# Comparison of the Sealing Ability of GuttaFlow Bioseal with Different Obturation Systems (An in vitro study)

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**Abstract**

The major goal of a root canal filling is the three-dimensional obturation with the complete seal of the whole canal system. The aim of this study is to quantitatively evaluate and compare the sealing ability of GuttaFlow bioseal with different obturation systems (GuttaFlow 2, AH plus, Bioceramic sealer) of single cone techniques.

64 freshly extracted maxillary first molars with a straight palatal root canal were selected. After sectioning of the palatal roots, their canals were instrumented using EdgeEndo X7 rotary system in sequence (20/04 – 40/04) then divided into 4 experimental groups according to the obturation system, Group I: AH plus sealer, Group II: GuttaFlow 2, Group III: Bioceramic sealer, Group IV: GuttaFlow bioseal sealer, and 2 control groups. Apical leakage evaluation was done by dye extraction methods. Data were analyzed using One-way ANOVA, and Tukey HSD tests.

The lowest leakage was in GuttaFlow bioseal, while the highest leakage was for GuttaFlow 2. The statistical analysis revealed that GuttaFlow bioseal had significantly lower leakage than GuttaFlow 2 and Bioceramic sealer ( $P< 0.05$), while it had no significant difference in the mean leakage when compared with AH Plus.

The type of the sealer act as a major determinant of the sealing ability when used with a single cone technique. Bioactive glass based sealer showed the best sealing ability.

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## Introduction

The major goal of a root canal filling is to prevent infection of the root canal via leakage of microorganisms and their by-products. It is a common knowledge that the apical leakage is considered the communal cause for endodontic failure with 59% percent as Ingle reported and is affected by many variables such as different filling techniques, physical and chemical properties of root canal filling materials and existence and absence of smear layer.[1] This emphasizes the need for using materials that are able to create a hermetic seal between the root canal system and the periapical tissues.[2]

AH-plus (Dentsply, Konstanz, Germany) which based on epoxy resin that has great sealing properties and was considered to be the gold standard against which all new sealers and bondable root canal filling materials had to be compared.[3] A Systematic review done by Alghamdi and Abduljawad [4] showed that the resin-based sealer provided a better seal than other sealers.

In recent years, a new root canal filling materials, tricalcium silicate-based root canal sealers have received significant attention due to their favorable physicochemical properties and their ability to form hydroxyapatite during the setting procedure as well as their interaction with the dentin and forming the so-called mineral infiltration zone. One of the calcium silicate-based root canal sealers that have appeared is TotalFill® BC Sealer (FKG Dentaire, La Chaux-de-Fonds, Switzerland).[5]

Another new root canal sealer containing calcium silicate GuttaFlow® bioseal (Coltène/Whaledent, Langenau, Germany) which is Bioactive glass-based sealer, also known as GuttaFlow 3 which developed recently in 2015 and was launched to the market in 2016. This material is composed of gutta-percha,

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polydimethylsiloxane, zirconium oxide, platinum, nano silver and bioactive ceramic glass.[5]

Several studies measuring apical sealing abilities and even with various results, there are still no studies compare the apical seal of single cone and GuttaFlow bioseal with the different obturating systems.

## Materials and methods

Sixty-four freshly extracted maxillary first molars were selected with a straight palatal root canal, mature centrally located apical foramen and the initial size equal to 20# K-file (Dentsply Maillefer, Ballaigues, Switzerland). By using a diamond disc bur with straight handpiece the palatal roots of teeth were sectioned perpendicular to the long axis of the root at the furcation area at 11 mm length. Teeth were instrumented with EdgeEndo X7 rotary system (Edge Endo, EDGEFILE®, U.S.A.) in sequence (20/04 – 40/04) at the working length of 10 mm. Initially, the canals were irrigated with 1 ml of NaOCl before instrumentation. During canal preparation 1 ml of 2.5% NaOCl irrigation used between instruments by using a 30-gauge needle 2 mm short of working length to remove debris. After instrumentation, the canals were irrigated with 2 ml of 2.5% NaOCl. And finally, 1 ml of EDTA were used for 1 min using passive ultrasonic irrigation followed by 3 ml of 2.5% NaOCl for 1 min using passive ultrasonic irrigation and final irrigation of 5 ml distilled water to remove the irrigants. Then samples were randomly divided into 4 experimental groups (n= 15 for each) according to the type of root canal sealer used. And 2 control groups (n= 2 for each), a Positive control group (teeth were instrumented and left without obturation and nail varnish) and Negative control group (teeth were completely coated with nail varnish). After that All the canals were dried with paper point size 40 with 0.04 taper (Komet, Lemgo Germany) until a dry paper point comes out. Then the obturation were done according to the manufacturer's instructions for each group using single-cone technique with gutta-percha point(GP) size (40-0.04).

