Acta Scientific Dental Sciences (ISSN: 2581-4893)

Volume 7 Issue 2 February 2023

Research Article

To Compare and Evaluate the Microleakage of Four Different Tooth Coloured Restorative Materials in Class V Cavities: A Stereomicroscopic Study

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DOI: 10.31080/ASDS.2023.07.1556

Received: December 08, 2022

Published: January 06, 2023

Abstract

A major advancement in the current practice of dentistry is the restoration of the teeth with tooth coloured restorative material. The success and longevity of a dental restoration depends on sealing of the cavity walls as well as the retention to the tooth surface.

Design: Forty caries free human permanent maxillary premolar of comparable dimensions extracted for orthodontic purposes were selected for the study. Standardized class V cavities of length 4mm, depth 2mm, width 2mm mesiodistally were prepared on the buccal aspect of the specimen. Dimensions were standardized by measuring with digital vernier caliper. The prepared specimens were randomly divided into four experimental groups of ten specimens each (n = 10) and the prepared cavities were restored with four different tooth-coloured restorative materials, group-I nanocomposite Filtek Z350XT, group-II Filtek Bulkfill, group III microhybrid Clearfill AP-X, group- IV RMGI Fuji II LC all the specimen were restored and aged artificially. Specimens were sectioned buccolingually through the restoration using diamond disc and examined under stereomicroscope at 30 X magnification to assess the micro leakage.

Results: The present study showed the least microleakage in (group I) nanocomposite filtek z350xt followed by (group II) clear fill AP-X, (group III) filtek bulk fill and (group IV) fuji II LC

Conclusion: Overall FILTEK Z350XT restoration with liner as Beautiful Flow Plus performed better than other three groups with least microleakage

Keywords: Micoleakage; Composite; Restoration

Introduction

A crucial development in the current practice of dentistry and the restoration of the teeth with tooth coloured restorative material. The success and durability of a dental restoration depends on sealing of the cavity walls and the retention to the tooth surface [1].

For the past years aesthetic dentistry has shown considerable progress leading to the development of a number of improved restorative material currently main concern regarding the performance of the material refer to their durability and integrity of marginal sealing especially in cavities that involve cementum area where clinical problem is aggravated [2].

Cervical lesions have been restorative challenge for clinicians for many years the complex morphology of class 5 cavities with partly in enamel and partly in dentin presents challenging outcome for the restorative material. the primary problem is associated with restoration of this kind of cavity is leakage at gingival margin located in dentin [2].

Composite resin and GIC are advised for dental cervical lesion these materials are capable of bonding to tooth structure but they are also subject to micro leakage that allows oral microorganism, fluids and chemical substances to migrate through the tooth restoration interface, progress of the material can cause dissolouration of the restoration, recurrent decay, sensitivity and damage to the pulp [3].

Polymerization shrinkage following in micro leakage and increasing marginal integrity is the main cause of resin-based restoration fracture microleakage is thought to be responsible for hypersensitivity, secondary caries, pulpal pathosis and fracture of restoration the use of liner to act as flexible intermediate layer

between Restoration and substrate has been suggested as method of relieving the stresses associated with polymerization shrinkage [4].

Flowable composite have been advocated as liner due to their low viscosity is increased elasticity and wettability, there has always been a eager interest in the adaptation of dental restorative material to the walls of cavities and the retentive ability of the material to seal the cavity against the Ingress of oral fluids and microorganisms [5].

Current dental adhesive systems that can create a hybrid layer between resin and dentin have shown improved marginal seal due to use of acidic molecules and improve bonding technology [6].

Glass ionomer cement (GIC) is a restorativel material that contains fluoraluminosilicate glass in its powder composition of calcium, basic silicon oxide, aluminum oxide and calcium, magnesium, and sodium fluoride. The liquid is an aqueous solution of polyacrylic acid, Even so, its use as restorative material is still limited due to its brittleness and low compressive strength. In order to overcome these limitations, the resin-modified GIC (RMGIC) was developed. In addition to the neutralisation reaction, RMGICs have a polymerization reaction as they have resin monomers in their composition. In most cases, this polymerization is photo-initiated.

In 1962 Bowen developed the Bis-GMA monomer in an attempt to improve the physical properties of acrylic resins, as their monomers only allowed linear chain polymers to be formed. Earlier, chemically cured composites required the base paste to be mixed with the catalyst, leading to problems with the proportions, mixing process and colour variation [7].

Therefore, this study is undertaken to compare and evaluate the microleakage of Resin modified GIC, Filtek Z350XT, Filtek Bulkfill, ClearfillAP-X and in class V cavities by using stereomicroscope.

