

A Confocal Microscopic Evaluation of Microleakage in Class V Cavities Restored With Composite Resin Using Different Intermediate Liner

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Abstract

Background And Objective: Composite resin is the most popular material of choice in esthetic dentistry. The goal of improving longevity of this restoration can be achieved by preventing microleakage. The aim of this study is to evaluate the effect of bulk fill composite (Tetric N ceram,) smart dentin replacement (SDR) , compomer (cention N) and flowable composite (Filtek Z 350) as a intermediate material on micro leakage in class v composite restoration.

Material And Methodology: 48 class V cavities was be prepared on buccal and lingual aspects of 24 freshly extracted premolars. These cavities were divided into four groups (n=6) after etching and bonding .Group I, control group —restored with Bulk fill composite resin(TBF) ,Group II — smart dentin replacement (SDR) liner + TBF restoration , Group III — compomer (cention N) liner +

TBF restoration , and Group IV— flowable composite liner (Filtek Z 350) + TBF restoration. After curing, the samples were subjected to thermocycling. Nail polish was be applied to the teeth except on restorative material and tooth structure of 1 mm from cavosurface margins. And they were immersed in aqueous solution of 2% Rhodamine-B dye for 24h. samples were sectioned buccolingually and were subjected to confocal microscopy

Statistical Analysis: Performed using ANOVA-KRUSKAL WALLIS TEST followed by MANN WHITNEY POST HOC TEST and WILCOXON SIGNED RANK TEST.

Results: The Group II with smart dentine replacement as intermediate material gave better result compared with other Groups(I,III,IV) in class V composite restoration.

Conclusion: SMART DENTINE REPLACEMENT showed the least microleakage at both gingival and occlusal margin Followed by COMPOMER, BULK FIL COMPOSITE, FLOWABLE COMPOSITE.

Keywords: Bulkfil Composite, Compomer, Flowable Composite, Gingival Margin , Occlusal Margin, SEM

Introduction

Esthetic dentistry has gained prime importance as the demand for tooth color restoration are more from the patients. With the recent investigation in the material science the esthetic tooth color material have been extensively studied which almost produces a life like tooth appearance and possess biocompatible property. Various materials include composite resin , Glass ionomer cement, ceramic, veneers and crowns etc. Among these materials composite resin has been widely used. The various factors like polymerization shrinkage, marginal seal, adhesive property and marginal discoloration which occur due to caries, trauma or any metallic material. The Chemical properties, microleakage and hypersensitivity of restored tooth should be considered as the basic requirement for the longevity of the restoration.¹The compositional differences among enamel\ dentine and restorative material, co-efficient of thermal expansion, polymerization variables, cavity location, “c” factor , resin composite insertion technique all of which plays an important role in a successful composite restoration.²Various types of composite restoration include Bulk fill composite , macrofill composite , microfill composite ,compomer, hybrid composite, flowable composite, nanofill composite etc. Among this flowable composite have low viscosity enables better adaptation of the resin composite to the cavity by the clinician. Liners are the materials which are used between the tooth surface and restoration. It generally helps in preventing toxic and thermal effects

caused by restorative material over the underlying pulp, microleakage at the interface between tooth and restorative material. Various liners used are caoH, Zinc oxid Eugenol ,Glass ionomer type III, Flowable composite. Etc..A search for better liner material was being done for many years which helps the restoration to have an increased micro tensile bond strength. With this regard an attempt was made to assess the effect of various properties like microleakage of the liner used under composite restoration. The liner material serves as an intermediate layer between tooth surface and restoration. The properties of the intermediate layer which is basically flowable composite resin has an effect on the final result of the restoration. The composition which consist of filler and resin matrix also determines the property of flowable composite.³Bulk fill resin composite have emerged as a new class of restorative materials, which has comparable physical property to regular micro \nano hybrid resin composites.⁴In this study intermediate material like compomer (cention N), flowable composite (filtekZ 350), SDR and bulk fil composite(Tetric N ceram) are used in order to evaluate microleakage in class V cavity on enamel and cementum margin.

