Comparative evaluation of sealing ability of four differen restorative materials used as a pre -endodontic build up: an *in vitro* study

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Abstract

Context: Teeth that require endodontic intervention are often structurally compromised, and requires pre-endodontic build up, beneficial in various aspect.

Aim: The aim of the study is to evaluate and compare the sealing ability of packable, bulk fill flowable, dual cure composite and glass hybrid restorative material used as a Pre-endodontic restorative materials.

Materials and Method: Eighty single rooted freshly extracted premolars were decoronated 5mm above the CEJ, 5-6 mm step was prepared by removing distal or mesial wall of access preparation. Designated into Group1: Packable composite, Group 2: Bulk fill flowable composite, Group 3: Dual cure composite and Group 4: Glass hybrid restorative material. The apex and periphery were sealed using self-curing acrylic resin. Then, root canal preparation was completed; all the canals were filled with calcium hydroxide and sealed using temporary sealing material. The samples were thermocycled and immersed in a methylene blue aqueous solution for 2 days, they were cut perpendicular to the long axis of the tooth and dye penetration depth was measured on the restorative side. The statistical analysis was done using two-way analysis of variance and Tukey's HSD test, P (< 0.05).

Results: The micro leakage values for the given groups as per order EQUIA forte < Luxa core <Bulk fill flowable composite < Packable composite.

Conclusion: EQUIA forte and Luxa core have shown less micro leakage when used as a pre-endodontic restorative materials.

Keywords: Bulk fill flowable, dual cure composite, glass hybrid restorative material and packable composite.

INTRODUCTION

Endodontic management of a badly broken down tooth as result of caries, trauma, or a root resorption often possess a problem in isolation and restoration due to minimal coronal tooth structure.[1] which often complicates the endodontic procedures. Therefore, the use of pre-endodontic build-up act as an important building block of endodontic therapy,[2] for effective placement of rubber dam clamp during the treatment and a temporary coronal restoration in inter appointment periods.

The materials used for pre-endodontic restoration are silver amalgam, glass ionomer cements, flowable composite, packable composite or dual-cure composite. While traditional non-adhesive techniques of pre-endodontic restoration, may still prove useful for some clinicians when appropriately performed, they also present with many shortcomings which, along with the development of adhesive approaches, have limited their clinical value for this purpose.[3]

Packable composite being promoted as amalgam alternative, having less stickiness or stiffer viscosity than conventional composite.

Bulk Fill flowable resins are low-viscosity materials with the reduced percentage of inorganic filler particles and higher amount of resinous components which improves its mechanical and chemical characteristics. Flowable composite with their low elastic modulus compete with stress development and thus help to maintain the marginal seal of the restoration.[4]

Dual-curing composites combine the advantages of self-curing and light-curing composites. Due to the light-curing components, rapid light polymerization can takes place. This leads to an initial stabilization of the restoration and the deeper areas of the restoration the curing is chemically controlled[2].

Glass hybrid restorative system constitutes fluoroaluminate silicate glass, polyacrylic acid, surface treated glass, polybasic carboxylic acid, water. It provides a good mechanical and physical properties like high wear resistances to acid, high fluoride release and high flexural strength.[5]

Marginal micro leakage is observed with various restorative materials which may cause marginal staining, secondary caries and can lead to pulpal pathology. Therefore, less micro leakage has been key to the success in operative dentistry.

To the best of the authors' awareness, there hasn't been any research conducted to date to assess the sealing ability of restorative material as a pre-endodontic build up. Since considering pre-endodontic restoration before initiating endodontic treatment is valuable and none of the study has been done to check the composite restoration used as a pre-endodontic build up. As a result, the goal of the study is to compare and evaluate the sealing ability of Packable, Bulk fill flowable, Dual cure composite and Glass hybrid restorative material used as a Pre-endodontic restorative materials.

SUBJECTS AND METHODS:

Freshly extracted 80 human single rooted premolars free from caries, cracks, restorations or defects were selected for this study and immediately stored in a 0.9% thymol solution until use.

