

Comparison of Micro Leakage of Zirconia induced Glass ionomer and Flowable Composite as Coronal Orifice Barrier Materials- An in vitro Study

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ABSTRACT:

Aim & Objective: The purpose of this in-vitro study is to Compare Micro Leakage Of Zirconia induced Glass ionomer and Flowable Composite as Coronal Orifice Barrier Materials used in root canals after endodontic treatment.

Materials and Methods: A total of 48 central incisors were instrumented and obturated with gutta-percha by lateral condensation technique using AH PLUS sealer. The teeth were sectioned just apical to CEJ. The roots were randomly assigned into 3 groups (n=16). Coronal 3mm of the canal was cleaned of gutta-percha and sealer. Then group I received a 3mm barrier of Intermediate restorative material (IRM); group II received a 3mm barrier of ZIRCONOMER; group III received a 3mm barrier of GC G-AENIAL UNIVERSAL FLO. All samples were stored in 100 % relative humidity at 37⁰c for 48 hours. All the samples were coated with two layers of nail varnish except for 1mm around tooth-restoration interface and were placed in 2 % methylene blue at 37⁰ c for 2 weeks. Then samples were rinsed under water and nail varnish was removed. Teeth were longitudinally sectioned in mesio-distal direction. Dye penetration was viewed using stereo-microscope. Statistical analysis was performed by oneway ANOVA followed by Post Hoc test. Statistical significance was defined at P<0.05.

Results: There were statistically significant differences between all the experimental groups (P<0.05).

Conclusion: Within the limitations of this study, GC G-AENIAL UNIVERSAL FLO provided an acceptable coronal seal compared to ZIRCONOMER and Intermediate restorative material.

Keywords: Coronal Micro leakage, Flowable Composite, Zirconomer, Intermediate restorative material, Stereomicroscope.

INTRODUCTION

Bacteria and their products are the main cause of peri-apical inflammation.^{1,2} The chief aim of root canal treatment is to eliminate micro-organisms from the root canal system and to prevent re-infection.³ Ray and Trope reported that the quality of coronal restoration might be more important factor than the quality of obturation in maintaining the peri radicular health of the tooth.⁴ A hermetic seal is needed

after root canal treatment to prevent bacteria from invading the peri-apex.⁵

Marshall and Massler (1961) were concerned about the role of the occlusal seal in root-filled teeth. They conducted the study to know whether the overall seal of the root canal was altered if the seal was broken coronally. They also observed on the prognosis of root-canal treatment if the quality of obturation of the

root canal was poor, but the coronal seal was good.^{6,7} Allison et al. (1979) made brief reference to the possibility that a poor coronal seal might lead to clinical failure.⁸

Complete bacterial penetration can occur due to coronal microleakage of nonsurgical root canal treatment. So it is important in nonsurgical root canal therapy to have a complete knowledge of the number and location of each root canal orifice. Hence the use of a material helps to seal the orifice along with the temporary restoration, could prevent this bacterial leakage if that temporary restoration gets washed off. Studies of orifice sealers have shown ability to provide an adequate seal, ease of placement removal, but all have evaluated materials placed to the same depth. long term success remains questionable without an adequate seal and failure to maintain the seal may expose filled canals to microbes that could inhibit healing and create infection in the periodontal ligament or supporting osseous structures.⁹

Placement of intra orifice barrier is an efficient alternative method to decrease coronal leakage in endodontically treated teeth. After removal of the coronal portion of gutta-percha and sealer additional material is placed immediately into the canal orifice. To prevent microleakage, Several materials have been used in an attempt to provide an intra-coronal seal such as Cavit, Amalgam, Intermediate restorative material(IRM), Super-EBA, Composite resin, Glass-ionomer cement and Mineral trioxide aggregate. Lee et al., (1991) reported that seal provided by Cavit is not durable against mastication forces; therefore, the search is still going on for a new temporary filling material.¹⁰

Zmener et al. conducted a study using Cavit, IRM(Intermediate Restorative material) and Ultra Temp Firm as orifice barriers and showed no statistically significant differences in coronal leakage . A further study showed that placement of either bonded composite or IRM as coronal orifice barriers showed significantly reduced periapical inflammation.

