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Comparative evaluation of sealing ability of gutta flow and bio ceramic sealer under different moisture control methods and in absence of smear layer. An in vitro study

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Abstract:
Aim and Objective:
This in vitro study aimed to evaluate the effect of different moisture control methods on apical microleakage in root canals obturated with bioceramic sealer and Gutta flow. The objective was to determine whether moisture control significantly impacts the sealing quality of root canal obturations.
Materials and Method:
Forty extracted single-rooted human teeth with fully developed apices were instrumented using ProTaper rotary files (up to size F4) and irrigated with 5% sodium hypochlorite, saline, and 17% EDTA. Teeth were randomly divided into two groups (n=20) based on moisture control methods: Group A (paper points) and Group B (70% ethanol + paper points). Then these group are subdivided into GroupA1,GroupA2,GroupB1,GroupB2 in which groupA1and groupB1 obturated with bioceramic sealer while group A2 and group B2 are obturated with gutta flow. Specimens were immersed in 2% rhodamine B dye for 24 hours, sectioned longitudinally, and evaluated under a stereo microscope (20× magnification) for linear dye penetration.
Result
Bioceramic sealer shows lesser dye penetration when moisture control method is 70% ethanol in conjunction with paper points
Conclusion
The study concluded that the type of moisture control method—paper point alone or 70% ethanol followed by paper point—did not significantly influence the apical microleakage when using bioceramic sealers. This suggests bioceramic sealers exhibit reliable sealing ability regardless of minor moisture variations during obturation. While guta percha shows lesser microleakage when mosture control method is 70% ethanol along with paper point.
Keywords: *Bioceramic sealer, gutta percha, root canal obturation, moisture control, microleakage, apical sealing, in vitro study, endodontics, rhodamine B dye penetration*

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I.Introduction

The onset, progression, and persistence of periapical illness and apical periodontitis are largely influenced by endodontic microorganisms. Therefore, the main goal of root canal therapy (RCT) is to stop oral bacteria and debris from entering the root canal system and entering the periapical tissues. The root canal system, including the coronal and apical seals, is fully sealed off to achieve this.[1]

One of the main objectives of root canal therapy is to completely obturate and hermetically close the root canal system. Root filling techniques, moisture management, and the physical and chemical characteristics of the employed sealer are some of the variables that might affect the complex problem of root canal microleakage.[2] Microleakage is defined as the "diffusion of the bacteria, oral fluids, ions and molecules into the tooth and the filling material interface"

OR "defined as the clinically undetectable passageof bacteria, fluids, molecules or ions between tooth a nd therestorative or filling material." Causes of microleakage: Microleakage via the root canal system is one of the main reasons why root canal therapy fails, while there are other reasons as well. Numerous investigations have looked at this problem, pinpointed numerous potential contamination sources, and highlighted the clinician's responsibility to stop microleakage after root canal therapy. Long-term biological reactions within the material and between the substance and its surroundings are what cause microleakage to progress. [3]

It has been shown that the degree of residual moisture in the root canal system influences the sealing performance of both conventional and resin-based sealers. Consequently, the degree of adhesion between root canal dentin and traditional sealers may be impacted by the moisture content of the root canals before obturation procedures. Alcohols such as ethyl alcohol are used to cleanse the root canal before obturation, according to anecdotal reports. The fundamental idea is that alcohol lowers the surface tension of the root canal system, irrigants, and sealants. Reducing a fluid or sealant's surface tension can increase the flow of fluid into the dentinal tubules. [4,5]

