree of tubule penetration by the sealer be as great as possible in all cases, whether previously infected or not. The efficacy of a root canal sealer is enhanced by minimizing the amount of sealer used, ensuring good adaptation, and penetration of the sealer into root dentin. Adaptation of sealers to canal walls and marginal gaps can be assessed with scanning electron microscopy (SEM), as the defects submicron level can be observed at the required magnification. Thus, the aim of this study was to evaluate the interfacial adaptation of EndoSequence BC sealer, MTA Fillapex and Vioseal sealers to root canal Dentin with and without a main cone.

## MATERIALS AND METHODS

The study was approved by the Institutional Review Board (IRB) Of Riyadh Elm University, Kingdom of Saudi Arabia under the registration number: (FPGRP/43733005/224).

### Selection of teeth

A total of 60 freshly extracted human permanent mandibular Premolar with a single, straight and fully formed root was selected based on clinical and radiographic examination. The teeth with open apices, cracks and resorptive defects were excluded. Preoperative radiograph had been taken to exclude the teeth with internal resorption and calcifications. All teeth were stored in 10% ethyl alcohol solution until the sample preparation was completed. Organic debris from the external surface of the roots was removed by submerging the teeth in 1% NaOCl solution for 4 days before the initiation of the experiment.

### Sample preservation and root canal preparation

Sample were submerged in alcohol solution (Kol AL Hamaya Medical Factory, Riyadh, KSA) and glycerin (sun Care Pharma, KSA) mixed in 1:1 ratio to keep the sample in moist. The crowns of the teeth were removed at the level of CEJ using a low-speed diamond disc (UKAM Industrial Superhard, Valencia) and root length was standardized to 16 mm. The working length and patency of the root canal were determined by inserting a #10 K-file (Dentsply Sirona) until it reaches the apical foramen, then subtracting 1 mm from this measurement. All samples were instrumented using ProTaper Next NiTi rotary system at a speed of 300 rpm and torque of 2 N cm connected to tri-auto mini endodontic motor according to manufacturer instructions up to size X [5]. EDTA cream lubricant was used during root canal preparation. The canals were irrigated with 5 ml of 2.5% NaOCl and the working length established by measuring the penetration of a size 10 K-file (Dentsply Sirona) introduced passively until it reached the apical foramen and then subtracting 1 mm.

Root canal shaping was performed with Protaper next NiTi rotary instruments at a speed of 300 rpm and torque of 2 N cm [1]. After the use of each instrument, canals were irrigated with 5 mL of 2.5% NaOCl. At the end of the shaping procedures, the canals were irrigated with 5 ml of 2.5% NaOCl and then filled with 5 ml of 17% EDTA for 5 min to remove the smear layer and irrigated again with 10 ml of distilled water. The canals were dried with size 50.02 taper paper points (Dentsply Sirona) and size 50, .02 taper gutta-percha cones (Dentsply Sirona) were tested for tug-back at the working length and confirmed radiographically.

### Specimen distribution and obturation

The samples were randomly divided into three experimental group, twenty teeth each based on the sealer used as follow:

Group one A (with cone): (n=10) EndoSequence BC sealer (Brasseler USA, Savannah, GA).

Group two A (with Cone): (n=10) MTA Fillapex sealer (Angelus, Londrina PR, Brazil).

Group three A (with Cone): (n=10) Vioseal Sealer (Spident co, Korean).

Group one B (without Cone): (n=10) EndoSequence BC sealer (Brasseler USA, Savannah, GA).

Group two B (without Cone): (n=10) MTA Fillapex sealer (Angelus, Londrina PR, Brazil).

Group three B (without Cone): (n=10) Vioseal Sealer (Spident co, Korean).

For the preparation of the sealer, 2 mm of each paste was placed onto a glass slab measured with a millimeter ruler. The sealers were manipulated according to the manufacturer's instructions and inserted into the canals using a size 25 K-file

(Dentsply Sirona), calibrated 1 mm short of the working length, in a clockwise rotation.