Recently, several improvements in resin composite formulations have been developed like flowable low viscosity composites like GC G-Aenial Universal Flo. The main rationale behind the use of flowable composites is the formation of an elastic layer that may compensate for the polymerization shrinkage stresses.¹¹ Recently a zirconia induced glass ionomer cement has been introduced with a trade name Zircomer which has superior mechanical and physical properties. It chemically bonds to enamel/dentin and has tooth like co-efficient of thermal expansion.

However, a literature search did not reveal any previous studies conducted to compare coronal marginal leakage of GC G-Aenial Universal Flo, Zircomer and IRM as intracoronal orifice barrier materials. Thus, the aim of this in-vitro study was to compare coronal marginal leakage of different orifice barrier restorative materials used in root canals after endodontic treatment.

MATERIALS & METHODS

In this experimental study, 48 extracted human central incisors were used. An access opening was prepared using a high-speed handpiece with a #2 round bur and constant water spray. After the pulp tissue was removed, working length was determined. The canals were instrumented to a #40 master file and tapered with a step-back technique.

Instrumentation was performed using 2.5% sodium hypochlorite as irrigating solution. Canals were dried with paper points. After cleaning and shaping, all the canals were obturated with gutta-percha (Pearl endopia, Pearl dent, Vietnam) by lateral condensation technique using AH PLUS sealer (DeTrey, Konstanz, Germany). Then, the teeth were sectioned with a low-speed diamond saw just apical to the cemento-enamel junction .

Randomly the roots were assigned to three experimental groups with 16 samples each. The coronal aspect of the gutta-percha was measured by periodontal probe and adjusted to terminate 3 mm apical to the level of

decoronation . Moistened alcohol pellet was used to clean the gutta percha and sealer from coronal 3 mm of the canal and rinsed with sterile saline and dried with an air stream.

The first group (16 teeth) received a 3 mm barrier of composite resin (GC G-Aenial Universal Flo; GC America). The second

group received Zirconia induced Glass ionomer (Zirconomer -SHOFU INC; Japan). The third group was sealed with Intermediate restorative material (IRM -Dentsply Caulk). All the restorative materials were mixed and handled according to manufacturer’s instructions.

Table 1: Anova Oneway Results

VALUES

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
G-AENIAL FLO	16	2.81	.040	0.1000	2.80	2.82	2.75	2.90
ZIRCONOMER	16	1.62	.018	0.0045	1.616	1.62	1.58	1.64
IRM	16	1.22	.019	0.0048	1.03	1.24	1.20	1.26
Total	48	5.65	0.076	0.109	1.03	1.24	1.20	1.26

Table 2: Post Hoc Test Results

Multiple Comparisons

Dependent variable VALUES

Tukey HSD

(I) GROUP		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
G-AENIAL FLO	ZIRCONOMER	-0.4	0.25	.000	-0.50	-0.30
	IRM	-1.59	0.25	.000	-1.595	-1.5855
ZIRCONOMER	G-AENIAL FLO	0.4	0.25	.000	0.30	0.50
	IRM	-1.19	0.25	.000	-1.20	-1.1850
IRM	G-AENIAL FLO	1.59	0.25	.000	1.5855	1.60
	ZIRCONOMER	1.19	0.25	.000	1.1850	1.20

*. The mean difference is significant at the 0.05 level.

After placement of the materials into access preparations, the samples were stored in 100% relative humidity at 37°C for 48 hours. The samples in all the experimental groups were coated with two layers of nail varnish except for 2 mm around the tooth-restoration interface. All the samples were placed in 2% methylene blue solution and stored at 37°C for 2 weeks . After storage period, they were removed from dye solution and rinsed under

tap water. After removal of the nail varnish, the teeth were longitudinally sectioned in a mesiodistal direction with a low-speed diamond saw. The penetration of dye was viewed using a stereomicroscope (Zeiss; Geometrix Laser solutions, Tada) at 20X magnification and the degree of dye penetration was evaluated.

Data was statistically analyzed by oneway ANOVA for comparison followed by a post-

hoc Tukey test. Statistical significance was defined at $P < 0.05$.