Material And Methodology

24 Freshly extracted caries free, cracks free premolars teeth were collected cleaned of the soft tissue and hard tissue debris, following OSHA guidelines. Teeth were then stored in 0.2% chlorhexidine solution for 24hrs. Standard class V cavities were prepared both on the buccal and lingual surfaces of each of the 24 teeth, for a total of 48 cavities of 3 x 3 x 1.5 mm dimension. This was measured using William’s graduated probe. The gingival cavosurface margin of the preparation was deliberately kept 1 mm below , occlusal margin 2 mm above the cemento enamel junction in order to evaluate microleakage exactly at cemental and enamel margin

respectively . The preparations were made with a No. 245 carbide bur in a standardized handpiece (NSK) under copious water coolant.

24 samples were then randomly divided into 4 groups (I,II,III,IV) based on placement of different intermediate layer material;(n=6)

Group I — Tetric N ceram bulk fill composite resin(TBF) liner +TBF restoration

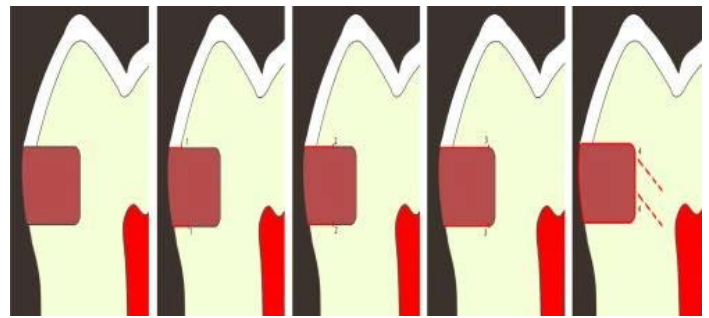
Group II — Smart dentin replacement (SDR) liner + TBF restoration ,

Group III —Compomer (Cention N) liner + TBF restoration

Group IV —Flowable composite (Filtek Z 350) + TBF restoration

The prepared samples were etched with 35% phosphoric acid for 15 sec, rinsed with water for 15 sec and adhesive system was applied to the entire preparation according to the manufacturer’s instructions, and light cured for 20 sec . The restored samples were stored in distilled water at 37 C for 24 h. The restorations were then finished and polished with composite polishing kit . The samples were coated with two layers of nail varnish, except for a 1.0 mm rim around the restoration, to allow the contact of the dye with the margin of the restoration. The specimens were thermocycled for 500 cycles at 5 ±10 and 55 ± 10 C with 30 s of dwell time .The samples were immediately immersed in 2% Rhodamine B dye solution for 24 h to assess the leakage. Then samples were sectioned through and through the center of the restoration in a bucco-lingual direction using a precision, slow speed diamond saw with water coolant. The sectioned samples were subjected under CONFOCAL MICROSCOPE at 5X magnification and then analyzed for dye penetration.

Scoring system was done a/c to Mirosław Orłowski as follows:



0= no microleakage.

1= dye penetrates up to the dentino-enamel junction (DEJ) or correspondent length at the dentin wall.

2= dye beyond the DEJ or correspondent length at the dentin wall, surpassing half the cavity depth

3= dye penetrates beyond half the cavity depth, without reaching the axial wall

4= dye penetrates along the axial walls.

The data were analyzed with ANOVA- KRUSKAL WALLIS TEST followed by MANN WHITNEY POST HOC TEST and WILCOXON SIGNED RANK TEST.

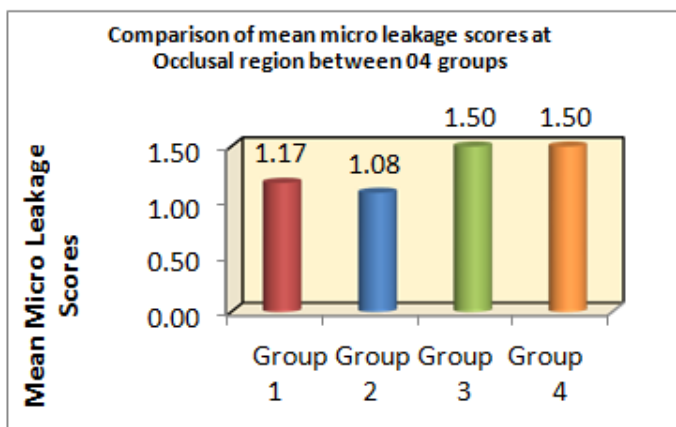
The testing was performed at the 95% confidence level.