However, although the sample of teeth was standardized, the volume used varied from one tooth to another because the canals were filled with sealer. After complete filling of the canal, activation of the sealer in each group was performed for 20 s 2 mm short of the working length. Ultrasonic activation was performed with the insertion of a size 20. 0.02 taper ultrasonic device as in (EMS, Le Sentier, Switzerland) at power level 1. The main (master) cone, first, the master cone was checked in the canal prior to placement by noting the point where 'tugback' at working length was first achieved.

Thereafter for (Group one A) EndoSequence BC sealer (n=10), a size 50, matching 0.06 taper gutta-percha cone, with EndoSequence BC sealer was premixed was inserted to the full working length and canal filling was completed using a single cone method. And for (Group one B) (n=10), the mixed EndoSequence BC sealer was then introduced into the root canal orifices with the intraoral tip, till the orifice. For (Group two A) MTA Fillapex sealer (n=10), a size 50, matching 0.02 taper gutta-percha cone, with MTA Fillapex sealer was inserted to the full working length and canal filling was completed using a single cone method. For (Group two B) MTA Fillapex sealer (n=10), the mixed MTA Fillapex sealer was then introduced into the root canal orifices with the intraoral tip, till the orifice.

For (Group three A) Vioseal sealer (n=10), a size 50, matching .02 taper gutta-percha cone, with Vioseal sealer was inserted to the full working length and canal filling was completed using a single cone method. For (Group three B) (n=10), the mixed Vioseal sealer was then introduced into the root canal orifices with the intraoral tip, till the orifice. After radiographic confirmation of complete filling of the canal, excess material was removed with a heated instrument and vertically condensed with a plugger. After obturation, all the specimens were stored at 37°C and at 100% humidity for 48 hours, corresponding to three times the setting time of the sealer recommended by the manufacturer in an incubator.

**Sectioning method**

Each samples were embedded in chemical cured acrylic resin block (Figure 1) and then cross-sectioned using high speed 0.6mm thickness diamond disk at speed 2500 rpm under water cooling to obtain 1mm thickness section (Isomet 1000, Buehler, Lake Buff, IL, USA). Three 1.0-mm thick slices will be obtained for the analysis. Each specimen was polished with sandpaper of decreasing grit size (up to 1200) and felt discs with polishing paste.

**Qualitative analysis of interfacial adaptation**

The slices were submitted to an ultrasonic bath for 5 min, rinsed in distilled water and decalcified superficially with 37% phosphoric acid for 15 s. The samples were mounted on an aluminum stub, placed in a vacuum chamber, and targeted sputter coated with gold (Figure 2) and examined under Scan Electron Microscope (Jeol JSM-6360LV Japan) (500 X magnification). The interfacial adaptation of the sealer to canal walls (gaps) and the presence of voids, gaps at sealer and root dentin interfaces were evaluated under 500X magnification at coronal, middle, and apical halves of the root canal by taking photomicrographs. For each section, the maximum gap in millimicrons (μm) was recorded. Evaluation of the specimens were made by two investigators who were blinded to the method applied in each specimen. The Data were examined for normal distribution (Kolmogorov–Smirnov test $P \leq 0.05$) test. Gaps width in sealer Dentin interface in (um) was recorded per root section then the mean (M) and standard deviation (SD) was calculated for

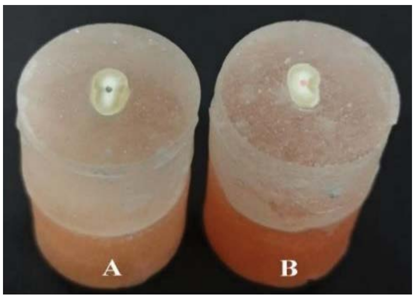


**Figure 1: Photograph showing sample (A) group tow without cone after embedded with resin block and (B) from group one with cone.**

**Figure 2: Photographs showing example of coronal (A), middle (B) and apical (C).**

each group. The data were analyzed by one-way Anova. Multiple comparison procedure was performed using Tukay's post-hoc test. All test was performed using SPSS 22.0. Soft were package (systat s oftware Inc., San Jose, (A, USA) with the significance level set at P ≤ 0.05.