Materials and Method

Forty caries free human permanent maxillary premolar of comparable dimensions extracted for orthodontic purposes were selected for the study for evaluating the microleakage. Standardized class V cavities of length 4mm, depth 2mm, width 2mm mesiodistally were prepared on the buccal aspect of the specimen. Dimensions were standardized by measuring with digital vernier caliper. The cavity preparation was done using diamond burs BR-41 and SI-46 (Dia-Burs, Mani Inc, Tochigi, Japan), used with high speed airotor and adequate water spray coolant by the same operator to eliminate the operator variability. Bur was replaced after every five cavity preparations. The prepared specimens were randomly divided into four experimental groups of ten specimens each (n = 10) and the prepared cavities were restored with four different tooth-coloured restorative materials

- **Group-I:** NANOCOMPOSITE FILTEK Z350XT (3M ESPE)
- **Group-II:** MICROHYBRID CLEARFILL AP-X (KURARAY NORITAKE)
- **Group-III:** FILTEK BULKFILL POSTERIOR (3M ESPE)
- **Group-IV:** RMGI FUJI II LC (GC EUROPE).

The sample teeth of first three group were thoroughly dried and restored with the respective restorative materials using Teflon-coated instruments, incrementally cured, polished, and finished as per the manufacturer's instructions for group IV the dentin surface was conditioned for 20 s with dentin conditioner. The cement were mixed according to the manufacturer's instructions, and was inserted into the cavity Immediately after the restorations were placed, it was cured with an LED curing unit for 20 seconds.

Specimens were immersed in a thermocycling chamber between 5°C and 55 ± 2°C for 500 cycles with dwelling time of 15 seconds. All the specimens were coated with nail polish varnish (Galaxy Nail ColourTM, Vasai, Mumbai) except on restorative material and tooth structure 1mm from cavosurface margins. Then the specimens were immersed in 50% wt silver nitrate solution (High purity laboratory chemicals Pvt Ltd, Mumbai, India) for 6 hours in a dark container at room temperature for dye penetration.

Microleakage analysis

Specimens were sectioned buccolingually through the restoration using diamond disc in a low speed micromotor handpiece and examined under stereomicroscope at 30 X magnification to assess the micro leakage. The evaluation of leakage was made with a three-point severity scale as described by Araujo., *et al.* and Munro., *et al.*

The results of microleakage scores were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS) version 28 The mean and standard deviation of microleakage scores of four study groups was compared using one way analysis of variance (ANOVA) followed by test and non-parametric Kruskal-wallis test to determine the significant difference at occlusal and gingival margin.

The depth of dye penetration of each slice was recorded, and mean was obtained which was used in statistical analysis.

Figure 1

Results

The comparison was done between the mean dye penetrations of Group I and Group II, group III, group IV at gingival and occlusal levels The comparison of the mean scores of microleakage scores showed high mean scores at gingival region in group I, group III and group IV while group II showed high mean score in occlusal region.

On intergroup comparison using mann whitney U test Between four groups group I nanocomposite filtek Z350XT showed least microleakage in comparison with group II CLEARFILL AP-X, group III filtek bulkfill posterior, group IV RMGI FUJI II LC which was statistically significant

Discussion

The important standards to improve the prognosis by increasing the durability of the restoration is to prevent microleakage, it is achieved by proper adhesion of the restorative material to tooth structure.47 Because of the enduring increase in esthetic demands,

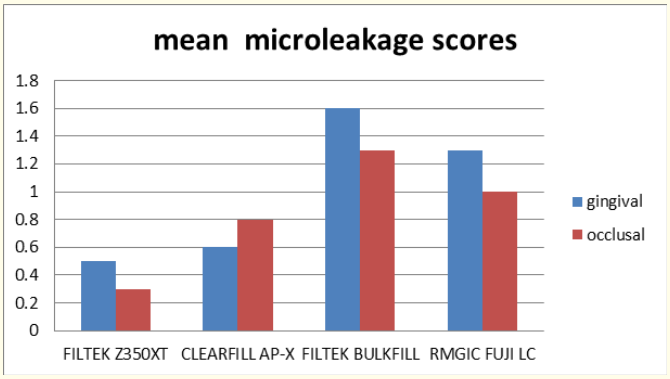

Figure 2

	Groups	Mann Whitney Value	P value	Significance
Gingival	FILTEK Z350XT group I	45.000	0.661	Not significant
	CLEARFILL AP-X Group II			
	Total			
Occlusal	FILTEK Z350XT Group I	25.000	0.028	Significant
	CLEARFILL AP-X Group II			
	Total			

Table 1

	Groups	Mann Whitney Value	P value	Significant
Gingival	FILTEK 350XT Group I	10.000	0.001	Significant
	FILTEK BULK-FILL Group III			
	Total			
Occlusal	FILTEK 350XT Group I	10.500	0.001	Significant
	FILTEK BULK-FILL Group III			
	Total			

