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Marginal Leakage of Endodontic Entrance Filling Materials around Access Cavities Prepared with Pre-Endodontic Composite Build-UP: An In Vitro Study

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Abstract

Background: Pre endodontic buildup of severely damaged teeth prior to Root Canal Treatment is advantageous in terms of rubber dam placement and isolation. The quality of marginal seal between Pre-endo buildup and various entrance filling materials determines the amount of bacterial microleakage into the orifice.

Aim: The study aims to assess the marginal seal between various restorative materials used for post endodontic entrance fillings and Pre-endodontic composite buildup up.

Materials And methodology: 30 Maxillary Premolars extracted for orthodontic purposes were collected. Access cavities prepared. Mesial wall of teeth are cut up to 5mm towards the center of the tooth. The pre endodontic buildup of mesial wall was done with Nano Hybrid Composite. Access cavity are filled with restorative material based on grouping of specimen.

GROUP I – Nano Hybrid Composite

GROUP II –Nano Flowable Composite

GROUP III – ZIRCONOMER. The specimen are subjected to thermocycling and samples are kept for 2 days in a 2% methylene blue dye and sectioned mesio-distally along the long axis of the tooth. The depth of dye penetration at the pre endo buildup – entrance filling junction is measured at 20x using a stereomicroscope.

Results: Microleakage with flowable composite was less compared to packable composite with maximum values in the Zirconomer group.

Conclusion: The flowable composite group showed least microleakage with the maximum microleakage values in the Zirconomer group.

Clinical Significance: This study studies the microleakage values when two different resin cements and a GIC material is used as an entrance filling in conjuction with the pre endodontic buildup. The results aide clinicians in choosing the most appropriate restorative materials in teeth restored with composite pre endodontic buildup in order to minimise microleakage.

Keywords: Root, Endodontic, Cavity

Introduction

The goal of root canal treatment is the elimination of all deleterious agents and infected tooth structure in order to re-establish the tooth as a viable functional entity. However this is not to say that the tooth is now resistant to reinfection henceforth. The endodontically treated tooth can be an unchallenging target as it is located in the oral cavity which is a multifarious reservoir of acidic micro flora. Shielded only by the post endodontic restoration or prosthesis, one can only hope the quality of the restoration provides a satisfactory seal that prevents bacterial microleakage.

The Pre endodontic buildup of teeth prior to Root Canal Treatment is a commonly employed tool in case of grossly decayed teeth with missing walls. It is advantageous in terms of placing a rubber dam for isolation from oral fluids while also promoting better visibility. Generally the material of choice employed is resin composite due to their satisfactory mechanical properties.

After completion of root canal therapy the access cavity is sealed by placing an entrance filling also known as core buildup. Again the predominantly used restorative material is resin composite. The high filler content of this material enables the restoration to withstand occlusal forces to a greater degree than other restorations like glass ionomers.

Several types of composites are available to the practitioner such as those with nano particle fillers, micro filler composites, flowables, bulk fill and packable. More recently certain modifications of glass ionomers such as zirconia reinforced GIC are also being employed in core buildups due to their improved ability to withstand occlusal loading.

While placement of a prosthesis such as single unit crowns or a bridge after RCT is considered mandatory, fabrication and cementation could take a few days to weeks. This leaves the entrance filling exposed to oral fluids and prone to bacterial microleakage. The quality of marginal seal between Pre-endo buildup and the entrance filling material will have a significant impact on the amount of bacterial microleakage into the orifice.

Hence the goal of this in vitro study was to evaluate the amount of microleakage that can occur between a resin composite pre endo buildup and entrance fillings restored by nano hybrid composite, nano flowable composite and zirconia reinforced glass ionomer cement.

Materials And Methodology

Sample Collection : Thirty Maxillary Premolars with no caries or enamel defects extracted for orthodontic purposes were used for this study. The absence of caries and wear facets allowed for standardization of the access cavities. The external surface of the roots were cleaned manually to remove debris and disinfected with 0.5% thymol.

Preparation of access cavity: The Mesial wall of teeth from the level of CEJ were cut up to 5mm towards the centre of the tooth using a straight fissure bur and class

II cavities were prepared. Etchant and bonding agent were applied according to manufacturer's instructions and missing portion of the mesial wall was built up with Nano Hybrid Composite (Septodont,France).

Access cavities were prepared with long round bur (Dentsply Sirona) and a high speed airotor (NSK, Japan). Canal orifices were located and initial filing was done with #10 K stainless steel File (Mani Inc, Japan).

