Journal of Advances in Medicine and Medical Research

Volume 35, Issue 15, Page 1-9, 2023; Article no.JAMMR.99883
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Comparative Evaluation of Different Intra-orifice Barriers on the Microleakage of Endodontically Treated Roots Obturated with Gutta-percha "An *In-vitro* Study"

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Authors' contributions

This work was carried out in collaboration among all authors. Authors DA, PK and VT designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NS and MG managed the analyses of the study. Author SUN managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2023/v35i155063

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/99883

Original Research Article

Received: 08/03/2023
Accepted: 11/05/2023
Published: 25/05/2023

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ABSTRACT

Aim: To comparatively evaluate various Intra-Orifice barriers (IOB) namely; Cention N (Ivoclar Vivadent), Biodentine (Septodont), Light Cured GIC (GC Gold Label 2LC) and Tetric N Flow (Ivoclar Vivadent) for their effects on the microleakage of endodontically treated teeth.
Study Design: *In-vitro* study.
Place of Study: Department of Endodontics and conservative dentistry, Himachal dental college, Sundarnagar, Himachal Pradesh.
Materials and Methods: Seventy-five mandibular premolars were decoronated to a standardized length, prepared and obturated with Gutta-Percha and AH Plus sealer. Except for control specimens, the coronal 3-mm gutta-percha was removed and filled with different Intra-orifice barrier materials. The specimens (75) were divided into five groups (n = 15) on the basis of the Intra-Orifice barrier material used. Group 1: Control, Group 2: Cention N, Group 3: Biodentine, Group 4: Light Cured GIC, Group 5: Tetric N Flow. In experimental groups, 3 mm of coronal gutta-percha was removed and replaced with the study material. Samples were submerged in 2% methylene blue dye in vacuum for one week. Specimens were longitudinally sectioned and leakage measured using a 50X stereomicroscope and graded for depth of leakage.
Results: In the present study microleakage of roots were significantly affected by the type of Intra-Orifice barrier used and the following pattern was observed: Tetric N Flow > Biodentine >Light Cured GIC > Cention N>Control.
Conclusion: The present study concluded that Intra-Orifice barrier placement provides better coronal seal, prevents microleakage, and enhance the longevity of postobturation restorations, Tetric N Flow proved to be the best followed by Biodentine, Light Cured GIC and Control group.

Keywords: Endodontically treated teeth; Intra-Orifice barrier; microleakage; nail varnish; Methylene blue dye.

1. INTRODUCTION

"A coronal filling material is effective whenever it is able to fulfill some of the properties, like lack of porosity, good sealing of tooth margins, dimensional changes to hot and cold temperatures, lack of porosity, good abrasion and compression resistance, easy insertion and removal, compatibility with intra-canal medicaments, and good esthetic appearance" [1]. "Swatz found that the failure rate was two times as high in cases of inadequate coronal restoration compared to cases with adequate coronal restoration" [2].

"In presence of inadequate coronal seal, long-term success remains questionable and failure to maintain the seal may expose obturated root canals to delayed healing and also infection in the periradicular, periodontal ligament or supporting osseous structures" [3].

"Roghanizad and Jones suggested placing a coronal seal in the orifice.Hence, every effort should be directed to prevent infectious contamination of the pulp space. They suggested placing a coronal seal in the orifice of the root canal immediately after root canal filling after replacement of 3 mm of coronal gutta-percha" [4].

"An ideal intra-coronal barrier should have the following characteristics as proposed by Wolcott et al. They should (a) be easily placed (b) bond to tooth structure (c) seal against microleakage (d) be distinguishable from tooth structure (e) not interfere with the final restoration" [5]. "A better marginal sealing ability is seen by resin composites when used with newer generation bonding agents. Newer resin-modified glass ionomer cements (GICs) with enhanced strength, chemical bonding and fluoride releasing property make it a better option for using it as a coronal seal in root canal treated teeth" [6].