## RESULTS

One Way ANOVA was used to compare the mean value of gaps width between the different tested sealers and at different root sections. Whenever a statistically significant difference was recorded among different tested sealers groups or among root sections, Tukey's post-hoc test was performed to make pairwise comparisons between each two significant difference groups or root sections.

**Results of adaptation assessment (µm)**

In EndoSequence BC (G1 A) (Table 1), the highest mean gap width (µm) was recorded at the coronal section (8.030 ± 1.580) followed by the apical section (7.230 ± 2.4568) then the middle section (6.370 ± 2.061). In MTA Fillapex (G2 B) (Table 1), the highest mean gap width (µm) was recorded at the middle section (9.220 ± 3.902) followed by the coronal section (8.610 ± 4.168) then the apical section (6.00 ± 3.413). For Vioseal (G3 A) (Table 1), the highest mean gap width (µm) was recorded at the coronal section (3.210 ± 2.022) followed by middle section (3.100 ± 1.879) then apical section (2.790 ± 1.2455).

In multiple comparison test, (Table 2) showed that in coronal, middle and apical sections. EndoSequence BC group and MTA Fillapex there was a statistically significant difference when compared with vioseal Group (P-value=0.000). In Intercomparing between sealers group at different section (Table 3) revealed that for EndoSequence BC group (G1A) coronal section had a significant difference (p=8.030 ± 1.580) when compared to the middle and apical section, but statistically not significant. (P-value=0.217). For MTA Fillapex group (G2 A) middle section had a significant difference (p=9.220 ± 3.902) when compared to the coronal and apical section, but statistically not significant. (P-value=0.253). For the Vioseal group (G3 A), the coronal section had a significant difference (p=3.210 ± 2.022), when compared to the middle and apical section, but statistically not significant (P-value=0.864).

In EndoSequence BC (G1 B) (Table 4, Figure 3), the highest mean gap width (µm) was recorded at the Middle section (2.250 ± 0.952) followed by the coronal section (2.190 ± 1.067) then the apical section (1.660 ± 0.5337). In MTA Fillapex (G2 B) (Table 4), the highest mean gap width (µm) was recorded at the coronal section (4.200 ± 1.908) followed by the Apical section (4.110 ± 4.168) then the Middle section (3.890 ± 2.102).

For Vioseal (G3 B) (Table 4, Figure 3), the highest mean gap width (µm) was recorded at the Coronal section (2.670 ± 1.758) followed by the Apical section (2.600 ± 1.6533) then Middle section (2.070 ± 0.653). In multiple comparison test, (Table 5) showed that in coronal, middle and apical sections.

EndoSequence BC group and MTA Fillapex there was a statistically significant difference when compared with vioseal Group (P-value=0.000). Intercomparing between sealer group at different section revealed that for EndoSequence BC (G1 B) coronal section had a significant difference (p=2.190 ± 1.067) when compared to middle and apical section, but statistically not significant, irrespective of the root section. (P-value = 0.274).

For MTA Fillapex (G2 B) middle section had a significant difference (p=4.200 ± 1.908) when compared to the coronal and apical section, but statistically not significant, irrespective of the root section. (P-value=0.941). For Vioseal (G3 B) coronal section had a significant difference (p=2.670 ± 1.758) when compared to the middle and apical section, but statistically not significant, irrespective of the root section. (P-value =