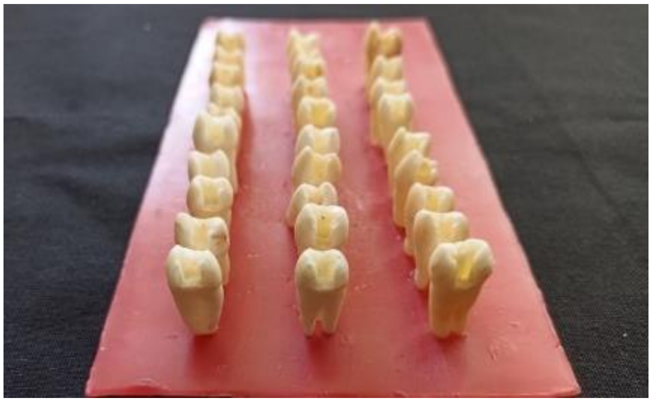


Fig.1: Class 2 access cavities in all 30 specimens

Grouping of specimen & restoration of access cavity:

Specimens were randomly divided into three groups (N=10). Access cavities were then filled with restorative materials based on grouping of specimen.

GROUP I – Nano Hybrid Composite (Septodont, France)

GROUP II –Nano Flowable Composite ((Septodont, France)

GROUP III – ZIRCONOMER (Shofu, Japan)

Fig.2: Restorative materials used for entrance filling

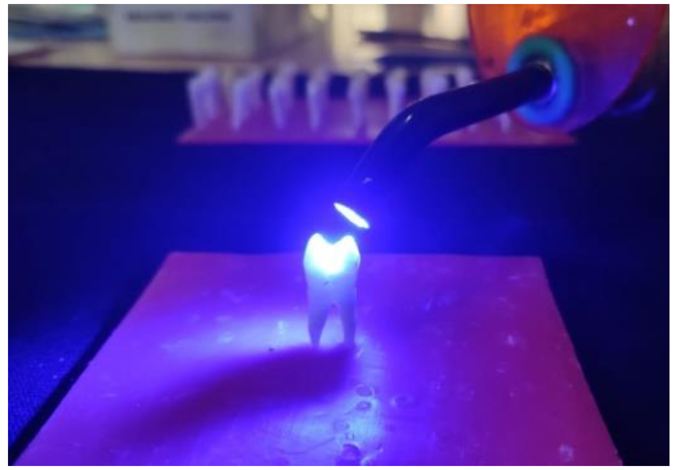


Fig.3: Curing of resin composite for entrance filling

Thermocycling and Storage of specimen:

The samples were stored in deionised water at 37ºC for 48 h. The coronal surface was trimmed with #150 SiC paper to expose the cavity margins. Thereafter, the specimens were subjected to thermocycling for 500 cycles in water at 05 +/- 1.5ºC and 55 +/- 1.5ºC, with a dwell time of 30s in each water bath. The specimens were then immersed in 37ºC deionised water again for 72 h.

Dye penetration and Sectioning:

The areas excluding the pre endo buildup-core buildup junction were covered with nail varnish. The samples were kept for 48 hours in 2% methylene blue aqueous solution at room temperature.

Following immersion in the dye solution, the specimens were mounted on 1.5cm x 1.5cm acrylic blocks with the apical third of the roots submerged in the acrlic. Subsequently, the samples were sectioned mesio-distally along the long axis of the tooth using a minitom (Struers, UK)

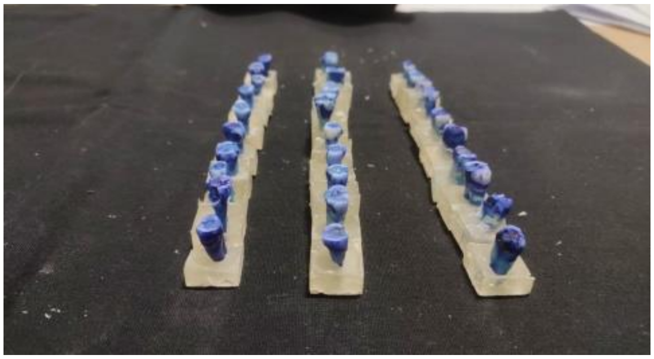


Fig.4 Dye penetration in methylene blue dye

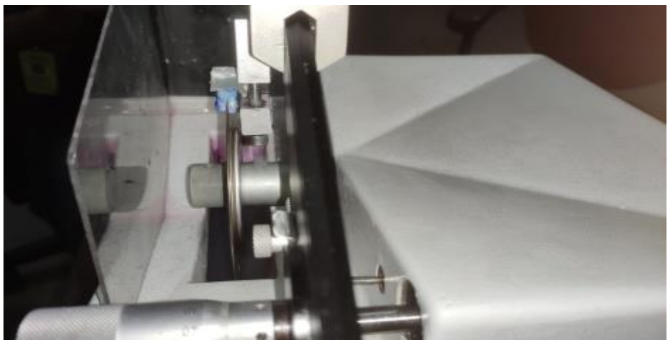


Fig.5 mesio-distal sectioning of specimens in microtome

Stereomicroscope Investigation

The sections were examined using a stereomicroscope(Zeiss,Germany) at x20 magnification by trained examiners at the Central Mechanical Testing Institute, Bengaluru.