To best of our knowledge, a few studies have been conducted on the reinforcing effect of Intra-Orifice barriers placed over root canal fillings. The present study comparatively evaluated the effect of various Intra-Orifice barriers namely Cention N (Ivoclar Vivadent), Biodentine (Septodont), Light Cured GIC (GC Gold Label 2LC) and Tetric N Flow (Ivoclar Vivadent)on microleakage of endodontically treated teeth using Stereomicroscope.

2. MATERIALS AND METHODS

2.1 Specimen Preparation

A total of seventy-five extracted human single rooted mandibular premolar were selected. The external root surfaces were cleared of adherent remnants and debris with periodontal curette.Specimens were decoronated at cemento-enamel junction with diamond disc and water as a coolant. Samples were kept in 0.1% Thymol solution until experimentation.

2.2 Endodontic Treatment of Specimens

The working length was established by placing a size #10 K(Dentsply, Maillefer, Ballaigues) file into the canal until it was observed at the apical foramen, then decreasing the file length by 1 mm. All the seventy five teeth were prepared with (Dentsply Maillefer Protaper Gold Kit)in a crown-down manner till F3 in combination with (Dentsply X Smart plus) torque–controlled engine at 300 rpm according to the manufacturer's instructions.

Along with this instrumentation, canals were irrigated between the use of each succeeding file, by introducing 10 ml of 3% sodium hypochlorite (Prime Dental Products, India), with 27 gauge needle. After complete instrumentation, all specimens received final irrigation with 10 ml of 17% of ethylenediaminetetraacetic acid (EDTA) (Prime Dental Products, India) to remove the smear layer. Final rinses were done with distilled water and the canals were dried with sterile paper points.

Corresponding protaper master cone was placed at the appropriate working length and apical tug back was confirmed in all the specimens of groups. Respective master cones were coated with AH PLUS sealer(Dentsply Detrey of MbH Germany) and introduced in to root canals up to working lengths. A spreader was used to laterally compact the 2% Gutta-Percha accessory cones(Dentsply, Maillefer, Ballaigues)coated with AH PLUS sealer(Dentsply Detrey of MbH Germany). Excess Gutta-Percha was sheared off and condensed with plugger**.** The specimens were grouped into Group 1: Control, Group 2: Cention N, Group 3: Biodentine, Group 4: Light Cured GIC, Group 5: Tetric N Flowi.e. Fifteen specimen in each group.

2.3 Placement of Intra-orifice Barriers

Except for control specimens G1, coronal 3 mm of root canal obturation was meticulously removed with the aid of a customized spoon excavator heated red hot on a Bunsen burner and after that verified with the help of William's periodontal probe.

Now among the total seventy five specimen we had, 15 (group 1) which does not consist of Intra-Orifice barrier material and rest 60 (15 from each group G2, G3, G4 and G5) consist of Intra-Orifice barrier material over root canal obturation.

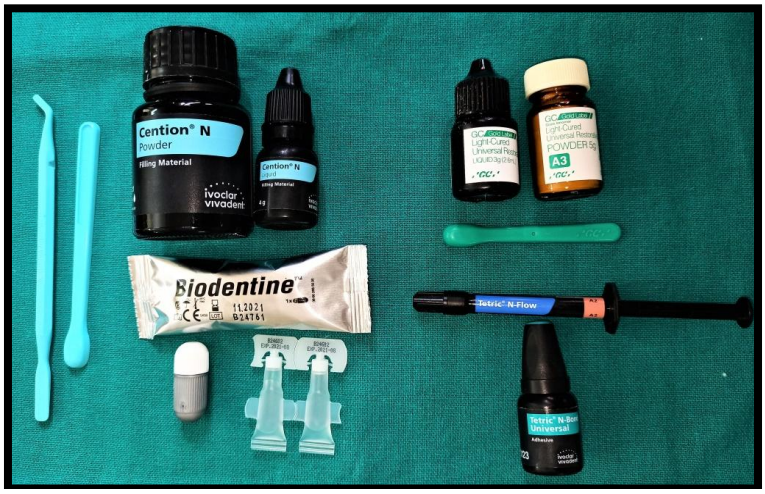

Fig. 1. Intra-Orifice barrier materials used for the study: Ivoclar Vivadent Cention N, Septodont Biodentine, GC Gold Label 2LC Light Cured GIC, Ivoclar Vivadent Tetric N Flow and Ivoclar Vivadent Tetric N Bond Universal