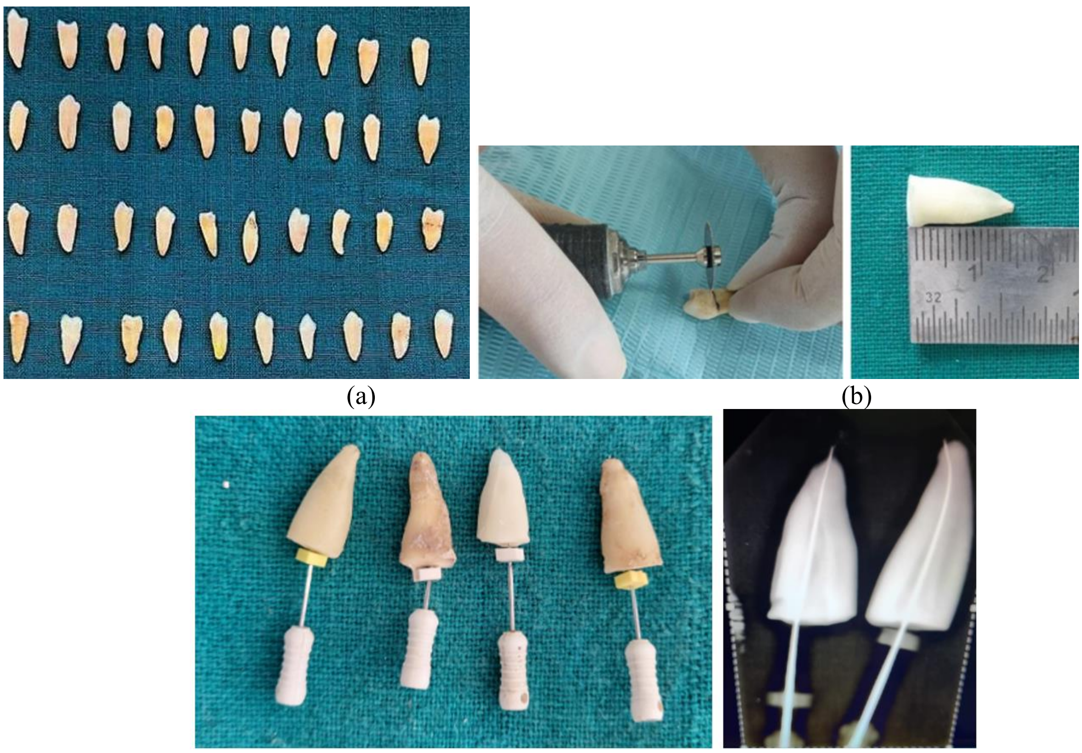
The classification of bioceramic materials as either bioactive or bioinert is based on their interactions with the surrounding living tissue. Bioactive materials, such as calcium phosphate and glass, interact with surrounding tissue to encourage the growth of stronger tissues. Bioinert materials, including alumina and zirconia, have no physiological or biological effect because they elicit a very small reaction from the surrounding tissue. Bioactive substances are further divided into degradable and nondegradable categories based on how stable they are. Bioceramics are frequently used to cover metal implants to increase their biocompatibility and for orthopedic procedures including joint or tissue replacements. Porous ceramics, including those based on calcium phosphate, have also been employed as alternatives to bone grafts [6,7].

Although the exact mechanism by which bioceramic-based sealers adhere to root dentin is uncertain, the following techniques have been proposed for calcium silicate-based sealers:

1. Tubular diffusion: This process forms mechanical interlocking links by allowing the sealer particles to flow into the dentinal tubules.[8,9]. .
2. A mineral infiltration zone is created when the mineral content of a strong alkaline sealer penetrates the intertubular dentin after denaturing the collagen fibers. [10].
3. Along the mineral infiltration zone, calcium silicate hydrogel and calcium hydroxide, which are produced when calcium silicates react with dentin moisture, partially react with phosphate to produce hydroxyapatite.[11].