The teeth were decoronated about 5 mm above the cemento-enamel junction with a low-speed handpeice (NSK, Kanuma, japan) and a diamond disk (Horico, Germany) under water cooling to

obtain a standaridzed length of 15mm. Next, the mesial or distal wall of the access preparation was removed using a diamond bur (Mani Dia-bur TF114, Mani, Utsunomiya, Japan) to prepare 5-6 mm step. The apex and its periphery were sealed with a self-curing acrylic resin (DPI-RR Cold Cure, DPI, Mumbai, India).
The samples (n=20) were categorized into four groups as:
Group I - Packable composite (3M Filtek Z350 XT)
Group II - Bulk fill flowable (3M^{TM} Filtek^{TM})
Group III- Dual cure (DMG luxacore Z) and
Group IV- Glass hybrid restorative material (Equiaforte)

Group I, II, III all the samples were etched using Scotchbond multi-purpose etchant (3m ESPE), washed with water jet and dried with gentle stream of air leaving a moistened surface. A layer of Tetric N bond (Ivoclar Vivadent) was then applied using a disposable microbrush, and light cured for 10s and samples were restored using packable, bulk fill flowable and dual cure composite.
In Group IV (Equiaforte), one end of the capsule was pressed against the firm surface to loosen the powder, following this the capsule was positioned in the amalgamator for mixing with dwell time of 10sec. Immediately capsule was placed into a capsule applier and the lever was clicked until the wall was completely filled by the material.
After this, standardized biomechanical preparation of canals using Pro taper universal rotary system (Dentsply) up to F3 apical size.During instrumentation, the canals were flushed with 3% NaOCL as an irrigating solution using disposable syringes and 30- gauge needles (Ultradent Product, Inc., South Jordan, Utah, USA).After completion of instrumentation the root canals were flushed for 1 minute with 2.0 ml of 17% EDTA solution, then washed with 2.0 ml of 3% NaOCl solution followed by copious rinsing with 5.0 ml of normal saline. All the groups were dried with absorbent paper points. A dry cotton pellet was placed in the pulp chamber and access cavity was packed with temporary filling material (Cavit, 3MESPE, Seefeld, Germany).
The samples were subjected to thermocycling of 500 cycles between 5-55 degree celsius with a dwell time of 30sec.This was done to simulate oral conditions. The samples were then air-dried, and the sticky wax was used to covered the root surface and coronal enamel. The nail varnish was applied in the area excluding 1mm around the cavity of the cut surface of the crown. The samples were then kept in a 2% methylene blue aqueous solution at 37 ◦C for 2 days. Later, the samples were well rinsed with running tap water, and a portion of the crown was cut perpendicular to the long axis of the tooth 15-20 mm away from the cut surface. The micro leakage was assessed by viewing all the samples under stereomicroscope at a magnification of 20x.
The scoring criteria were followed according to Vinay S and Shivanna V for the micro leakage assessment[5]-
0 = no dye penetration.
1 = dye penetration up to 1/3rdcavity depth (fig.1).
2 = dye penetration up to 2/3rdcavity depth (fig.2).
3 = dye penetration to full depth of cavity (fig.3).
Data were collected and were statistically analysed using Analysis of variance (ANOVA) followed by Tukey's Post hoc Test for pairwise comparison. 'P' value (<0.05) was considered statistically significant.

RESULTS:

Table 1 shows the mean and standard deviation of microlekage of four different restorative materials considered in the present study. Samples in group I (Packable composite) exhibited the highest mean value (1.80) followed by Bulk fill flowable, Dual cure composite and Glass hybrid restorative material. Glass hybrid restorative material exhibited the least mean micro leakage among all four restorative materials

Table 2 shows the comparison of mean micro leakage of four different restorative materials using One way ANOVA test.The result was statistically indicating that there exists a significant difference in the mean values of the four restorative materials including in the study($p<0.001$).

Table 3 shows the pairwise comparison of the mean microleakgae between Packable, Bulk fill flowable, Dual cure composite and Glass hybrid restorative material.

It is obsereved that, There was statistically significant difference on pair wise comparison between Group I Vs Group III ($p<0.001$*), Group I Vs Group IV ($p<0.001$*) while insignificant difference between Group I and Group II ($p=0.296$).

There was statistically significant difference on pair wise comparison between Group II Vs Group III ($p=0.031$*), Group II Vs Group IV ($p=0.012$*).

There was statistically insignificant difference on pair wise comparison between Group III Vs Group IV ($p=0.984$).