Table 2

	Groups	Mann-Whitney Value	P Value	Significant
Gingival	FILTEK Z350XT Group I	22.500	0.027	Significant
	RMGIC FUJI II LC Group IV			
	Total			
Occlusal	FILTEK Z350XT Group I	22.000	0.019	Significant
	RMGIC FUJI II LC Group IV			
	Total			

Table 3

Figure 3

tooth colour restorative material have been the common choice for restoration of class V cavitites. Formation of interfacial gaps is the major defect of a restorative material which develop as a result of long term thermal and mechanical stress over the restoration. The stresses may alter the thermal and physical properties of the material. The dimensional changes in the restoration can lead to microleakage which is a matter of care because it can lead to hypersensitivity, formation of secondary caries, staining at the margins and pulpal pathosis [5,8].

Microleakage is used as a benchmark to predict the performance of a restorative material [9]. The morphology of class V cavities with margins partly in enamel and partly in dentin/cementum presents a rigorous condition for the restorative material. In the present study, noncarious Class V restorations were chosen for evaluation, as the preparation of Class V cavities is minimal and their restoration is relatively easy, thereby reducing technique-sensitivity and operator- related variability. The other reason is as Class V cavities have margins located both in enamel and in dentin.

It was formerly thought that the only forces that dislodge the class V restorations were the pulling forces of sticky foods, very little thought was given to the biomechanics of the tooth structure. Gable was the first to consider the probability of occlusal forces affecting class V restorations. Further, direct measurements of the changes in the occlusalgingival diameter of class V cavities were made [10,11] shifting of the cavity margins and cuspal flexure were investigated to be responsible for the extrusion of amalgam and the change in the cervico-occlusal width of the cavity and the magnitude of deformation was related to the amount of tooth tissue lost. Heymann., *et al.* in 1991 have suggested a tooth flexure theory of retention to illustrate these findings [12]. They suggested that two mechanisms managed to cause failure. One is the lateral excursive movements effecting in lateral cuspal movements which generate tensile stresses along the tooth restoration interface and other are heavy forces in centric occlusion which leads to vertical deformation of the tooth leading to compressive and shear stresses at tooth restoration interface.

At present, tooth-coloured restorative materials recommended to restore class V cavities are Glass ionomers, RMGIC's, Nanocomposites, Microhybrid ccomposites, giomers. One of the important property of the optimal restorative material is to resist the micro-

leakage in and around the restoration. According to Yammazaki., *et al.* in 2006, Evaluating the leakage of bacterial fluid is the method most frequently used for assessing the sealing efficiency of the restorative system. A study by Castro., *et al.* 2002, stated that, importance of maintaining the marginal seal of the restoration is to avert the formation of secondary caries, marginal discolouration and post restorative sensitivity. The correlation between marginal leakage and type of restorative materials used in restorations has been critically evaluated both in clinical and laboratory experiments. Because of less clinical data and definitive clinical findings, *in vitro* microleakage studies are a most accepted method of testing and evaluating the restorative materials for marginal leakage.

In order to prevent the access of contaminants and bacterial products into the restoration, creation of perfect marginal seal is an important criteria. substitute of lost peripheral dentin is a primary goal to attain a proper margin in restoration-dentin interface [13].

In thermocycling procedure, two temperature ranges are used. The upper limit of 45-60˚c and lower limit of 4-15˚c. Many authors including Phillips and Peterson (1996) applied 15 ° and 45 ° to heat cycles, while the study by Grieve and his colleagues (1993) have advised thermocycling at 5 and 55 degrees. Hot and cold baths for 10, 15, 30, 60 or 120 seconds are advocated for immersion of the specimens to imitate oral environment. According to Diwanji., *et al*, thermocycling regimen provides thermal stresses by alteration in temperature. Material reaches thermal equilibrium only on resting bath. This alteration likely to increase the leakage by inducing the stress over the material [14].

Several studies have recommended different methods to evaluate the microleakage. Methods include the dye penetration, dye extraction, radioactive isotopes infiltration, acetate peel technique, bacterial leakage, neutron activation analysis, stereomicroscopic analysis, micro-computed tomography, confocal laser scanning microscopy, optical coherence tomography. All these accepted methods come with both advantages and disadvantages. The dye penetration assay using coloured agents and observed under stereomicroscope is the most commonly used technique. Despite the differences, dye penetration studies still remains the best method to evaluate the sealing ability of the materials.

The silver ion is very small 0.059 nm-diameter when compared to the size of a typical bacterium which is 0.5-1.0 μm. thus it has more penetration and serves as a test material to detect microleakage.53 Edan and others stated that a four hour immersion in a 50% silver nitrate solution allowed accurate and reliable measurements of microleakage [4].