II.Material And Methods

Total of 40 extracted single-rooted teeth [fig 1 (a)] with fully developed apex are collected. Teeth with open apex, severe curvature and with resorption are excluded. The teeth are stored in buffered isotonic saline solution to clean off blood and saliva. The crowns are removed at cemento-enamel junction (CEJ) by a carborandom disc bur[fig 1(b)] under water spray; apical patency is established with a #10 K-file and the length of each canal is determined by placing a #15 K-file into the canal until it became visible at the apical foramen. [Fig 1(c)]



(a) (b) (c)

Fig 1 : a) extracted tooth sample b) sectioning of the tooth from CEJ c) working length determination

The teeth are instrumented with a crown-down technique with Pro taper rotary files (Dentsply) [fig 2 (d)] up to master apical size F4. The canals are irrigated after using each file with 5% sodium hypochlorite (2 mL) and saline. removal of the smear layer [17% EDTA with ultrasonic instrument are used to remove the smear layer]. Every experimental group is devided into two groups(n=20) [group A] & [group B] based on moisture control methods.

In group A the moisture control method is paper point.

In group B the moisture control method will is 70 % ethanol + paper point.

Then these group are subdivided into

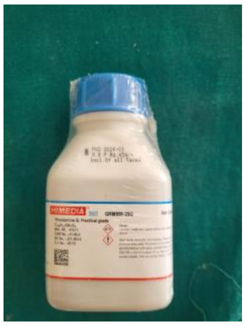
GroupA1 obturated with gutta flow bioceramic sealer.

GroupA2 obturated with gutta flow

GroupB1 obturated with bioceramic sealer.

GroupB2 obturated with gutta flow. [Fig 2a]

Specimens were immersed in 2% rhodamine B dye for 24 hours, sectioned longitudinally, and evaluated under a stereo microscope (20× magnification) for linear dye penetration.

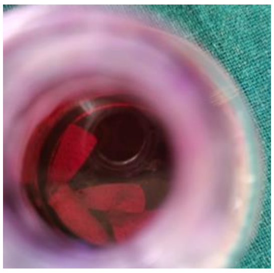


(a) (b)

(c) (d)

Fig 2: a) Bioceramic sealer b) Rhodamine b dye c) Ethanol d)Rotary file, densply protaper

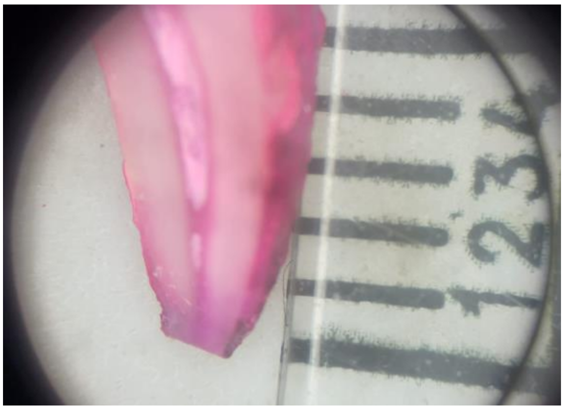
Then in all groups the coronal 3 mm of the obturation material is removed and filled with temporary restoration All teeth is then be stored in an incubator at 37°C at 100% humidity for 2 days [fig 3 (a)]. Then, the samples are coated with two layers of nail varnish except for a 2-mm area around the apical foramen. After 1 hour of drying, all the specimens are immersed in a 2% rhodamine B dye for 24hours [fig 3 (b)]

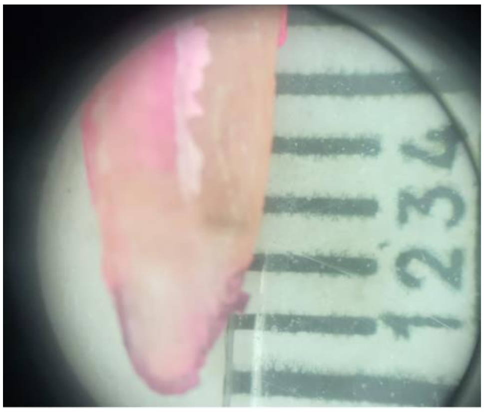


(a) (b)