Group I: Obturated with GP and AH plus sealer (Dentsply, Konstanz, Germany).
Group II: Obturated with GP and GuttaFlow 2 sealer (Coltène/Whaledent, Langenau, Germany).
Group III: Obturated with bioceramic coated (BC) GP and TotalFill BC sealer (FKG Dentaire, La Chaux-de-Fonds, Switzerland).
Group IV: Obturated with GP and GuttaFlow bioseal sealer (Coltène/Whaledent, Langenau, Germany).

Thereafter, excess material was removed using a heated instrument 1 mm below access opening, then the samples were sealed coronally with glass ionomer cement.


**Figure 1.** A. Root coated with two layers of nail varnish with the exeption of apical 0.5 mm, B.The samples dipped for 24 h at 37°C in a neutralized buffer 2% methylene blue solution, C. Varnish removed using BP blade and polishing disks, D. Samples in a plastic container containing 4 ml of 65% nitric acid for 3 days, E. Centrifugation of this solution done at 4000 rpm for 7 min, F. Spectrophotometer device for reading the optical density of the dye that penetrate samples.

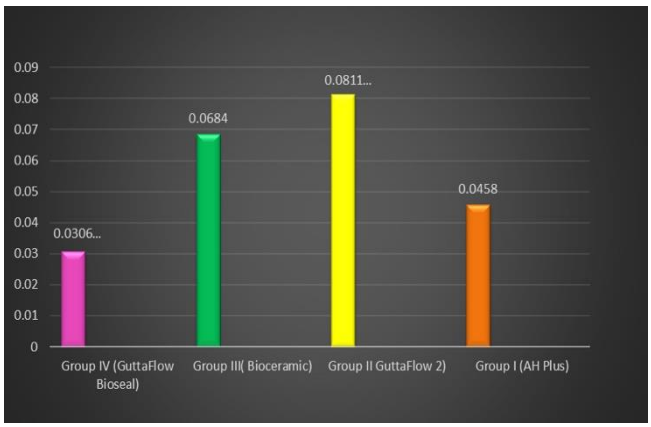


**Figure 2.** Bar chart showing the mean value of the dye leakage between groups.

The obturated samples stored for 1 week at 37ºC and 100% humidity in an incubator to allow the setting of the sealer. And after that the

roots were coated with two layers of nail varnish with the exception of apical 0.5 mm. Then the samples were dipped in a 2% methylene blue solution for 24h. Thereafter, the teeth were removed and rinsed in tap water for 30 min. Varnish was removed by surgical Blade and polish disk. Then, samples were transferred to a container containing 4 ml of 65% nitric acid for 3 days. After that, centrifugation of this solution was done at 4000 rpm for 7 min, and finally 2 ml of the supernatant layer from each sample was transferred to plastic cuvettes and the optical density of the solution was read by an automatic spectrophotometer (Shimadzu Europe - UV-1650PC, Germany) at 550 nm using concentrated nitric acid as the blank (Figure 1). Statistical analyses of the results were done by the use of the SPSS program (SPSS Statistics for Windows, Version 25.0; IBM Corp., Armonk, NY, USA). The normal distributions of the results were evaluated by the use of Shapiro-Wilk test, One-way ANOVA was use for hypothesis test, and Tukey HSD was used for pairwise comparisons.

