IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 3 Ser. 7 (March. 2024), PP 15-20
www.iosrjournals.org

A Comparative Evaluation Of The Apical Microleakage In Root Canals Sealed With Bio Ceramic, Neopex And Gutta Flow: An In-Vitro Study

Keerti Mishra[1] Sanjeev Tyagi[2] Vartul Dwivedi[3] Srisha Shivangi[4] Rashi Sahu[5] Deeksha Pawar[6]

[1](*Postgraduate Student, Department Of Conservative And Endodontics, Peoples Dental Academy, Bhopal, M.P, India)*
[2](*Professor And Hod, Department Of Conservative And Endodontics, Peoples Dental Academy, Bhopal, M.P, India)*
[3](*Professor, Department Of Conservative And Endodontics, Peoples Dental Academy, Bhopal, M.P, India)*
[4](*Postgraduate Student, Department Of Conservative And Endodontics, Peoples Dental Academy, Bhopal, M.P, India)*
[5](*Postgraduate Student, Department Of Conservative And Endodontics, Peoples Dental Academy, Bhopal, M.P, India)*
[6](*Postgraduate Student, Department Of Conservative And Endodontics, Peoples Dental Academy, Bhopal, M.P, India)*

Abstract:
***Background*:** *The success of endodontic treatments relies heavily on achieving a secure seal within the root canal system to prevent microbial invasion and maintain periapical health. This study compared the apical microleakage of three different endodontic sealers: Neopex, GuttaFlow, and Bioceramic, using dye penetration analysis.*
Materials and methods: *60 single rooted teeth (extracted for orthodontic purposes) were used for this study. The specimens were stored in 5.25% sodium hypochlorite for 2 hours, then washed and stored in distilled water at room temperature. All teeth were decoronated 12 mm from the anatomical root apex using a diamond disc and water coolant. The correct working length was established by inserting a size 15 K-file. The prepared roots were divided randomly into three experimental groups (in each group, n = 20): group A for obturation with GuttaFlow sealer , group B for obturation with Bioceramic sealer, group C for obturation with Neopex. For groups A, B, and C, the root surfaces were coated with two layers of nail varnish, except for the apical 2 mm.The linear dye penetration was measured from apex to the maximum coronal extent while magnified 40 times with a stereomicroscope.The depth of dye penetration was evaluated using criteria given by W.P. Saunders et al. The data collected were analysed and compared with ANOVA, paired t-test and interclass correlation.*
Result: *Thus, the present study concluded that the microleakage was maximum in Group C followed by Group A and Group B, had the least microleakage.*
Conclusion: *Within the limitations of the study ,it can be concluded that all sealers showed varying levels of apical microleakage, with the least penetration in the biocermaic sealer group.*
Key Words: *Microleakage, Bioceramics, Gutta Flow, Neopex, Root Canal, Endodontics*.

Date of Submission: 20-03-2024 Date of Acceptance: 30-03-2024

I. Introduction

For endodontic therapy to be successful, necrotic pulp tissue must be completely removed, and the radicular space must be optimally sealed off to prevent microbial invasion and colonization of the root canal space and periapical tissue.[1] Root canal sealer fills the canal space by creating a genuine gap-free solid mass with gutta-percha that forms a fluid-tight seal.[2] Grossman[3], in 1976, listed the properties of a good ideal root canal sealer; these include unique adhesion of the sealer to both the dentinal surface and the core material.[4,5] NeoPex (Orikam, India) is a Calcium hydroxide paste containing iodoform is used as a temporary or permanent filling material. The addition of iodoform to calcium hydroxide improves radiopacity and adds an antibacterial agent to the paste.[6]

Both tissue healing and obturation are possible with the GuttaFlow sealer (Roeko–Coltene/Whaledent, Langenau, Germany). It has the thixotropic property, which allows it to enter the dentinal tubule and expand when it hardens.[7]

The Bioceramic sealer (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) is a newer, calcium silicate-based materials.[7] It has a small particle size, good flowability, and exhibits no shrinkage on setting.[8]

The percolation of liquids and microorganisms at the interface between the root canal surface and the obturation material is known as endodontic microleakage. Various methods are used to assess the apical seal after obturation.[9]

The aim of this in vitro study is to measure the apical microleakage of three endodontic sealers − Neopex, GuttaFlow and Bioceramic sealer − by dye penetration.