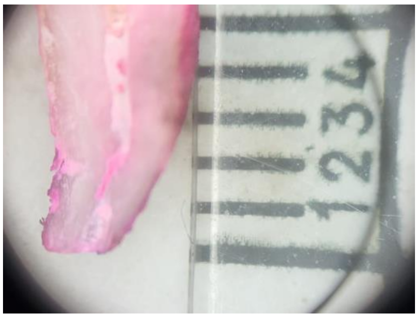
Fig 3: a) Incubator b) Rhodamine B dye

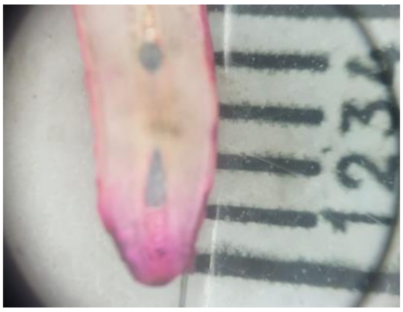
Then, the teeth are washed in water and the nail varnish was removed with a scalpel blade. These samples are longitudinally sectioned and observed under a stereo microscope with 20x magnification for assessing and measuring the linear dye penetration [fig 4]





(A1) **(B1)**





(A2) (B2)

Fig: 4 showing results of group A1) when only paper pionts were used with bioceramic sealer

B1) paper point along with ethenol and bioceramic sealer
A2) paper point with gutta flow
B2) paper point along with ethenol and gutta flow

III.Statistical Analysis

The data was entered into an Excel sheet and analyzed using SPSS (Statistical Package for the Social Sciences) version 30.0, IBM, Chicago. The probability distribution of the data was assessed using the Kolmogorov-Smirnov test. Mean values and standard deviations (SD) were calculated. Student's *t*-test was performed, and a *p*-value of <0.05 was considered statistically significant. The confidence interval was set at 95%.

IV.Result

SEALING ABILITY

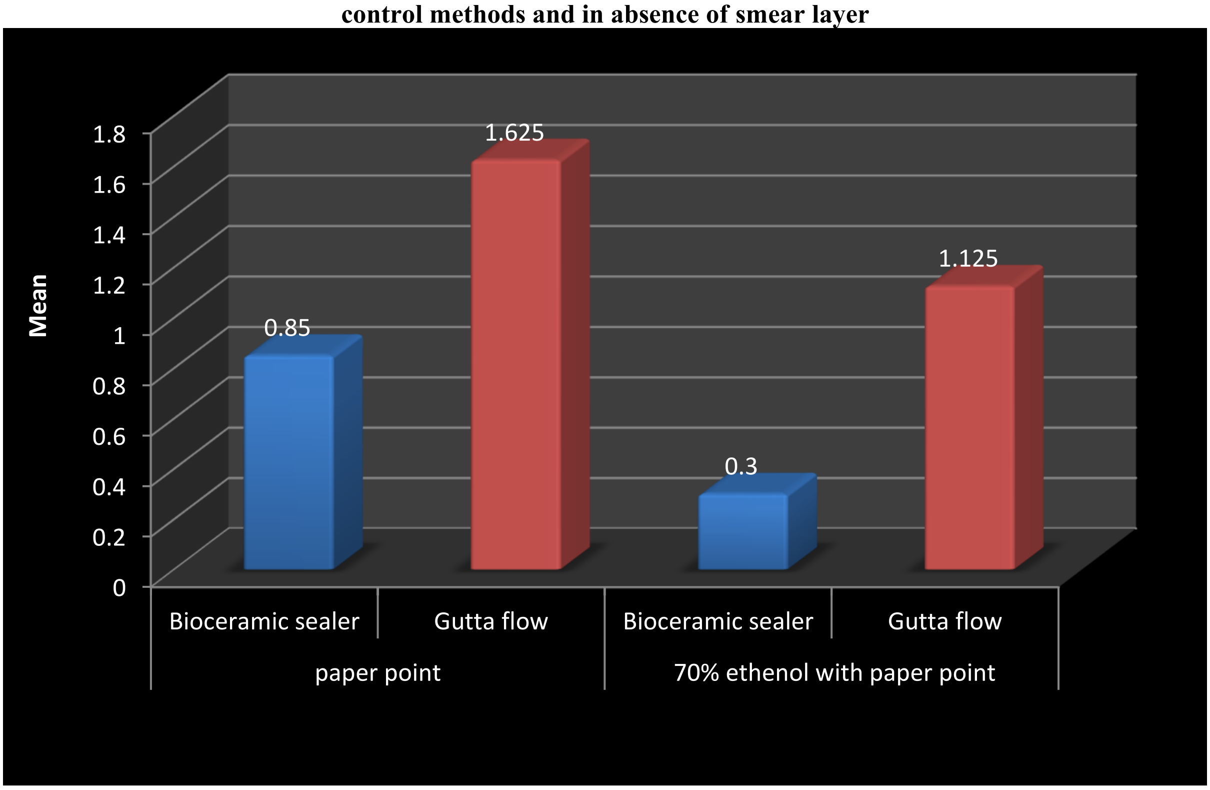
Table 1- Comparison of sealing ability of gutta flow and bio ceramic sealer under different moisture control methods and in absence of smear layer