In this study, the samples are immersed in 50% wt silver nitrate solution for 6 hours in a dark container at room temperature for dye penetration. Then the samples are washed under running water, immersed in a photographic developing solution and exposed to fluorescent light for 12hours and thoroughly rinsed with distilled water.

The results obtained in this study showed that all the four-tooth-coloured restorative materials that were tested exhibited more microleakage on the gingival margins than on the occlusal margins. Unique challenges are encountered with dentin surface bonding due to enamel that is 92% inorganic hydroxyapatite and 0dentin that is 45% inorganic by volume.

In this study, there was no statistically significant difference in the microleakage of group-I (FILTEK Z350XT) and group-II (CLEARFILL AP-X) at both occlusal and gingival margins. This finding is in accordance with previous studies.48 However, few studies have shown that there is statistically significant difference in microleakage of these materials. This could be due to arguements in experimental designs and testing methods used in these studies [15].

Filtek Z350 (3M ESPE) Universal Restorative is a nanocomposite that contains a combination of a nonagglomerated/nonaggregate, 20 nm nanosilica fillers, and loosely bound agglomerated zirconia/silica nanocluster, consisting of agglomerates of primary zirconia/silica particles with 5-20 nm fillers. The cluster particle size range is from 0.6 to 1.4 microns the result of this study is in accordance with the study conducted by Kazem Khosravi., *et al*. that nanocomposites (Z350XT61% filler content) show no significant difference in microleakge when compared to microhybrid P60 (63% filler content) composites filler content. Similar results were reported by Cara., *et al*. and Kusgoz., *et al*. In these studies microhybrid showed microleakage similar to nanocomposites.

Clearfil AP-X is a methacrylate based microhybrid with enhanced mechanical properties. The polymerization shrinkage decreased with increasing filler content. The correlation between

bond strength and shrinkage was greater, It is recognized that the filler level of composites is one of the important factors effecting the physical properties of the system (Germain., *et al*., 1985; Li., *et al.*, 1985). This study demonstrates an apparent relationship between filler level of composite systems and bond strength to bovine dentine.

On analyzing the result of our study it was found that the unmodified composite resin showed less microleakage using self-etch this results are in accordance with study conducted Nair., *et al*. Moosavi., *et al*. and Kambale., *et al*. and many other researches previously [16-18].

The result of this study correspond with the study conducted by gupta., *et al*. between packable composite, RMGIC, microfilled, nanocomposite which states that nanocomposites show least microleakage followed by microfilled composites maximum microleakage was seen in packable composites with curing depth of 4mm.

Filtek Bulk Fill Posterior composite used contains addition-fragmentation monomer that alleviates the stresses that result from the polymerization shrinkage. In addition, the Filtek Bulk Fill Posterior composite is mainly based on UDMA while the incremental Z350 composite contains BisGMA in addition to the UDMA. The study conducted by David Alain Gerdolle., *et al.* compared and evaluated that packable composite is exceptional at microleakage in Class V cavities than RMGIC FUJI II LC.

Resin-modified glass ionomer cement (RMGIC) were introduced to increase the mechanical and esthetic features of the conventional GICs via the adjunct of hydrophilic monomer, 2-hydroxyethyl methacrylate (HEMA), and photo-initiators to the conventional GIC. Its lower sensitivity to moisture and increased mechanical properties made it a successful substitute to composite resins at especially the restoration of cervical lesions however, in this study it showed maximum microleakage which is in accordance with a study conducted by Gopinath., *et al*. where RMGIC's showed more microleakage on comparison with composite resins.

Flowable composite resin is a alteration of composite resin with a low filler composition that affects low viscosity, high wetting ability on the surface, and high material flowability, thus increasing adaptability to the cavity base and walls Flowable composite resin in its use as an intermediate layer is able to improve the marginal adaptation of composite resins to dental hard tissue. The advantage of flowable composite resin is that when applying these composites it has a high modulus of elasticity creating it more flexible. Flowable composite resins have the ability to form layers with a minimum thickness. Hence, flowable composite resins can reduce microleakage [19].

Conclusion

Within the limitations of this study, none of the four materials were free from microleakage. All the four materials demonstrated more microleakage at gingival margins compared to occlusal margins. Among all the groups Filtek Z350XT showed the least microleakage at the gingival margin.

Conflict of Interests

All authors deny any conflict of interest.

Author Contributions

Dr Rahul M and Dr Zaryab M designed the study, drafted the initial manuscript, reviewed the search strategy and approved the final manuscript as submitted. Dr Zaryab M, collected data, analyzed data, and approved the final manuscript as submitted.

Funding

Statement Not financially supported.

Acknowledgements

The authors would like to thank everyone who help us in this work.

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