II. Material And Method

60 single rooted teeth (extracted for orthodontic purposes) were used for this study. Each root surface was cleaned manually using a periodontal curette. The specimens were stored in 5.25% sodium hypochlorite for 2 hours, then washed and stored in distilled water at room temperature. With the aid of transmitted light and a stereomicroscope set at 40X magnification, teeth were selected by the following criteria: straight root with no visible caries, fully developed apices, and free of calculus, cracks, and anatomical irregularities. The presence of a single straight canal, no signs of internal resorption, previous endodontic treatment, and calcification were confirmed by diagnostic X-ray. All teeth were decoronated 12 mm from the anatomical root apex using a diamond disc and water coolant. Pulp extirpation was carried out using a barbed broach. The correct working length was established by inserting a size 15 K-file .

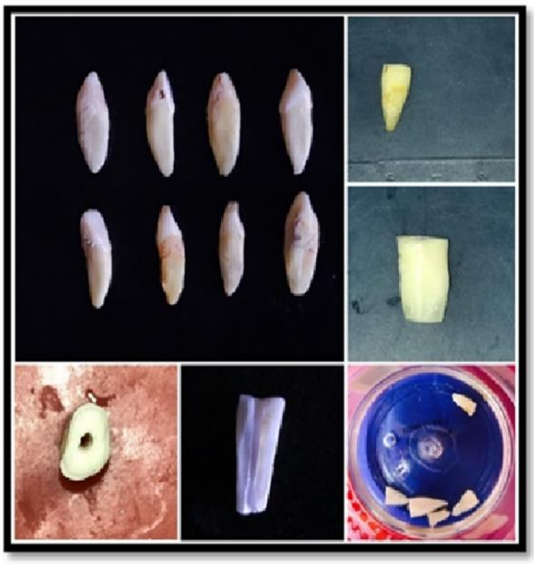
Using a dental surveyor, all roots were wrapped in two layers of aluminum foil and then inserted in 2.5 mL plastic test tubes that were filled with silicone impression material.After the impression material had set, the aluminum foil was replaced with saline-soaked gauze to keep the roots moist throughout root preparation. The roots were instrumented, according to manufacturer's instructions, using the rotary ProTaper Next file system to size 4× using an X-Smart Plus Endo Micromotor .

During canal instrumentation and between files, 17% ethylenediaminetetraacetic acid (EDTA) gel was used as a lubricant, and at every file change, 1 mL of NaOCl 2.5% was used as an irrigant. Finally, after preparation, each root was irrigated for 1 minute with 2 mL of 17% EDTA liquid, then rinsed with 2 mL 5.25% NaOCl followed by 10 mL distilled water. Next, the canals were dried using absorbent sterile paper points .

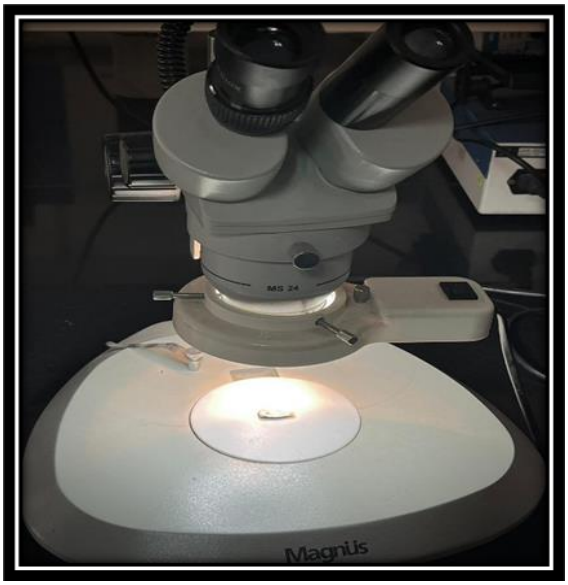
The prepared roots were divided randomly into three experimental groups (in each group, $n = 20$): group A for obturation with GuttaFlow sealer , group B for obturation with Bioceramic sealer, group C for obturation with Neopex.