The Intra-orifice barrier materials Cention N (IVOCLAR VIVADENT), Biodentine (SEPTODONT), Light Cured GIC (GC GOLD LABEL 2LC), and Tetric N Flow (IVOCLAR VIVADENT) were mixed according to manufacturer's instruction and placed in group G2, G3, G4 and G5 respectively. All the specimens were then coated with nail varnish of different colors, coating their root surface from root apex to the level of cemento-enamel junction.

2.4 Dye Peneteration of Samples

Experimental and control teeth were submerged in 2% methylene blue dye for one week. Much of the ink was removed from the root surface by washing it in water followed by nail paint remover.The samples were subsequently longitudinally sectioned using a diamond disc and observed under a stereomicroscope. The leakage was measured using a 50X Stereomicroscope (Vardhan, India) by measuring the distance from the coronal extent of the orifice material to the greatest depth of penetration of the dye**.** Hence the results obtained were subjected to statistical analysis. The endodontic preparation, material / sealing procedure and stereomicroscope examination was done by single examiner.

2.5 Statistical Analysis

Data was normally distributed as tested using the Shapiro-Wilk test (p-value was less than 0.05). Therefore, analysis was performed using the non-parametric test "Kruskal Wallis Test" (for comparing more than two groups). Mann Whitney U was done for pairwise comparison. Statistical analysis was considered significant if *P*-value was less than 0.05.

3. RESULTS

The mean value of microleakage of different groups is G1 (CONTROL) >G2 (CENTION N) >G4 (LIGHT CURED GIC) >G3 (BIODENTINE) >G5(TETRIC N FLOW) (Table 1). The Tetric N Flow group showed less microleakage, where as the control group showed highest leakage.

The result of the present study indicates that a significant difference between G2, G3, G4 and G5 (*P*=0.001*) in relation to the control group and justifies the need for the use of an Intra-Orifice barrier to decrease the microleakage of endodontically treated teeth. In addition, Group 5 was found to be a better Intra-Orifice barrier, followed by G3, G4, G2 and G1 and further clinical trials on human patients are advised to support our hypothesis/results (Table 2).

Table 1. Mean, Standard deviations (SD) and standard error of microlekage of endodontically treated teeth restored with different intra-orifice barrier

Groups	Mean (mm)	Standard Deviation (mm)	Median (mm)	Minimum Interval for Mean (mm)	Maximum Interval for Mean (mm)
G1	5.65	0.32	5.78	5.01	5.96
G2	3.52	1.24	2.23	2.47	3.47
G3	1.96	1.52	1.22	2.00	2.54
G4	2.86	1.05	1.84	2.50	3.90
G5	1.50	0.85	1.20	1.25	1.75

Table 2. Comparison of microlekage of endodontically treated teeth restored with different intra-orifice barrier

Group	Mean (N)	Standard Deviation (N)	95% Ci for Mean Upper Bound (N)	95% Ci for Mean Lower Bound (N)	Chi Square Value	P[a] Value	P[b] Value
G1	5.65	0.96	5.01	5.96	10.856	**0.001*, Significant**	5>3>4>2>1
G2	3.57	0.24	0.47	1.63			
G3	1.63	1.05	2.50	3.90			
G4	2.90	0.07	1.05	1.74			
G5	1.52	0.24	0.47	1.63			

*[a] Kruskal Wallis test, [b] Mann Whitney U test, * Significance of relationship at p < 0.05, SIG: Significant, NS: Non-Significant*