## Results

The lowest mean value of leakage was recorded in group IV (GuttaFlow bioseal) (0.03067); followed by group I (AH plus) (0.0458); then group III (Bioceramic sealer) (0.0684) while the highest mean value was for group II (GuttaFlow 2) (0.08113) Figure 2. Means and ±S.D were recorded as shown in Table 1.

| Groups | No. of Samples | Mean | Min | Max | Median | St dev |
|---|---|---|---|---|---|---|
| Group I | 15 | .04580 | .022 | .072 | .04400 | .016644 |
| Group II | 15 | .08113 | .041 | .147 | .06800 | .034355 |
| Group III | 15 | .06840 | .042 | .100 | .06300 | .019595 |
| Group IV | 15 | .03067 | .003 | .075 | .03100 | .023089 |

**Table 1**. Descriptive statistics of the dye leakage of different Experimental Groups.

The use of One-way ANOVA revealed a significant difference (P<0.05) among the experimental groups. And to evaluate the difference between each two groups Tukey HSD was performed and as shown in Table 2 there is significant difference (P<0.05) between group I (AH plus sealer) and group II (GuttaFlow 2 sealer), group IV ( GuttaFlow bioseal sealer ) and group II (GuttaFlow 2 sealer), group IV (GuttaFlow bioseal sealer) and group III (Bioceramic sealer). There is a non-significant difference (P>0.05) between group I (AH plus sealer ) and group III (Bioceramic sealer), group I (AH plus sealer) and group IV (GuttaFlow bioseal sealer), group II (Gutta Flow 2 sealer) and group III (Bioceramic sealer).

**Multiple Comparisons**

Dependent Variable:

Tukey HSD

| Groups | Groups | Mean Difference | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| Group I | Group II | -.035333* | .008896 | .001 | -.05889 | -.01178 |
| | Group III | -.022600 | .008896 | .065 | -.04616 | .00096 |
| | Group IV | .015133 | .008896 | .333 | -.00842 | .03869 |
| Group II | Group I | .035333* | .008896 | .001 | .01178 | .05889 |
| | Group III | .012733 | .008896 | .486 | -.01082 | .03629 |
| | Group IV | .050467* | .008896 | .000 | .02691 | .07402 |
| Group III | Group I | .022600 | .008896 | .065 | -.00096 | .04616 |
| | Group II | -.012733 | .008896 | .486 | -.03629 | .01082 |
| | Group IV | .037733* | .008896 | .000 | .01418 | .06129 |
| Group IV | Group I | -.015133 | .008896 | .333 | -.03869 | .00842 |
| | Group II | -.050467* | .008896 | .000 | -.07402 | -.02691 |
| | Group III | -.037733* | .008896 | .000 | -.06129 | -.01418 |

**Table 2.** Tukey HSD between each two groups.

## Discussion

The three-dimensional obturation with the complete seal of the whole canal system especially the apical third is one of the important objectives of different obturation systems of root canal treatment. Therefore, an adequate sealing is critical for the ideal clinical performance to prevent the microleakage in endodontically treated teeth. Innovation in obturation materials continue to enhance the predictable success of endodontic treatment.[6]

Several methods were used to evaluate leakage in endodontic. One of these methods is the dye extraction this method has long been used in endodontic because it is fast, gives a quantitative results, and takes into account all absorbed dye in the samples, minimizes human measurement error and provides determinations of volume leakage rather than liner measurement.[7]

A new Bioactive glass-based root canal sealer GuttaFlow bioseal was tested in the present study for its ability to provide a better seal of the root canals. And to the extent of our knowledge, there are limited researches of this sealer, in the literature. Moreover, there is no study of the sealing ability of GuttaFlow bioseal sealer.

AH plus have been used in this study because it is commonly used in clinical work as a kind of epoxy resin-based sealer and is frequently chosen as a standered in studies of the properties of new sealers because of its sealing ability, proper film thickness, good flowability, and viscosity.[4,8]