**Table 1: Mean ± SD for gap width (μm) of EndoSequence BC (G1 A), MTA Fillapex (G2 A) and Vioseal sealers (G3 A) groups at different root sections.a**

| | Material | N | Mean | Std. Deviation | P-value |
|---|---|---|---|---|---|
| Coronal | EndoSequence BC sealer (G1A) | 10 | 8.03 | 1.58 | 0 |
| | MTA Fillapex (G2 A) | 10 | 8.610* | 4.168 | |
| | Vioseal (G3 A) | 10 | 3.21 | 2.022 | |
| | Total | 30 | 6.617 | 3.6736 | |
| Middle | EndoSequence BC sealer (G1 A) | 10 | 6.37 | 2.061 | 0 |
| | MTA Fillapex (G2 A) | 10 | 9.220* | 3.902 | |
| | Vioseal (G3 A) | 10 | 3.1 | 1.879 | |
| | Total | 30 | 6.23 | 3.6886 | |
| Apical | EndoSequence BC sealer (G1 A) | 10 | 7.230* | 2.4568 | 0.001 |
| | MTA Fillapex (G2 A) | 10 | 6.44 | 3.4134 | |
| | Vioseal (G3 A) | 10 | 2.79 | 1.4255 | |
| | Total | 30 | 5.487 | 3.1605 | |

*=Significant, G1 A=EndoSequence sealer group with cone, G2 A=MTA Fillapex sealer group with cone, G3 A=Vioseale sealer group with cone.

**Table 2: (Group 1A, 2A, 3A): Multiple comparison test among sealer between root sections.**

| | Material | N | Mean | Std. Deviation | P-value | 95% Confidence Interval for Mean | | Multiple comparison test | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | EndoSequence BC sealer (G1 A) | MTA Fillapex (G2 A) | Vioseal |
| Coronal | EndoSequence BC (G1 A) | 10 | 8.03 | 1.58 | 0 | 6.899 | 9.161 | 1 | | |
| | MTA Fillapex (G2 A) | 10 | 8.61 | 4.168 | | 5.629 | 11.591 | 0.891 | 1 | |
| | Vioseal (G3 A) | 10 | 3.21 | 2.022 | | 1.764 | 4.656 | 0.002 | 0.001 | 1 |
| | Total | 30 | 6.617 | 3.6736 | | 5.245 | 7.988 | | | |
| Middle | EndoSequence BC (G1 A) | 10 | 6.37 | 2.061 | 0 | 4.895 | 7.845 | 1 | | |
| | MTA Fillapex (G2 A) | 10 | 9.22 | 3.902 | | 6.429 | 12.011 | 0.073 | 1 | |
| | Vioseal (G3 A) | 10 | 3.1 | 1.879 | | 1.756 | 4.444 | 0.035 | 0 | 1 |
| | Total | 30 | 6.23 | 3.6886 | | 4.853 | 7.607 | | | |
| Apical | EndoSequence BC (G1 A) | 10 | 7.23 | 2.4568 | 0.001 | 5.473 | 8.987 | 1 | | |
| | MTA Fillapex (G2 A) | 10 | 6.44 | 3.4134 | | 3.998 | 8.882 | 0.772 | 1 | |
| | Vioseal (G3 A) | 10 | 2.79 | 1.4255 | | 1.77 | 3.81 | 0.002 | 0.01 | 1 |
| | Total | 30 | 5.487 | 3.1605 | | 4.307 | 6.667 | | | |

*G1 A=EndoSequence sealer group with cone, G2 A = MTA Fillapex sealer group with cone, G3 A = Vioseale sealer group with cone.

**Table 3: Inter-comparison between EndoSequence BC (G1 A), MTA Fillapex (G2 A) and Vioseal sealers (G3 A) groups at different root sections.**

| | Coronal | | Middle | | Apical | | P-Value |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | |
| EndoSequence BC (G1 A) | 8.030* | 1.58 | 6.37 | 2.061 | 7.23 | 2.4568 | 0.217 |
| MTA Fillapex (G2 A) | 8.61 | 4.168 | 9.220* | 3.902 | 6.44 | 3.4134 | 0.253 |
| Vioseal (G3 A) | 3.210* | 2.022 | 3.1 | 1.879 | 2.79 | 1.4255 | 0.864 |

*= Significant, G1 A= EndoSequence sealer group with cone, G2 A = MTA Fillapex sealer group with cone, G3 A = Vioseale sealer group with cone.