(Figure No. 1)

All roots were obturated by the single-cone filling technique using corresponding ProTaper Next paper gutta-percha. All sealers were prepared according to manufacturers' instructions. Then, the samples were incubated in 100% humidity at 37°C for 7 days, for complete setting. All of the experimental group specimens' surfaces were dried after the incubation period. With the exception of the apical 2 mm, groups A, B, and C's root surfaces were covered in two coats of nail varnish.



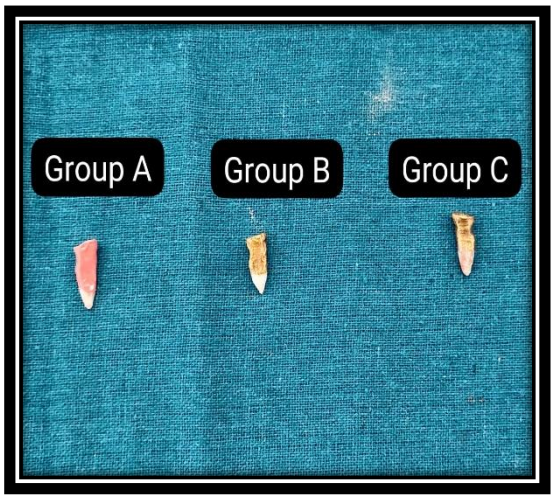
(Figure No. 2)



(Figure No.3)

Following an hour, all of the roots were suspended vertically in a glass container with their apices facing downward and were kept in an incubator for 72 hours at 37°C with a fresh solution of 2% methylene blue.
To get rid of extra dye, all samples were then rinsed under running water for 30 minutes.
The nail varnish was then carefully removed from root surface using a Lacron .

Using a diamond disk and water coolant, two longitudinal grooves were cut on the roots along the long axis, and then the roots were split in half by applying gentle pressure. The linear dye penetration was measured from root apex to the most coronal extent under Stereomicroscope (at 40X magnification. The depth of dye penetration was evaluated [Table 1] using criteria given by W.P. Saunders et al.[8]by two investigators.



(Figure No. 4)

[Table 1]:
Depth of dye penetration, according to degree of microleakage.

Degree of Leakage	Depth of Dye Penetration
0	No leakage detected
1	Less than 0.5 mm
2	0.5-1 mm
3	Greater than 1 mm

(Table 1)

III. Statistical Analysis

The whole study was repeated three times and the readings were calculated. The data obtained was then subjected to statistical analysis using SPSS software (version 26.0). The tests used for statistical analysis used were ANOVA, paired t-test and interclass correlation.

IV. Result

The apical microleakage for study groups was evaluated and results obtained were subjected to statistical analysis using SPSS software (version 26.0). The number of study samples was distributed for each of the three study groups based on the dye penetration scores [Table 2].The apical dye penetration was observed minimum in Group B followed by Group A , then Group C.

[Table 2]:
Distribution of samples by dye penetration score criterion among all five study groups.

Score	Group A	Group B	Group C
0	6	8	5
1	7	7	4
2	6	5	8
3	1	0	3

(Table 2)

The mean values for apical microleakage, according to dye penetration test for all the three study groups was observed. The maximum mean was found in Group C followed by Group A, and least in Group B. The analysis of variance for microleakage values used in the study exhibited highly significant correlation (p-value <0.01) between all the study groups [Table 3].

[Table 3]:
Mean values of three study groups and their intergroup comparison using ANOVA statistical analysis according to dye penetration test.

Score	Group I	Group II	Group III		
Mean±SD	0.067 ±0.013	0.50± 0.030	1.83 ±0.065		
Statistical analysis					
Variation	SS†	Df††	p – value		
Total	25.631	59	0.001*		

†Sum of Squares; †† Degree of freedom *p – value < 0.01 is highly significant.

(Table 3)

The intra-observer dependability for each of the five study groups is displayed in [Table 3] by statistical analysis of intra-class correlation .The p-value was found to be insignificant (p-value >0.05) for all the study groups. The Paired t-test was utilized to evaluate the microleakage data for each of the five groups in an intergroup comparison.