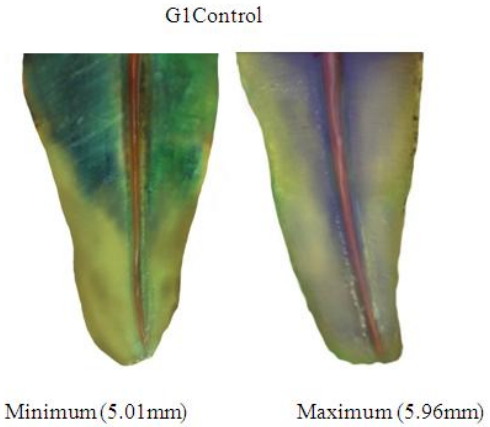

Fig. 2. Minimum and maximum dye penetration seen under stereomicroscope (50 X) in Group 1 Control

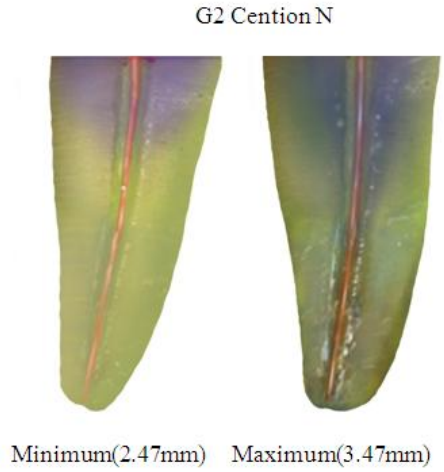

Fig. 3. Minimum and maximum dye penetration seen under stereomicroscope (50 X) in Group 2 Cention N

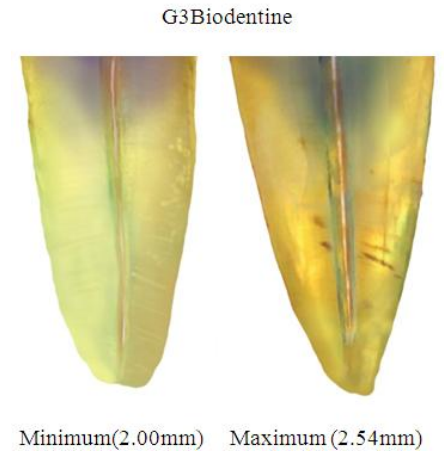

Fig. 4. Minimum and maximum dye penetration seen under stereomicroscope (50 X) in Group 3 Biodentine

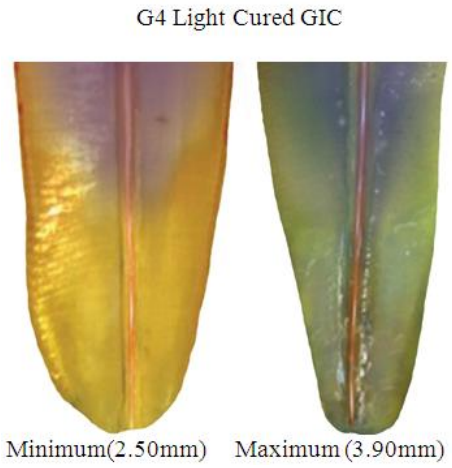

Fig. 5. Minimum and maximum dye penetration seen under stereomicroscope (50 X) in Group 4 Light Cured GIC

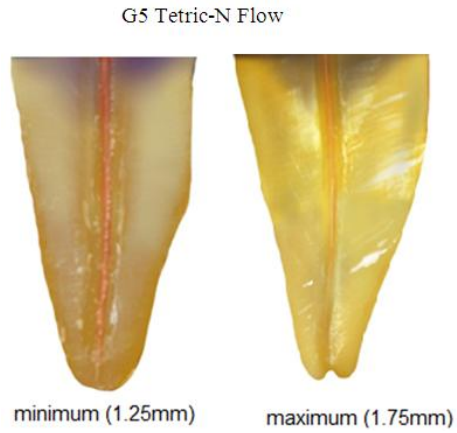

Fig. 6. Minimum and maximum dye penetration seen under stereomicroscope (50 X) in Group 5 Tetric-N Flow

4. DISCUSSION

"The major goal of endodontic therapy consists of complete removal of necrotic debris, microbes, and their byproducts followed by obturation of the root canal space which leads to prevention of microleakage by creating a fluid tight seal and the entry of oral fluids and also the microbes into the root canal. Dow and Ingle observed that failure most commonly results because of inadequate apical seal. Moreover, studies are there which observes that a good coronal seal is equally important" [7].