0.682). In comparison between the two Group (Group A and Group B) Recorded significant Difference between the two, regardless of the root sections, the highest mean gap width for the EndoSequence BC (G1) sealer was found in (G1 A ) statically significant different was found between the two group in Coronal, Middle and Apical (P value=0.000). For MTA Fillapex (G2) the highest mean gap was found in (G2 A), a statically difference was found in Coronal and Middle sections between the two groups (P-value=0.007). Even for Vioseal (G3), the highest mean gap width was found in (G3 A), there was no statically difference between the two groups (P Value = 0,532). Regardless of root sections, the highest mean gap width (μm) was recorded at MTA Fillapex (G 2 A) (8.090 ± 3.8991) as in Figures 3 and 4 followed by EndoSequence (G1 A) (7.210 ± 2.1077) , followed By MTA Fillapex (G2 B) group (4.067 ± 1.9732), Followed by Vioseal (G3A) (3.033 ± 1.7399) , followed by Vioseal (G3 B) (2.447 ± 1.4190) , followed by EndoSequence BC (G1 B) (2.033 ± .8922). Table 6 shows the data collection.

**Table 4: Mean ± SD for gap width (µm) of EndoSequence BC (G1 B), MTA Fillapex (G2 B) and Vioseal sealers (G3 B) groups at different root sections.**

| | Material | N | Mean | Std. Deviation | P-value |
|---|---|---|---|---|---|
| Coronal | EndoSequence BC (G1 B) | 10 | 2.19 | 1.067 | 0.026 |
| | MTA Fillapex (G2 B) | 10 | 4.200* | 1.908 | |
| | Vioseal (G3 B) | 10 | 2.67 | 1.758 | |
| | Total | 30 | 3.02 | 1.7893 | |
| Middle | EndoSequence BC (G1 B) | 10 | 2.25 | 0.952 | 0.012 |
| | MTA Fillapex (G2 B) | 10 | 3.890* | 2.102 | |
| | Vioseal (G3 B) | 10 | 2.07 | 0.653 | |
| | Total | 30 | 2.737 | 1.5743 | |
| Apical | EndoSequence (G1 B) | 10 | 1.66 | 0.5337 | 0.001 |
| | MTA Fillapex (G2 B) | 10 | 4.110* | 2.1053 | |
| | Vioseal (G3 B) | 10 | 2.6 | 1.6533 | |
| | Total | 30 | 2.79 | 1.8346 | |

*= Significant G1 B= EndoSequence sealer group without cone, G2 B = MTA Fillapex sealer group without cone, G3 B = Vioseale sealer group without cone.

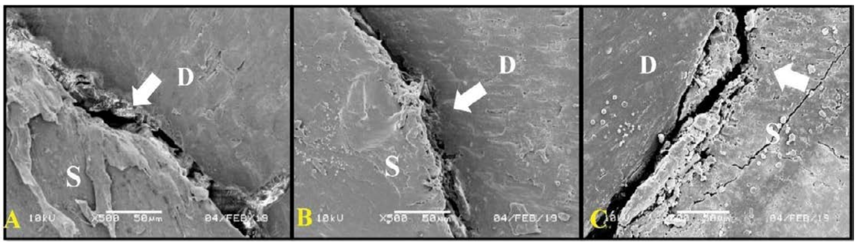


**Figure 3: SEM photograph shows sealer Dentin interface of MTA Fillapex sealer (G2 A) representative sample at coronal (A), middle (B) and apical (C) sections. The arrows point to the gaps. (S: sealer, D: Dentin). X500 magnification.**