Result

Table 1

Comparison Of Mean Micro Leakage Scores At Occlusal Region Between 04 Groups Using Kruskal Wallis Test						
Groups	N	Mean	SD	Min	Max	P- Value
Group 1	12	1.17	1.03	0	3	0.69
Group 2	12	1.08	0.52	0	2	
Group 3	12	1.50	1.17	1	4	
Group 4	12	1.50	0.80	1	3	

Graph 1



The table 1 shows the mean micro leakage Scores at occlusal level between 04 groups. The mean score of Group 1 is 1.17 ± 1.03 , Group 2 is 1.08 ± 0.52 , Group 3 is 1.50 ± 1.17 and Group 4 is 1.50 ± 0.80 . This difference in the mean micro leakage values between 04 groups is not statistically significant [P=0.69].

Table 2

Comparison Of Mean Micro Leakage Scores At Gingival Region Between 04 Groups Using Kruskal Wallis Test						
Groups	N	Mean	SD	Min	Max	P-Value
Group 1	12	2.42	0.79	2	4	<0.001*
Group 2	12	1.08	0.52	0	2	
Group 3	12	2.17	1.12	1	4	
Group 4	12	3.17	1.12	1	4	

Graph: 2

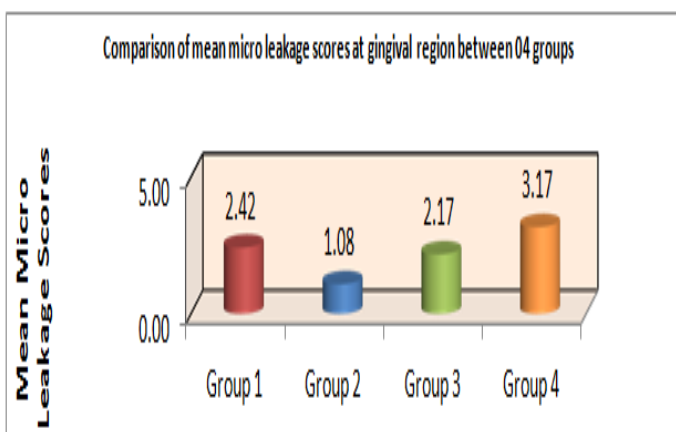
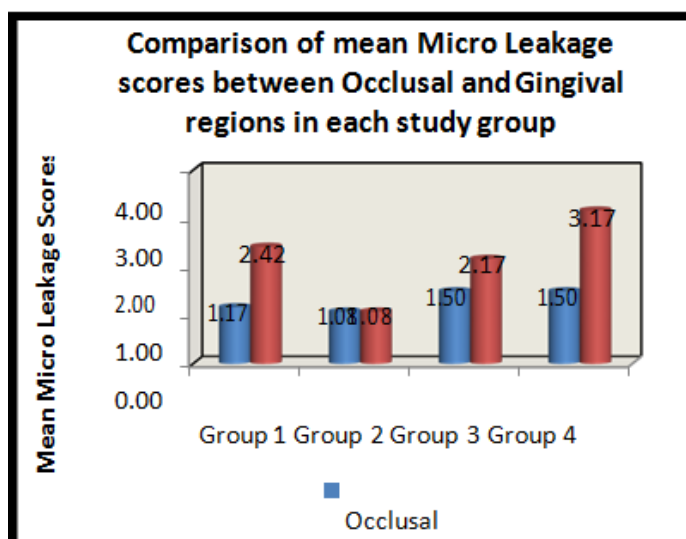


Table 3

Comparison of Mean Micro Leakage Scores B/W Occlusal & Gingival Regions In Each Study Group Using Wilcoxon Signed Rank Test						
Groups	Regions	N	Mean	SD	Mean Diff	P-Value
Group 1	Occlusal	12	1.17	1.03	-1.25	0.004*
	Gingival	12	2.42	0.79		
Group 2	Occlusal	12	1.08	0.52	0.00	1.00
	Gingival	12	1.08	0.52		
Group 3	Occlusal	12	1.50	1.17	-0.67	0.02*
	Gingival	12	2.17	1.12		
Group 4	Occlusal	12	1.50	0.80	-1.67	0.004*
	Gingival	12	3.17	1.12		