A highly significant difference (p-value <0.01) in microleakage scores was found among all the study groups between Group I vs II, I vs III and II vs III [Table 5]. Thus, the present study concluded that the microleakage was maximum in Group C followed by Group A and Group B, had the least microleakage.

[Table 4]:
Intra observer reliability was assessed in triplicate for each of the five study groups.

Group	Mean difference	Intraclass correlation	p - value
Group A	0	1	1.000*
Group B	0.06	0.928	0.870*
Group C	0.03	0.922	0.780*

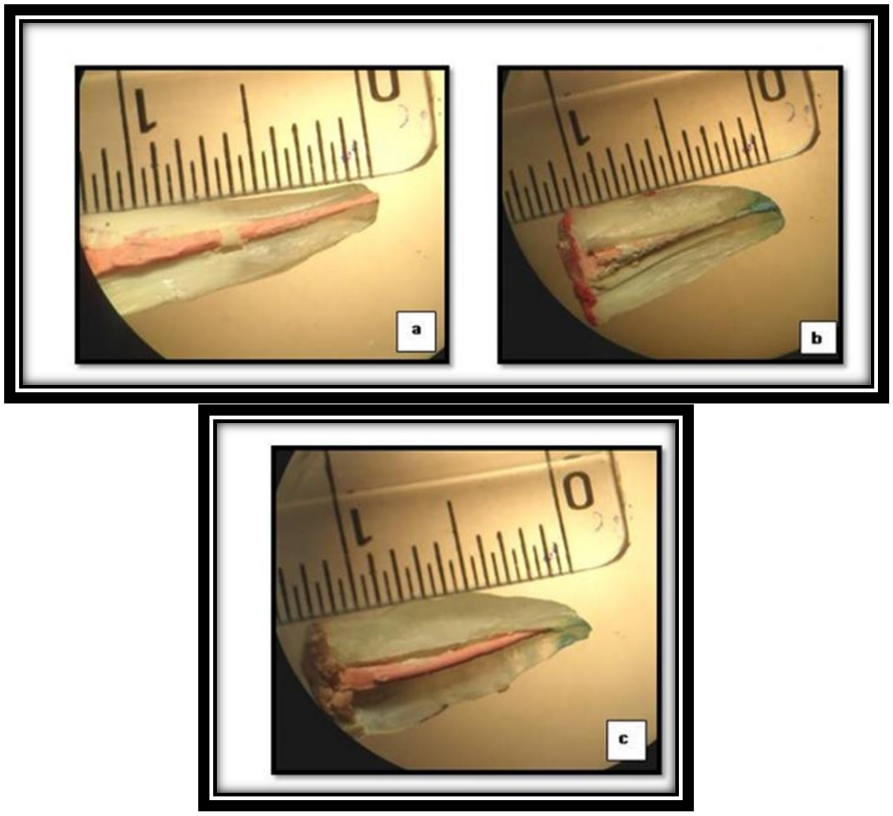
*p – value > 0.05 is insignificant.

[Table 5]:
Inter group comparison of all the five study groups using paired t-test statistical analysis.

Groups	t- value	CI (95%)of difference		p – value
		Upper Limit	Lower Limit	
A vs B	102.860	-1.728	-1.798	0.001*
A vs C	51.291	-0.416	-0.45	0.001*
B vs C	71.862	1.368	1.292	0.01*

* p - value ≤ 0.01 is highly significant.

Apical microleakage assessment by dye penetration shows (a): Group A, (b): Group B(c): Group C



(Figure No. 5)

V. Discussion

It is possible to stop the infiltration of microorganisms and their waste products along root canals by filling the spaces at the gutta-percha/dentin interface and properly sealing the root canal in three dimensions.[10]

Torabinejad et al.[11] stated that "if a root filling material does not allow penetration of small particles such as dye molecules, it is more likely to have the potential to prevent microleakage of bacteria and their by-products." Methylene blue was chosen because it has a low molecular weight, comparable to that of bacterial by-products that can leak out of infected root canals.[12]

Among all the tested groups used in this study, Bioceramic sealer was the best group which showed the least leakage.