**Table 5: (Group 1A, 2A, 3A): Multiple comparison test among sealer between root sections.**

| | Material | N | Mean | Std. Deviation | P-value | 95% Confidence Interval for Mean | | Multiple comparison test | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | EndoSequence BC sealer (G1 A) | MTA Fillapex (G2 A) | Vioseal |
| Coronal | EndoSequence BC (G1 A) | 10 | 8.03 | 1.58 | 0 | 6.899 | 9.161 | 1 | | |
| | MTA Fillapex (G2 A) | 10 | 8.61 | 4.168 | | 5.629 | 11.591 | 0.891 | 1 | |
| | Vioseal (G3 A) | 10 | 3.21 | 2.022 | | 1.764 | 4.656 | 0.002 | 0.001 | 1 |
| | Total | 30 | 6.617 | 3.6736 | | 5.245 | 7.988 | | | |
| Middle | EndoSequence BC (G1 A) | 10 | 6.37 | 2.061 | 0 | 4.895 | 7.845 | 1 | | |
| | MTA Fillapex (G2 A) | 10 | 9.22 | 3.902 | | 6.429 | 12.011 | 0.073 | 1 | |
| | Vioseal (G3 A) | 10 | 3.1 | 1.879 | | 1.756 | 4.444 | 0.035 | 0 | 1 |
| | Total | 30 | 6.23 | 3.6886 | | 4.853 | 7.607 | | | |
| Apical | EndoSequence BC (G1 A) | 10 | 7.23 | 2.4568 | 0.001 | 5.473 | 8.987 | 1 | | |
| | MTA Fillapex (G2 A) | 10 | 6.44 | 3.4134 | | 3.998 | 8.882 | 0.772 | 1 | |
| | Vioseal (G3 A) | 10 | 2.79 | 1.4255 | | 1.77 | 3.81 | 0.002 | 0.01 | 1 |
| | Total | 30 | 5.487 | 3.1605 | | 4.307 | 6.667 | | | |

*G1 A=EndoSequence sealer group with cone, G2 A = MTA Fillapex sealer group with cone, G3 A = Vioseale sealer group with cone.

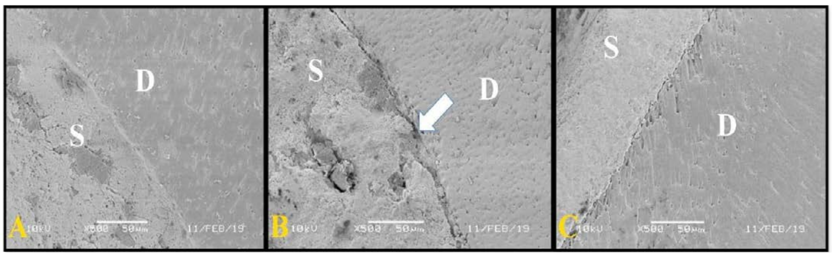


**Figure 4: SEM photograph shows sealer Dentin interface of EndoSequence BC sealer (G1B) representative sample at coronal (A), middle (B) and apical (C) sections.**