Thus the study observes that Glass hybrid restorative material (Group IV) and Dual cure composite (Group III) showed least micro leakage compared to other groups.

Table 1 Descriptive statistics for Micro leakageamong four groups.

Descriptive Statistics					
Groups	N	Minimum	Maximum	Mean	Std. Deviation
Group 1 = Packable composite	15	1	3	1.80	.561
Group 2 = Bulk fill flowable composite	15	1	2	1.47	.516
Group 3 = Dual cure composite	15	0	2	.93	.458
Group 4= Glass hybrid restorative material	15	0	2	.87	.516

Graph 1 Descriptive statistics for Micro leakage among four groups.

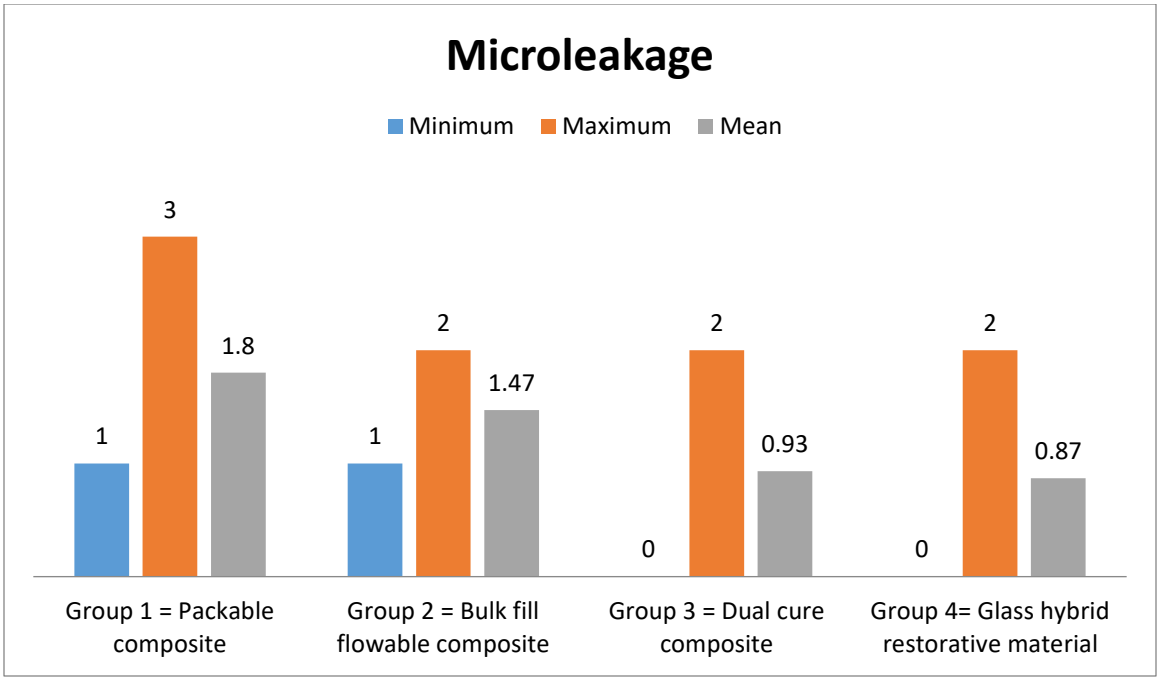

Table 2 Comparison of Micro leakage between four groups by Analysis of variance (ANOVA).

ANOVA					
Micro leakage					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig. p value**
Between Groups	**8.933**	**3**	**2.978**	**11.267**	**<0.001***
Within Groups	**14.800**	**56**	**.264**		
Total	**23.733**	**59**			

*** Statistically significant**

There was statistically significant difference among four groups for Micro leakage with p<0.001*

Graph 2 Comparison of Micro leakage between four groups.