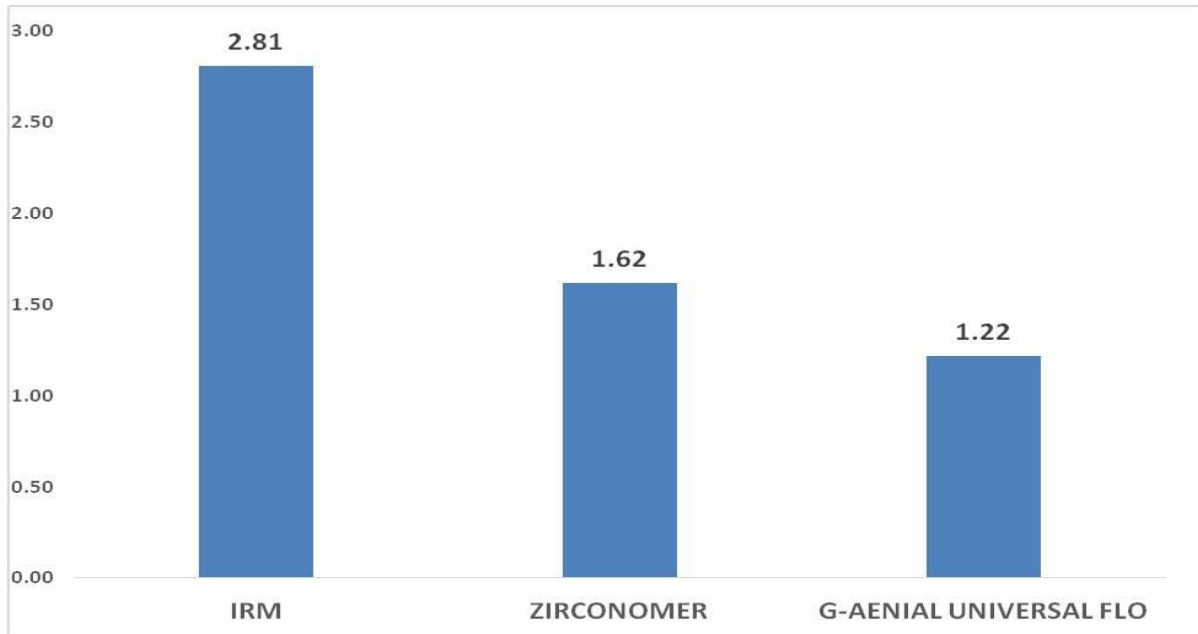


Figure 1: Comparison of mean values between the experimental groups

RESULTS

All the tested materials showed leakage at the interface of restorative material-dentin wall. The standard deviations (SD) and mean leakage values (mm) are listed in Table 1. There were statistically significant differences between all the experimental groups ($P < 0.05$); therefore, potential coronal microleakage can be minimized by placing suitable intra-orifice barrier material before final restoration. Therefore, leakage comparison between the groups was analyzed using oneway ANOVA. The test results indicated significant differences between the three groups ($P = 0.000$). The post hoc test Table 2 revealed that this difference was only significant when comparing GC G-Aenial universal flo with other groups ($P = 0.002$) and there were no significant differences in pair-wise comparison of Zirconomer and IRM ($P = 1.00$).

DISCUSSION

The major goal of root canal therapy is the complete removal of necrotic debris, microbes and their byproducts followed by obturation of the root canal space. This helps in creating a fluid tight seal by preventing microleakage and

the ingress of oral fluids and microorganisms into the root canal. However, the most

commonly encountered problem influencing the long-term success of endodontic treatment is microleakage.¹²

Studies have shown that a good coronal seal is equally important. The need of an early final restoration is discussed by many studies. Iowa group stated that "After RCT, the need for an immediate and proper coronal restoration is important".¹²

Restorative materials should provide a permanent, leak-proof seal. Main cause of coronal leakage is defective temporary and permanent restoration during or after root canal therapy.^[13] Conventional root filling materials such as gutta-percha and sealer provide susceptibility to bacterial microleakage. Therefore, the coronal part of the root canal must be sealed as tightly as possible to minimize the endodontic treatment failure rate.