**Table 6: Data collection sheet.**

| | | EndoSequence BC G1 | | MTA Fillapex G2 | | Vioseal G3 | |
|---|---|---|---|---|---|---|---|
| | | A | B | A | B | A | B |
| 1 | Coronal | 8,9 | 2,2 | 2,2 | 4 | 5,5 | 2,6 |
| | Middle | 7,6 | 1,5 | 6,1 | 3,7 | 1,2 | 1,7 |
| | Apical | 3,8 | 2,4 | 5,9 | 2,2 | 1,1 | 1,5 |
| 2 | Coronal | 8 | 3,5 | 6,5 | 1 | 1,9 | 2,3 |
| | Middle | 5,6 | 3 | 5,2 | 1,7 | 1,9 | 2,8 |
| | Apical | 7,6 | 1,9 | 4,7 | 1,4 | 1,1 | 4 |
| 3 | Coronal | 8 | 2,8 | 12,3 | 5,9 | 2,1 | 1,8 |
| | Middle | 7,2 | 1,4 | 7,1 | 6,5 | 1,5 | 2,7 |
| | Apical | 10,8 | 1,4 | 6,4 | 7,1 | 1,2 | 1,4 |
| 4 | Coronal | 9,8 | 1,3 | 10,8 | 6,6 | 1,4 | 1,6 |
| | Middle | 5,6 | 3,1 | 15,8 | 5 | 2,6 | 1,7 |
| | Apical | 9,7 | 2,3 | 5,3 | 4,5 | 3,4 | 1,7 |
| 5 | Coronal | 5,2 | 2,1 | 8,5 | 5,5 | 1,5 | 1,1 |
| | Middle | 5 | 3,8 | 12,4 | 6,7 | 5,2 | 2,1 |
| | Apical | 4,8 | 1,2 | 3,5 | 5 | 2,4 | 1 |
| 6 | Coronal | 7,3 | 4,3 | 15,4 | 6,2 | 4,6 | 1 |
| | Middle | 2,8 | 2,8 | 8,5 | 3,4 | 1,2 | 1,7 |
| | Apical | 8,8 | 1,2 | 12,5 | 6,1 | 3,3 | 2,5 |
| 7 | Coronal | 7,3 | 1 | 12,9 | 3,5 | 3,5 | 4,1 |
| | Middle | 10,8 | 1,4 | 14,9 | 5,5 | 3,6 | 1,2 |
| | Apical | 7,6 | 0,8 | 13,1 | 4,2 | 5,5 | 1,4 |
| 8 | Coronal | 10,3 | 1,8 | 5,1 | 3,6 | 7,2 | 6,7 |
| | Middle | 6,9 | 1,7 | 10,9 | 2,3 | 6,8 | 2,2 |
| | Apical | 7,5 | 1,4 | 4 | 3,5 | 3,4 | 3,8 |
| 9 | Coronal | 9,2 | 1,1 | 7,6 | 4,2 | 3,3 | 1,7 |
| | Middle | 6,4 | 1 | 6,6 | 0,2 | 4,4 | 1,4 |
| | Apical | 3,5 | 1,9 | 4,3 | 6,2 | 2,5 | 6,3 |
| 10 | Coronal | 6,3 | 1,8 | 4,8 | 1,5 | 1,1 | 3,8 |
| | Middle | 5,8 | 2,8 | 5,2 | 3,9 | 2,6 | 3,2 |
| | Apical | 8,1 | 2,1 | 4,9 | 0,9 | 4 | 2,4 |

## DISCUSSION

Combination of core material and sealer is the standard protocol used in root canal filling nowadays. Because of the lack of adhesion property in guttapercha, sealer was introduced to overcome this limitation. Good sealing ability is a fundamental requirement of root filling materials [6]. Bonding of the sealer to Dentin either by mechanical retention or chemical adhesion or both is important mainly to maintain a tight seal between them after treatment against bacterial leakage. Additionally, it is important to withstand stresses produced during function or due to successive treatment as post preparation or coronal restoration [7-10].

End Sequence BC is a recently introduced sealer with many advantages and properties such as it is insoluble, does not shrink on setting and it forms a chemical bond to dentin [11]. MTA Fillapex is one of MTA based sealers that is developed trying to replicate the clinical and scientific success of MTA into endodontic sealer. It had low solubility, providing sealing through expansion during setting. Vioseal® is Resin Based Sealer with the following Characteristics: Excellent biocompatibility Superior, radiopacity, tight sealing, and insoluble in tissue fluids excellent antibacterial effect and Lubricant during inserting of GP point Components, the manufacturer claims that Vioseal has good sealing ability and biocompatibility [12].

Moreover, up to our knowledge no studies investigated the adaptation of those sealers to Dentin wall with different obturation technique. So, the current study was carried out to evaluate the interfacial adaptation of EndoSequence BC, MTA Fillapex and Vioseal sealer with cone and without cone.