Moisture control	Sealer used	n	Mean	SD	Mean Difference	95% CI		t-value	p-value
						Lower	Upper		
Group A1- Moisture controlled by paper point	Group A1- Bioceramic sealer	4	0.850	0.50	-0.775	-1.627	0.077	-2.224	0.068
	Group A(2)- Gutta flow	4	1.625	0.47		-1.628	0.078		
Group B2- Moisture controlled by 70% ethenol	Group B1- Bioceramic sealer	4	0.300	0.24	-0.825	-1.25321	-0.396	-4.714	0.003*
	Group B2-	4							

with paper point	**Gutta flow**	**1.125**	**0.25**	**-1.25325**	**-0.396**

***Statistically significant**

Figure 5- Comparison of sealing ability of gutta flow and bio ceramic sealer under different moisture control methods and in absence of smear layer



V.Result

In this evaluation, the sealing ability of two sealers—bioceramic sealer and GuttaFlow—was compared under two moisture control methods (using paper points alone and using 70% ethanol with paper points), all in the absence of a smear layer. In Group A1, where moisture was controlled by paper points alone, the mean leakage value for the bioceramic sealer was 0.850 (±0.50), while it was higher at 1.625 (±0.47) for GuttaFlow. Although the bioceramic sealer showed better sealing ability (indicated by lower mean leakage), the difference was not statistically significant (p = 0.068), with a mean difference of -0.775 and a 95% confidence interval ranging from -1.627 to 0.077, which includes zero.

However, in Group A2, where moisture control was achieved using 70% ethanol along with paper points, the bioceramic sealer again outperformed GuttaFlow, with mean leakage values of 0.300 (±0.24) and 1.125 (±0.25) respectively. In this case, the difference was statistically significant (p = 0.003), with a mean difference of -0.825 and a 95% confidence interval from -1.253 to -0.396, clearly excluding zero. These findings suggest that the bioceramic sealer provides superior sealing ability compared to GuttaFlow, especially when optimal moisture control is achieved using ethanol, and that proper moisture control can enhance the performance of certain sealers. **(Table 2, Figure 5)**

In this analysis, the sealing abilities of bioceramic sealer and GuttaFlow were assessed under two moisture control techniques in the presence of the smear layer. In Group B1, where moisture control was achieved using paper points alone, the mean leakage for the bioceramic sealer was 1.375 (±0.47), compared to a higher mean leakage of 2.000 (±0.40) for GuttaFlow. Although the bioceramic sealer showed better sealing ability, the difference was not statistically significant (p = 0.094), with a mean difference of -0.625 and a 95% confidence interval from -1.395 to 0.145, which includes zero.

In contrast, Group B2, where moisture control was performed using 70% ethanol along with paper points, demonstrated a statistically significant difference between the two sealers. The bioceramic sealer again showed a lower mean leakage of 1.375 (±0.47), while GuttaFlow exhibited a higher leakage of 2.375 (±0.47). The mean difference was -1.000, and the 95% confidence interval ranged from -1.828 to -0.172, excluding zero. The difference was statistically significant with a p-value of 0.025.