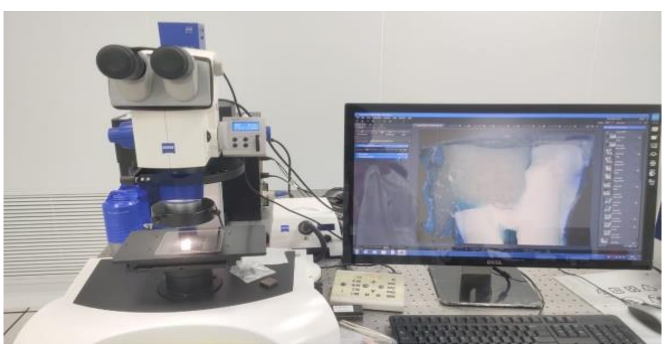


Fig. 6: Investigation of microleakage using stereomicroscope

Statistical Analysis

Data collection and analysis was done using SPSS V20 software and Microsoft Excel 2010. The data was statistically analysed using kruskal wallis , Man Whitney U test and Chi Square test. There was significant statistical difference between all the groups ($p<0.001$)

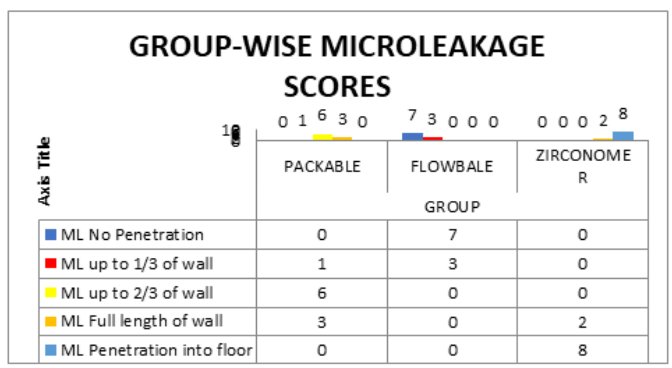
Results

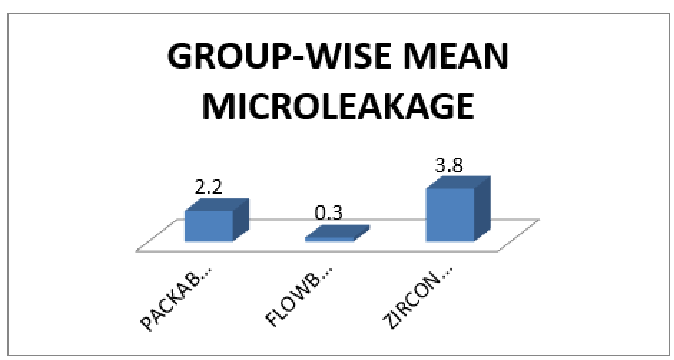
All groups showed varying degrees of microleakage. The microleakage scores with mean and standard deviations for each of the three groups were 2.2±0.63246 for Nano hybrid Composite (Group 1), 0.3±0.48305 for Nano flowable composite (Group 2) and 3.8±0.42164 for Zirconomer (Group 3).

The present study showed microleakage with Nano Flowable composite was less compared to Nano Hybrid composite with maximum values in the Zirconomer group.

Chi square test

			GROUP			p
			Packable	Flowable	Zirconomer	
ML	No Penetration	Count	0	7	0	<0.001
		%	0.0%	70.0%	0.0%	
	up to 1/3 of wall	Count	1	3	0	
		%	10.0%	30.0%	0.0%	
	up to 2/3 of wall	Count	6	0	0	
		%	60.0%	0.0%	0.0%	
	Full length of wall	Count	3	0	2	
		%	30.0%	0.0%	20.0%	
	Penetration into floor	Count	0	0	8	
		%	0.0%	0.0%	80.0%	





Discussion

The goal of endodontic treatment is to repair and retain the damaged tooth structure such that a prosthesis can be placed in order to regain functionality. Root canal therapy is effective in neutralizing the bacterial infection in the canal space and promoting healing of the periapical lesion. However this is no guarantee that tooth is protected from future bacterial invasion.

Pre endodontic buildup of teeth prior to Root Canal Treatment is advantageous in terms of rubber dam placement and isolation. It restricts the amount of oral fluids entering into the canal orifices. There is also an element of mechanical reinforcement for the extensively damaged tooth allowing it to withstand occlusal loads during the course of the root canal treatment. It is with this particular intention that Pre endo buildups are predominantly done using resin composites.