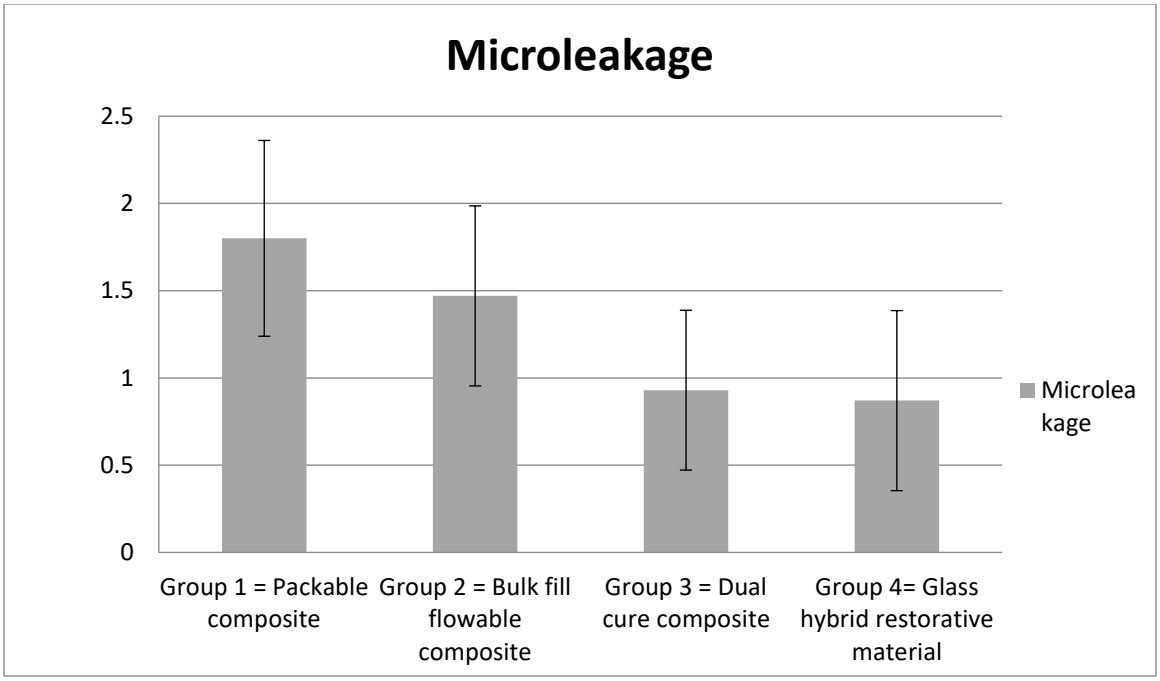

Table 3 Pair wise Comparison of Micro leakage between four groups by Tukeys' Post hoc Test.

Multiple Comparisons						
Dependent Variable: Micro leakage Tukey HSD						
(I) Groups	**(J) Groups**	**Mean Difference (I-J)**	**Std. Error**	**Sig. p value**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Group 1 = Packable composite	**Group 2 = Bulk fill flowable composite**	**.333**	**.188**	**.296**	**-.16**	**.83**
Group 1 = Packable composite	**Group 3 = Dual cure composite**	**.867***	**.188**	**<0.001***	**.37**	**1.36**
Group 1 = Packable composite	**Group 4= Glass hybrid restorative material**	**.933***	**.188**	**<0.001***	**.44**	**1.43**
Group 2 = Bulk fill flowable composite	**Group 3 = Dual cure composite**	**.533***	**.188**	**.031***	**.04**	**1.03**
Group 2 = Bulk fill flowable composite	**Group 4= Glass hybrid restorative material**	**.600***	**.188**	**.012***	**.10**	**1.10**

Group 3 = Dual cure composite	**Group 4= Glass hybrid restorative material**	**.067**	**.188**	**.984**	**-.43**	**.56**
***. The mean difference is significant at the 0.05 level.**						

***Statistically significant**

fig 1 fig 2 fig 3

DISCUSSION:

Pre-endodontic build up of the clinical crowns is often required to preserve the functional integrity of teeth, which require root canal treatment and the goal of endodontic treatment should be directed toward minimizing the critical concentration of microbial irritants.[6] thorough mechanical and chemical debridement of the root canal space results in successful endodontic outcomes. Thus, investing time in placing pre-endodontic restoration before starting endodontic treatment can provide ease in rubber dam placement, follow proper irrigation protocol, ensure a low probability of losing the provisional restoration, and improve the endodontic treatment prognosis.[7] Different materials are used as pre-endodontic build up, e.g. Amalgam, Packable composite, flowable composite, dual-cure composite and self cure or light-cure Glass-ionomer cement.