The superior effectiveness of Bioceramic sealer can be attributed to its small particle size, hydrophilicity, and low contact angle, which facilitate easy cement spreading over the root canal's dentin walls and entry into the lateral micro canals for filling. Both the appropriate BC particle-impregnated gutta percha and the root canal dentin walls are chemically bonded to by BC root canal sealers. Additionally, a notable expansion of 0.20% is shown. These properties result in a gap-free chemical contact between the sealer and the dentinal walls, which is what gives the sealer its effectiveness.[11,13]

According to the maker of GuttaFlow Bioseal, the product offers natural mending ingredients including calcium and silicates that crystallize into hydroxyapatite in a moist environment.[14] It mechanically binds to bone tissue through hydroxyapatite crystals and exhibits both osteointegrative and osteoconductive properties. When water and calcium oxide come into contact, calcium hydroxide is created. The apatite precursor known as calcium phosphate is generated when phosphorus ions are present, and this process is also crucial for the creation of apatite crystals.[15]

Bioceramic sealer has demonstrated bond strength, cytocompatibility, and dentin penetrability.[16] It is a calcium silicate-based bioceramic sealer, described by its manufacturer as a radiopaque, insoluble, and aluminum-free material that requires moisture to set and harden. It is both biocompatible and hydrophilic in nature, and expands on setting.

The expansion of the sealer to the root canal walls is attributed to a combination of increased chemical bonding and micromechanical bonding.[17]

The GuttaFlow Bioseal and Bioceramic sealers utilized in this investigation include stability, adherence to dentin, and no shrinkage upon hardening as physical characteristics. By Grossman's standards, both sealers

might be deemed perfect[4] and better than resin-based sealers.[2,18] Both sealers are capable of producing a tight seal and a solid, gap-free obturation mass. The seal tightness is attributed to how the sealer bonds with the wall of the canal space. The sealers bond differently with the dentin: Bioceramic sealer forms a chemical and mechanical bond with the dentin, whereas GuttaFlow Bioseal forms a mechanical and physical bond.[13,18]

In this study, Bioceramic sealer showed the lowest microleakage of the treatment groups. These findings might be explained by the bioactive glass particles in the sealer causing the creation of a tag-like structure inside dentinal tubules and at the tubule entrance. It was determined that these crystals were hydroxyapatite, which greatly improves adherence to the dentinal wall.[19]

Because the gutta-percha nanoparticles in GuttaFlow Bioseal sealer can cover the uneven geometry of the root canal space, achieving the monoblock structure is made easier. Additionally, the water sorption process may contribute to the sealing ability by means of volumetric expansion, low solubility, alkalizing activity, minimum release of calcium, and an ideal Ca/P ratio. This will cause anapaite to form in three days.[20,21]

Neopex is a calcium hydroxide based sealer[6] Calcium hydroxide used as root canal sealer since it stimulates periapical tissues in order to maintain health or promote healing and secondly for its antimicrobial effects[22].

Studies have noted that the solubility of calcium hydroxide sealers is increased by water absorption, which causes a notable volumetric expansion during setting. This might be one of the causes of group C's noticeably greater dye penetration than that of groups A and B.

Nonetheless, additional clinical assessments are advised in the future due to the limits of in vitro research.

VI. Conclusion

Within the limitations of the study ,it can be concluded that all sealers showed varying levels of apical microleakage, with the least penetration in the biocermaic sealer group.

References

[1] Razmi H, Bolhari B, Dashti Nk, Fazlyab M. The Effect Of Canal Dryness On Bond Strength Of Bioceramic And Epoxy-Resin Sealers After Irrigation With Sodium Hypochlorite Or Chlorhexidine Iran Endod J. 2016;11:129–33

[2] Singh H, Markan S, Kaur M, Gupta G, Singh H, Kaur M. Endodontic Sealers: Current Concepts And Comparative Analysis Dent Open J. 2015;2:32–7

[3] Grossman L. Physical Properties Of Root Canal Cements J Endod. 1976;2(6):166–175

[4] Van Meerbeek B, Peumans M, Poitevin A, Et Al Relationship Between Bond-Strength Tests And Clinical Outcomes Dent Mater. 2010;26:E100–21