These findings indicate that while bioceramic sealer consistently provides better sealing ability than GuttaFlow in the absence of the smear layer, the advantage becomes statistically significant only when effective moisture control is achieved using 70% ethanol. This suggests that both the type of sealer and the method of moisture control influence the sealing effectiveness, even in the absence of smear layer. **(Table 3, Figure 5)**

VI.Discussion

Achieving a fluid-tight apical seal remains a crucial goal in endodontic therapy, as leakage can result in periapical inflammation and treatment failure. This clinical case report evaluated and compared the sealing ability of two contemporary root canal sealers—GuttaFlow and a bioceramic sealer—under different moisture control conditions (70% ethanol and paper point drying) and in the absence of a smear layer. The findings of this case are consistent with existing literature highlighting the influence of canal moisture and smear layer removal on the sealing efficacy of root canal obturation materials[12,13]

The present case demonstrated that **bioceramic sealers** provided superior apical sealing compared to GuttaFlow, especially when canals were dried with **70% ethanol**. This can be attributed to the hydrophilic nature and superior flow characteristics of bioceramic sealers, which allow them to adapt better to canal irregularities and dentinal tubules even in moist conditions. Moreover, bioceramic sealers exhibit chemical bonding with dentin, enhanced by the removal of the smear layer, which exposes collagen fibrils and opens tubules for better sealer penetration [13,14].

Conversely, **GuttaFlow**, despite its advantageous properties such as expansion on setting and minimal shrinkage, showed less favorable sealing ability when canals were dried using paper points alone. GuttaFlow is a silicone-based sealer that is less hydrophilic, which could affect its adaptation in humid environments . However, its performance improved with 70% ethanol drying, suggesting that partial moisture removal enhances its flow without completely drying the canal—thereby avoiding desiccation and collapse of collagen fibrils.[15,16]

The **removal of the smear layer** was shown to significantly improve the sealing performance of both sealers, aligning with previous studies that recommend smear layer removal to enhance the sealer-dentin interface. Chelating agents such as EDTA followed by sodium hypochlorite effectively eliminate the smear layer and facilitate deeper sealer penetration, which is crucial for long-term sealing efficacy.[17,18]

The choice of **moisture control technique** also played a pivotal role. Ethanol, acting as a drying agent, improves sealer penetration by reducing surface tension and promoting better interaction between the sealer and dentin walls. This suggests that ethanol drying could be particularly beneficial when using hydrophobic or less flowable sealers.[19]

Despite the clinical insights provided by this case, limitations such as the in vivo variability in canal anatomy and operator-dependent factors must be acknowledged. Further **in vitro studies** with standardized methodologies and **microleakage assessments** (e.g., dye penetration, fluid filtration, or micro-CT analysis) are needed to corroborate these observations.

VII.Conclusion

The clinical findings from this case indicate that both the type of root canal sealer and the method of moisture control significantly influence the sealing ability of root canal obturation. **Bioceramic sealer** demonstrated superior apical sealing compared to **GuttaFlow**, particularly when used following **smear layer removal** and **ethanol-based drying**. These results can be attributed to the hydrophilic nature and chemical bonding potential of bioceramic materials, which are enhanced in appropriately conditioned canal environments.

GuttaFlow, although a promising silicone-based sealer with beneficial handling and expansion properties, was less effective in moist conditions and showed improved performance only when ethanol was used for drying. This suggests that moisture control and smear layer management are critical factors for optimizing the clinical performance of all sealers, particularly those with limited hydrophilicity.

In conclusion, for optimal sealing efficacy and long-term success in endodontic treatment, clinicians should consider not only the choice of sealer but also the **moisture control technique** and **smear layer management** strategy. The combination of smear layer removal and ethanol drying appears to be particularly advantageous when using advanced bioceramic sealers.
variables on the sealing ability of bioceramic sealers.

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