Marginal microleakage is commonly observed with various restorative materials. Which can lead to ingress of microbial contents into the canal and thus can cause pulpal and periapical pathology. These factors are the main reasons for restoration replacement. An important goal of operative dentistry has been always controlling micro leakage.[8]

To determine durability of the restorative material, dye penetration test is used by clinicians and researchers. Regardless of its limitation, dye penetration method was used in this study because they are considered to be still popular to determine micro leakage. They also have a benefit of low cost and simplicity of technique.[9]Numerous methods used to detect micro leakage, dye penetration with methylene blue (0.5%) has confirmed to be a time-tested method. It has low molecular weight known to be smaller than bacteria, which helps to determine leakage in places where even bacteria cannot penetrate.[10]

The use of composites as build-up material should be favoured. But one of the main drawbacks associated with composite restoration is its shrinkage during polymerization which is responsible for marginal gaps around restorations resulting in micro leakage. Leads to marginal staining, poor marginal seal and recurrent caries, which affects the longevity of the restoration.[8]Glass hybrid restorative material, which is a new class of glass ionomer restorative material, showing strength and durability, along with bondable and fluoride releasing property of glass ionomer cement.

Flowable composite resins are the most common resin material and are widely used in clinical practice that are recommended instead of Packable resin composite which has a high percentage of filler and having difficultly in adaptation between one composite layer and another thus can lead to more micro leakage. Therefore, Bulk Fill flowable resins with improved mechanical and chemical characteristics has been used in this study. Filtek Bulk Fill (3M ESPE), a low-viscosity, visible-light activated flowable material, containing inorganic filler particles of lesser percentage about 44-55% in volume and higher amount of resinous components. Which fills with bulk-fill technique, which may be polymerized in 4 mm increments.[4] Thus, ensures penetration into every irregularity; ability to form layers of minimum thickness, so improving or eliminating air inclusion or entrapment. But, the high curing shrinkage, due to lower filler load can also weakeans the mechanical properties and which can affect the sealing ability of the material.[11]

In this present study EQUIA forte and Luxa core exhibited lesser micro leakage value when compared to Packable and Bulk fill flowable composite with statistically significant difference with p value of less than 0.05%, whereas Glass ionomer hybrid restorative material and dual cure composite was statistically insignificant (P=0.984). It might be because EQUIA Forte is an innovative, highly reactive restorative system based on a new glass hybrid technology, which has more voluminous glass fillers of smaller size that penetrates the surface porosities of dentin thus increasing the strength of the overall EQUIA filling and reduces the micro leakage around the restoration. [12]

The study by Gowdaet. al in which they concluded that Glass hybrid restorative system (EQUIA forte)showed lesser microlekage than alkasite based restorative material, thereby having better sealing ability.[13]

The dual curing mechanism is: light curing and self-curing. LuxaCore Z-Dual is a dual-curing, nano-hybrid 2-component composite consisting of a base and a catalyst paste. The two components are mixed during extrusion in a static mixer and the curing starts with a defined delay after the components are brought together. The ability to bulk fills the core and lutes an opaque restoration while minimizing the risk of light attenuation that would disrupt the setting of the deepest portions of the resin material are the benefit of dual-cure resin materials[14]. The fact that it both flows well and has a high level of stability is crucial for pre-endodontic build-up[2].

Temperature changes that take place in-vivo can stimulate by attempting thermo cycling procedures. The Marginal seal of a dental material can adversely affect due to Temperature fluctuations. To test this factor, thermocycling was incorporated into this study design. The temperature range used in thermocycling (5˚C and 55˚C), corresponds to the extremes of temperatures experienced in the oral environment.[15]

The study design is invitro and this forms a major limitation of the current study. The effect of glass hybrid restorative material and dual-cure composite on micro leakage must be assessed under in vivo conditions to better determine the utility of the restorative material.

CONCLUSION:

Within the limitation of study we can conclude that, EQUIA forte and Luxa core, showed minimum micro leakage compared to Bulk fill flowable and Packable Composite. The clinician is taking the first step toward a successful result by planning and executing a stable pre-endodontic restoration. Which will enhance endodontic treatment by preventing marginal leakage before a final restoration is placed.

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