"Hence, continuous efforts are made to develop modern filling materials and techniques to achieve an impermeable barrier between the root canal system on one side and the oral environment on the other. Thus, several studies have been conducted to evaluate and compare the various restorative materials used as Intra-Orifice barriers" [8]. "Both MTA and Calcium enriched cement (CEM) showed good sealing capacity [9] but having least desirable physical properties such as setting time, solubility, pH so they were not used in this study" [10,11].

"Single rooted mandibular premolar were selected so as to minimize anatomical variation, allow standardization, and moreover, can be easily restored" [12]. "Obturation was done with non-eugenol based sealer, selected in this experimental design to circumvent the potentially detrimental influence the eugenol containing sealers have on adhesion between root dentin and composite resin" [13,14]. Carvalho, et al. observed that "temporary sealing cement

containing eugenol reduced the bonding strength of adhesive systems" [15].

"In an in-vitro study by Parekh B et alconcludedthat LCGIC+Tetric N-Flow was found to be superior over other experimental materials as intra-orifice barriers" [16]. These results were in accordance to the results seen in our study.

Many different types of dyes such as eosin, methylene blue, black India ink, procion brilliant blue, rhodamine B and basic fuchsin have been used for dye penetration studies.

"In the present study, methylene blue dye was used as it can act as an adequate indicator of passage of microorganisms and larger endotoxins as well as toxic agents of lower molecular weight. Methylene blue because of its lower molecular weight (319.9) penetrates deeper than other dyes leading to greater sensitivity. Methylene blue exhibits leakage similar to butyric acid, a microbial metabolic product with greater penetration than Indian ink" [17].

Leakage of Tetric-N Flow was less than the other experimental materials at all experimental depths. Placement technique and sealing ability of the bonded composite were two possible factors for why Tetric-N Flow leaked less than the other materials. Leakage, occurring as a result of time, was not measured in this study, although it could also be a factor.

Biodentine is considered as a suitable material for permanent restoration of dentin and also endodontic purposes owing to optimal properties like remineralization of dentin, mechanical properties comparable to those of dentin, like short setting time, nontoxic and resistance against leakage.

"Cention N exhibits a high polymer network density and degree of polymerization over the complete depth of the restoration" [18]. Cention N has modulus of elasticity 13 Gpa. It also has patented isofiller which acts as shrinkage stress reliever thus, it helps to relieves polymerization shrinkage. It also bond to tooth structure micromechanically. Isofiller that causes increased microhardness due to its nanoparticle sized filler particles. It also resists stresses and strains of the oral cavity. It can also be placed conservatively thus, reinforcing the remaining tooth structure [19].

"GIC'S are the only restorative materials that depend mainly on a chemical bond to tooth structure. They form an ionic bond to hydroxyapatite at dentin surface and also obtain mechanical retention from micro porosities in the hydroxyapatite" [20].

Uranga et al. [21] observed that "composite resin did not demonstrate any leakage, unlike other experimental materials which leaked significantly more" Leonard et al. [22] showed that "dentin-bonding agents and resins seal more completely than Glass Ionomer".

5. CONCLUSION

Within the limitation of the study, it can be concluded that the Tetric N Flow and Biodentine followed by Light cure GIC and Cention N significantly decrease the microleakage of endodontically treated teeth.Further research with different material coupled with clinical trials is necessary to validate the result of this in vitro study.

6. LIMITATIONS

1. The results of the study cannot be completely applied in clinical conditions.
2. The study was conducted under in-vitro conditions, best simulation of intra oral conditions were created with available resources. But oral cavity is a complex body structure, so exact similar conditions could not have been reproduced which may have affected results.
3. The influence of sealer on the bonding of restorations to the root canal walls was not taken in consideration.
4. Further laboratory research with different materials coupled with clinical trials is necessary to validate the results of this in-vitro study.
5. However, more studies with simultaneous testing of both microleakage and fracture resistance are needed including more materials and parameters to acertain the findings and results.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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