Graph 3



The table 3 shows the mean Micro leakage scores at Gingival region is significantly higher in Group 1 [2.42 ± 0.79], Group 3 [2.17 ± 1.12] and Group 4 [3.17 ± 1.12] as compared to their counterpart of Occlusal region 1.17 ± 1.03 , 1.50 ± 1.17 and 1.50 ± 0.80 at $P=0.004$, $P=0.02$ and $P=0.004$ respectively. However, the mean micro leakage scores in Group 2 did not show any significant change between the Occlusal [1.08 ± 0.52] and Gingival [1.08 ± 0.52] regions [P=1.00].

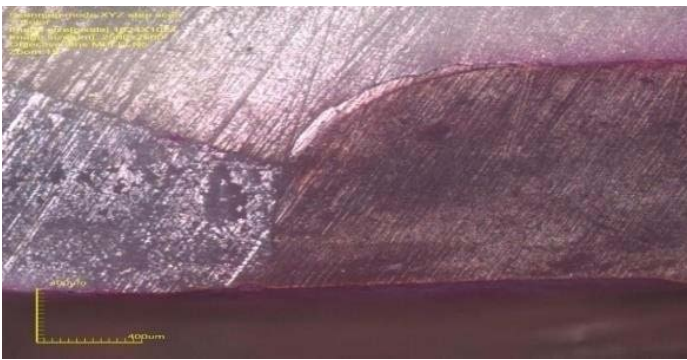


Figure 1 : Group I - occlusal margin showing microleakage score 1

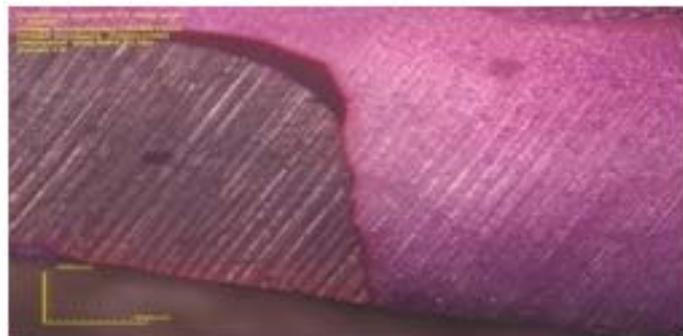


Figure 2: Group I- gingival margin showing microleakage score 3



Figure 3: Group II - occlusal margin showing microleakage score 0

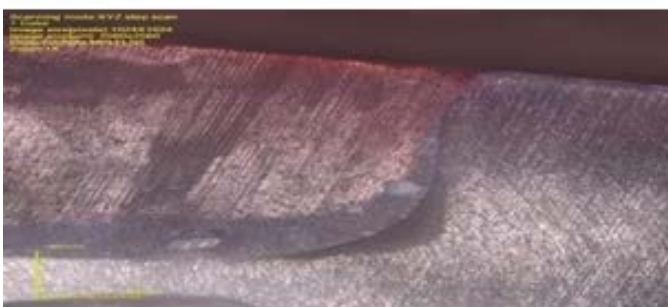


Figure 4: Group II - Gingival margin showing microleakage score 1

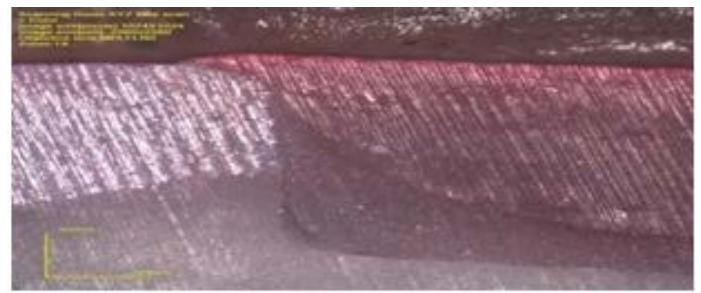


Figure 5: Group III - occlusal margin showing Microleakage score 1

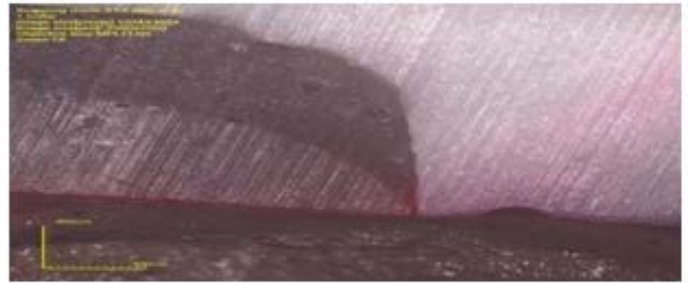


Figure 6: Group III - Gingival margin showing microleakage score 1



Figure 7: Group IV - occlusal margin showing microleakage score 4



Figure 8: Group IV - Gingival margin showing microleakage score 4

Discussion

The bonded composites resin have been the common choice for the aesthetic restorations. One of the main reasons for failure of composites is interfacial defects which develop as a result of long term thermal , mechanical stress, polymerization shrinkage along with the physical and chemical properties of the material. These interfacial defects can lead to microleakage which is a matter of concern because it can lead to staining at the margins of restorations, recurrent caries, hypersensitivity, and pulp pathology .5The use of a liner to act as a flexible intermediate layer between restoration and substrate has been suggested as a method of relieving the stress associated with polymerization shrinkage. Application of intermediate layer may provide the cavity with a higher free surface proportion and smaller volume of each resin composite layer to reduce the stress. Another benefit from this procedure is that stress distribution is more uniform along the low elastic modulus layer. This technique is called Elastic cavity wall.6 Ferracane et- al. reported maximizing the free surface was likely to enhance stress relief by allowing more flow of the material7 .Van Ende et- al. studied that more light reached the cavity bottom when a thin increment was cured first, and as a result, the first increment of resin composite could polymerize more effectively. Previous studies with regard to thin increment layer shows, internal adaptation of the restoration which as intermediate layer turned out to be better than those without the layer.8In the present study class V cavities were selected because cervical lesions have been a restorative challenge for any kind of restorative material due to their complex morphology where the margins are partly in enamel and partly in dentin/cementum. Microleakage is an important property that has been used in assessing the success of any restorative material used