[5] Özcan E, Eldeniz Aü, Aydınbelge Ha. Assessment Of The Sealing Abilities Of Several Root Canal Sealers And Filling Methods Acta Odontol Scand. 2013;71:1362–9

[6] Neopex- Calcium Hydroxide Paste With Iodofrom. Accessbile At Https://Orikamhealthcare.Com/Product/Neopex/

[7] Donnermeyer D, Bürklein S, Dammaschke T, Schäfer E. Endodontic Sealers Based On Calcium Silicates: A Systematic Review Odontology. 2019;107:421–36

[8] Carvalho Nk, Prado Mc, Senna Pm, Et Al Do Smear-Layer Removal Agents Affect The Push-Out Bond Strength Of Calcium-Silicate Based Endodontic Sealers? Int Endod J. 2017;50:612–9

[9] Lahor-Soler E, Miranda-Rius J, Brunet-Llobet L, Farré M, Pumarola J. In Vitro Study Of The Apical Microleakage With Resilon Root Canal Filling Using Different Final Endodontic Irrigants J Clin Exp Dent. 2015;7:E212–7

[10] European Society Of Endodontology. Quality Guidelines For Endodontic Treatment: Consensus Report Of The European Society Of Endodontology Int Endod J. 2006;39:921–30

[11] Torabinejad M, Watson Tf, Ford Tp. Sealing Ability Of A Mineral Trioxide Aggregate When Used As A Root End Filling Material J Endod. 1993;19:591–5

[12] Padmanabhan P, Das J, Kumari Rv, Pradeep Pr, Kumar A, Agarwal S. Comparative Evaluation Of Apical Microleakage In Immediate And Delayed Postspace Preparation Using Four Different Root Canal Sealers: An In Vitro Study J Conserv Dent. 2017;20:86–90

[13] Patil P, Rathore Vp, Hotkar C, Savgave Ss, Raghavendra K, Ingale P. A Comparison Of Apical Sealing Ability Between Guttaflow And Ah Plus: An In Vitro Study J Int Soc Prev Community Dent. 2016;6:377–82

[14] Amanda B, Suprastiwi E, Usman M. Comparison Of Apical Leakage In Root Canal Obturation Using Bioceramic And Polydimethylsiloxane Sealer (In Vitro) Open J Stomatol. 2018;8:24–34

[15] Gandolfi Mg, Siboni F, Prati C. Properties Of A Novel Polysiloxane-Guttapercha Calcium Silicate-Bioglass-Containing Root Canal Sealer Dent Mater. 2016;32:E113–26

[16] Moinzadeh At, Portoles Ca, Wismayer Ps, Camilleri J. Bioactivity Potential Of Endosequence Bc Rrm Putty J Endod. 2016;42:615–21

[17] Tanomaru-Filho M, Torres Ff, Chávez-Andrade Gm, Et Al Physicochemical Properties And Volumetric Change Of Silicone/Bioactive Glass And Calcium Silicate-Based Endodontic Sealers J Endod. 2017;43:2097–101

[18] Zielinski Tm, Baumgartner Jc, Marshall Jg. An Evaluation Of Guttaflow And Gutta-Percha In The Filling Of Lateral Grooves And Depressions J Endod. 2008;34:295–8

[19] Washio A, Morotomi T, Yoshii S, Kitamura C. Bioactive Glass-Based Endodontic Sealer As A Promising Root Canal Filling Material Without Semisolid Core Materials Materials. 2019;12:3967

[20] Collado-González M, Tomás-Catalá Cj, Oñate-Sánchez Re, Moraleda Jm, Rodríguez-Lozano Fj. Cytotoxicity Of Guttaflow Bioseal, Guttaflow2, Mta Fillapex, And Ah Plus On Human Periodontal Ligament Stem Cells J Endod. 2017;43:816–22

[21] Hoikkala Np, Wang X, Hupa L, Smått Jh, Peltonen J, Vallittu Pk. Dissolution And Mineralization Characterization Of Bioactive Glass Ceramic Containing Endodontic Sealer Guttaflow Bioseal Dent Mater J. 2018;37:988–94

[22] Desai S, Chandler N. Calcium Hydroxide-Based Root Canal Sealers: A Review. J Endod. 2009;35(4):475–80