The restorative material used in the filling of the access cavity influences the entry of oral microorganisms into the endodontically treated tooth. While the largest route of microbial entry remains the tooth-restoration margins, the amount of microleakage along the junction between the pre endodontic buildup and the entrance filling can be wisely controlled with the choice of materials used for both these restorations.

According to Kidd et al, microleakage is the clinically undetectable passage of bacteria and bacterial product fluids, molecules, or ions from the oral environment along the various gaps present in the cavity restoration interface. This results in the softening of dentin along tooth-restoration margins resulting in endodontic failure by reinfection. Microleakage also occurs in the margin of two restorative materials as in the case of a pre endodontic buildup and core buildup. The degree of leakage varies based on the choice of materials used for the two procedures. This study focused on the assessment of marginal seal using the dye penetration method and analysis using a stereomicroscope. Scoring was done according to the formula by Popoff DV et al which is the standard widely implemented in microleakage studies.

Packable composites are the material of choice for the pre endodontic buildup of missing walls due to their desirable mechanical properties. Teeth are subjected to occlusal forces during the course of the root canal treatment and a material that is capable of withstanding these forces without fracture is necessary. The use of flowable composites and glass ionomer cements is not preferred due to their inability to withstand occlusal stress as effectively as packable composites. The primary requirement of an entrance filling material is its ability to withstand masticatory forces and the quality of marginal seal it can produce.

Among the 10 samples in group 1(Packable composite) 6 showed dye penetration up to 2/3 of the junction and in 3 samples the dye had penetrated all the way to the cavity floor. Among the three entrance filling cements packable composite without question has the best mechanical properties. This can be attributed to its larger filler particle size. However despite the same restorative material being used for the pre endo and core buildup the microleakage scores revealed that the quality of marginal seal was considerably poorer than the flowable composite group (Group 2).

Flowable composites in general contain nano sized filler particles of considerably smaller size than their packable counterparts. While this reduction in particle size compromises their structural durability the extent of this reduction in mechanical strength is not significant enough to contraindicate flowables as a core buildup material. On the other hand, the smaller filler particles allow for better flow of the material along the margins of the restoration resulting in an enhanced marginal seal along the pre endo buildup and core buildup junction. This is evident from the microleakage results of Group 2(Flowable composite) where in 7 out of 10 specimens showed no leakage at all and just 3 showed dye penetration up to 1/3 of the junction. The results are in accordance with a stud by Lokhande et al, which stated the improved flow properties due to the nano filler particles reduced the occurrence of void spaces in the restoration margins.

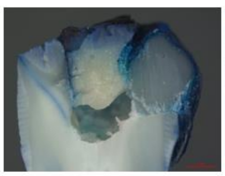
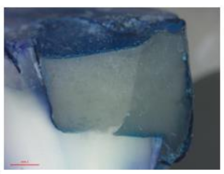
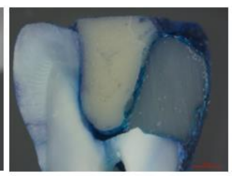




Figure 7: GROUP I   Figure 8: GROUP II   Figure 9: GROUP III

Fig.7: Microleakage of group 1 packable composite

Fig.8: Microleakage of group 2 flowable composite

Fig.9: Microleakage of group 3 zirconomer composite

While the use of Glass ionomers as a core buildup material is not desirable due to its poor mechanical properties in comparison with resin composites, certain modifications such as miracle mix and zirconia reinforced GICs have managed to improve their durability to a certain extent. Although the addition of zirconia fillers have contributed to increased strength while not compromising on the sealing ability, it is still not comparable to that of resin composites. Where GIC exceeds resin cements by a large degree is in the domain of marginal sealability. Through the process of chemical adhesion glass ionomers present significantly less opportunity for microleakage along the tooth-restoration margins.

The question then arises regarding the use of GIC for entrance fillings in teeth which have a composite pre endodontic buildup. The marginal seal between GIC and resin composite is of a poorer quality than when using packable or flowable composites. This is evident from the results of group 3(Zirconomer) which showed 8 out of 10 samples with the dye penetrating all the way to the floor of the cavity and the remaining 2 samples showing leakage along the entire junction.

The values from the three groups revealed a statistically significant difference in the microleakage of the three core buildup materials.

Conclusion

From the analysis of the results of this study it can be concluded that the use of Nano flowable composites(Group II) have a significant effect on the microleakage at the pre endo buildup – core buildup junction. The Nanohybrid Packable composite (Group I) did not yield better results despite the same material being used in the pre endo buildup. Zirconomer(Group III) showed maximum microleakage at the junction.

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