Although previous search reports the effectiveness of intra-orifice barriers, there is no protocol or material used as the coronal intra orifice barrier after root canal treatment. Many authors have reported different results

about the sealing ability of different materials when used as a barrier. Therefore, attempts are continuously made to introduce more accepted materials with the potential to provide a tight seal for long time.¹⁴

Recently new flowable universal composite material GC G-Aenial universal flo with silanation technology was developed. A new formulation of strontium glass was developed which is highly translucent, acid resistant and radio opaque. This new glass formulation is milled down to an incredibly fine 200 nanometre particle size, half the size of previous generations of glass fillers used in microhybrid composites. A revolutionary new silane treatment method is used on the surface of the nano sized glass, in order to strengthen the adhesion between glass particle and resin matrix and improve the hydrolytic stability and durability of the composite structure.

This is the reason why GC G-Aenial universal flo composite material showed minimal microleakage in the present study when used as an intra orifice barrier material.

Another new material named Zirconomer is used in this study which defines a new class of restorative glass ionomer that promises the protective benefits of glass ionomer with the strength and durability of amalgam while completely eliminating mercury toxicity. The inclusion of zirconia fillers in the glass component of Zirconomer imparts superior mechanical properties for the restoration and reinforces the structural integrity of the restoration. Combination of outstanding strength, durability and sustained fluoride protection deems it ideal for temporary as well as permanent restorations. It Chemically bonds to enamel/dentin and has tooth-like coefficient of thermal expansion resulting in low interfacial stresses and long-lasting restorations.

In the present study, Zirconomer, GC G-Aenial universal flo and IRM were compared. According to this study, all experimental groups exhibited leakage within the materials. GC G-Aenial universal flo showed the least coronal leakage, whereas IRM showed the

greatest coronal leakage compared to zirconomer and GC G-Aenial universal flo.

In the present study, dye penetration method was used. The dye penetration test is the most popular method of detecting leakage because it is easy to conduct, inexpensive and it has a high degree of staining.¹⁵

Molecules of dye have a low weight and can penetrate into locations that bacterial cells cannot. Therefore, in vitro micro leakage studies with low molecular-weight dyes or isotopes are more severe than those carried out with a clinically relevant macromolecular material.¹⁶ Therefore, in in vitro studies if cement resists dye penetration, it is likely to perform even better clinically. The limitation of dye leakage studies is that they measure the degree of leakage in only one plane, making it impossible to evaluate the total amount of leakage.^{17,18} Methylene Blue is a superior tracer of microspaces. This view is supported by Matloff et al. (1982), who found MB to be a more sensitive indicator of leakage than the three radioisotopes tested.¹⁸

The present study utilizes a material thickness of 3 mm to seal the coronal orifice as literature reports state that 3 mm of material is the minimum thickness required in coronal restoration to prevent leakage. Thus, the present study concludes that double tight seal is required to reduce microleakage which could be achieved by using an intraorifice barrier.¹² In the present study another restorative material IRM was also compared with zirconomer and GC G-Aenial universal flo.

Deveaux et al. (1995) conducted an in vitro study to compare the Bacterial microleakage of cavit, IRM, Term and Fermit and stated that the antibacterial properties of IRM could compensate for poor sealing properties may thus be questionable.¹⁹ We conclude on the fact that the concentration of the eugenol is insufficient to be bactericidal, the contact time between the bacteria and the eugenol is too short, any bactericidal activity would disappear over time as the eugenol evaporates. The increase in microleakage is explained by

mixing process and lack of homogeneity as well as variations in the volume of IRM due to contraction.²⁰

GC G-Aenial universal flo has several advantages. Optimum cavity adaptation can be realized with no risk of pull back that might cause voids at critical margins. Composite placement is exact and controllable. Controlled fluidity ensures placement is quick and stress free. G-Aenial flo wets surface easily because of the combination of smooth flow and thixotropic properties but is not runny and stays neatly in place which gives good adhesion to the tooth and decreased the microleakage.

To summarize, immediate placement of a suitable intra-orifice barrier like GC G-Aenial universal flo before final restoration could help to prevent recontamination of the remaining apical guttapercha.

CONCLUSION

Within the limitation of this in vitro study, GC G-Aenial universal flo provided an acceptable coronal seal compared to Zirconomer and Intermediate Restorative Material. Further in vivo studies on intra-orifice barriers are recommended.

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How to cite this article: Nusrath P, Koppolu M, Chinni S, Anumula L. Comparison of Micro Leakage of Zirconia induced Glass ionomer and Flowable Composite as Coronal Orifice Barrier Materials- An in vitro Study. *Arch of Dent and Med Res* 2016;2(2):18-24.