In this study GuttaFlow Bioseal showed the lowest mean value in microleakage than other groups and a significant difference (P<0.05) with GuttaFlow 2 and Bioceramic sealer. These results may be related to the formation of a tag-like structure inserted into dentinal tubules and at the entrance of the tubules which is a result of adding the bioactive glass particles to the content of the sealer. These crystals were recognized as Hydroxyapatite which significantly enhance the adhesion to the dentinal wall with fast curing time (12-16 minutes).[5,9] In addition, the water sorption may play a role in sealing ability through volumetric expansion of GuttaFlow bioseal, along with low solubility, alkalizing activity, minimal calcium release and perfect Ca/P ratio rendering GuttaFlow bioseal apatite forming layer within 3 days as shown by Collado, et al.[10] Another factor which could be one of the important factors affect the sealing ability is the dentinal tubule penetration of GuttaFlow bioseal as shown in a study by Zahid and Ghareeb.[11] In this later study the GuttaFlow bioseal has produced the highest mean of dentinal tubule penetration followed by AH plus especially in the apical third, while EndoSequence BC showed the lowest value for the apical third. Furthermore, the push out bond strength of GuttaFlow bioseal significantly better than GuttaFlow 2 but still less stronger than AH plus.[12] This observation may be owing to the calcium silicate in GuttaFlow bioseal that forms a bond with the dentin surface by forming apatite interface deposits.[13] These calcium and phosphate ions promote the development of a superficial layer of calcium phosphate, which can fill out the voids and progress the sealing ability.[14]

In the present Study, AH plus showed a non-significant difference in the mean value of microleakage with GuttaFlow bioseal and bioceramic sealer (P>0.05). On the other hand, a significant difference with GuttaFlow 2 (group II) (P<0.05) which is in agreement with a study conducted by Özok et al.[1] This may be due to its adhesive properties, the ability to penetrate and diffuse more deeply into the dentinal tubules and the inflow into the micro irregularities significantly higher than GuttaFlow 2 [15] because of the area energy, short contact angle, which gave a higher wettability resulting in a better flow and interaction with the surface. While the silicone in GuttaFlow 2 may cause an increase in the surface tension, and reducing the flowability to the sealer causing it to have poor wetting effects.[16] Besides, its film thickness is higher than AH plus, which may affect the penetrate into dentinal tubules.[12,15] In addition to the creep capacity, prolonged polymerization and volumetric expansion of AH plus at 7 days, which enhancing the mechanical bond between the sealer and dentin resulting in significantly better bond strength than GuttaFlow 2 [17,18] with the long standing dimensional stability and polymerization stress distribution for AH plus sealer.[19] On the other hand, the lower porosity, homogeneous surface and low solubility of AH plus sealer[20] which is related to their polymerization reactions. When the two pastes are mixed, forming covalent reaction, amine groups promote changes in morphology and density of the epoxy resins. When each amine group react with an epoxy group, resulting in the formation of a strong and compact cross-linked polymer.[21,22]

The results of this study disagreed with that reported by other studies who found that there is no significant difference between AH plus and GuffaFlow 2 but the lowest mean leakage for AH plus. This may be attributed to the different methods of microleakage test, the selected teeth and the storage period.[3,23,24]

Although there is a non-significant difference between AH plus and GuttaFlow bioseal, AH plus and Bioceramic sealers, the GuttaFlow bioseal showed the lowest mean of leakage followed by AH plus and Bioceramic sealers, this may be related to the use of EDTA in the present study which may reduce wetting ability of dentinal walls which may prohibit adhesion of material hydrophilic in nature such as Bioceramic sealer.[25] While resin-based sealers are strongly dependent on smear layer removal to get better penetration. Efficient irrigation is essential for effectiveness of resin based sealers as reported by Sakr et al.[26] that the incomplete removal of smear layer has obstructed the sealer from penetration the dentinal tubules.

In the present study when comparing AH

plus and Bioceramic sealer a non-significant difference was detected between them, this result is in accordance with several previous studies[27,28] which could be attributed to the mechanical and chemical bonding with the dentinal wall. In addition, there is numerous studies showed that there is a non-significant difference mean leakage between GuttaFlow 2 and Bioceramic sealers as shown in the present study.[29]

## Conclusions

Within the limitation of the comparative study, The type of the sealer act as a major determinant of the sealing ability when used with a single cone technique. GuttaFlow bioseal sealer ( Bioactive glass based sealer) showed the best sealing ability compared to GuttaFlow 2 and Bioceramic sealers.

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### Declaration of Interest

The authors report no conflict of interest.

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