In the present study, adaptation of the sealers to Dentin wall have been tested, compared to other studies which evaluated only bond strength, as strong bond of the sealer to Dentin wall does not assure that it covers and adapts to the entire surface of canal wall. It was proposed that, presence of interfacial gap areas due problems in the bond, manipulation or shrinkage of the sealer could allow leakage of bacteria and their byproducts [11-14]. In this Experimental study, Regarding Intercomparing between sealer group at different section revealed that for Endosequance BC coronal section had a significant difference when compared to middle and apical section, For MTA Fillapex middle section had a significant difference when compared to the coronal and apical section, For vioseal coronal section had a significant difference when compared to the middle and apical section, but statistically not significant.

The discrepancy between the apical and coronal levels might be accounted for by the lower density and diameter of dentinal tubules found at the apical level, resulting in lower sealer penetration [15,16]. Moreover, the smear layer removal is difficult at the apical third that might act as a physical barrier which interfered with sealer adaptation to root canal dentin [17,18]. The results of the present study showed that over all Vioseal sealer had a significant interfacial adaptation and least gap than EndoSequence BC and MTA Fillapex. This is come in accordance with the study done by Naser et al [19] which showed AH plus sealer had better adaptation to the canal wall than bio ceramic sealer.

AH Plus sealer exhibited the least number of gaps containing regions, a finding consistent with previous studies [20,21]. The superior adaptation of AH Plus could be due to its ability to bond to root dentin chemically by reacting with any exposed amino groups in collagen to form covalent bonds between the epoxy resin and collagen. Sun like alkaline bio ceramic-based sealers, AH Plus is slightly acidic and might result in self-etching when in contact with dentin, thereby enhancing interfacial adaptation [22].

This incidence and overall gaps of EndoSequence BC sealer might be a result of its hydrophilic nature. Al-Haddad et al [2] reported that EDTA irrigation for smear layer removal may alter the adhesion of bio ceramic sealers by decreasing the wetting ability of Dentin because Bio ceramic based sealers are hydrophilic by nature, in contrary AH Plus is hydrophobic which founds suitable environment in acidic medium of EDTA [23]. In the current study, although saline was used for the final irrigation, it might have been insufficient to completely flush away EDTA increasing the wetting ability of dentin.

During this study, SEM were selected for adaptation assessment. SEM has been developed for the purpose of imaging hydrated and non-conducting samples in their natural condition without prior dehydration or conductive coating or preparation [23]. SEM can record specimens under moderate pressure, at low temperature, low vacuum and low voltage and in 100% humidity during the observation period producing high quality and less electrostatically distorted images [24].

The present study evaluated the quality of interfacial adaptation of bio ceramic sealer to canal Dentin with two different obturation techniques. According to the results of the present study, the interfacial Adaptation after filling the canal with sealer alone were higher than those with main cone and sealer and may reflect different patterns of behavior when the sealer is present as a thin layer. There was significance difference of interfacial adaptation between the difference sealers at different root sections. Thus, the null hypothesis of the present study was rejected.

## CONCLUSION

Within limitation of the present study, following conclusion can be driven:

Vioseal sealer showed high interfacial adaptation when compared with EndoSequence BC and MTA Fillapex sealers.

The highest interfacial adaptation was observed in Vioseal without cone and the least adaptation with gaps were seen in MTA Fillapex with cone.

The interfacial Adaptation after filling the canal with sealer alone were higher than those with main cone and sealer and may reflect different patterns of behavior when the sealer is present as a thin layer.

## LIMITATION OF THE STUDY

One of the potential limation of the current study was that our result was entirely based on the observation under SEM. Micro-computed tomography (micro-CT) was also effective for the evaluation of voids and gap formation.

Horizontal sectioning may cause some interruption in the tooth structure and debris formation during preparation, while, longitudinal sectioning has an advantage of minimal sample and material contact.

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