in restoring tooth. 9 Results of our present study shows that microleakage at gingival wall is more compared to their respective occlusal wall. This finding is in accordance with the study conducted by Nayak et al. and Kumar Gupta et- al who reported the results obtained from their study that more microleakage on the gingival margins than on the occlusal margins because the flexural stresses at cervical margins are much more higher than that at the occlusal margins . Microleakage was significantly lesser in enamel than dentine or cementum margins. Enamel is considered a reliable substrate for bonding, and it possesses higher bond strengths compared to dentine. These significant differences can be attributed to tissue composition. Enamel is composed of hydroxyapatite with minor organic tissue when compared to dentine. Superficial layer of approx. 10 micrometer is removed during acid etching leaving an irregular high energy surface. Dentine on other hand contains high amount of water, which is expected to interfere with the adhesive particles. Hence microleakage is less in enamel margin, which is in consensus with the result of our study where microleakage at occlusal(enamel) margin was lesser than gingival (dentin/cementum)margin. 10In order to simulate temperature changes that take place in the oral environment , thermo cycling was done . 11,12. In the present study microleakage was assessed using dye penetration technique. The details were observed using confocal microscope in the fluorescence mode13 .K masouras et-al reported that the material properties of flowable resin composite used as the intermediate layer may affect the results of resin composite restorations. In terms of filler content, filler load percentage can decide the elastic modulus and polymerization shrinkage strain. Low filler content can indicate lower elastic modulus and higher shrinkage strain .14 R labella –et –al proved in his study that this lower elastic modulus producing highest

polymerization shrinkage imparts higher stress at the tooth restoration interface. This explanation is in consensus with our current study with respect to highest microleakage in (GROUP IV) flowable composite intermediate layer material¹⁵The present study showed higher microleakage in (GROUP I) bulk fill composite, next to that of flowable composite (GROUP IV) group. This could be due to medium viscosity of bulk fill which restricts the flow of the material for adaptation at internal cavity wall and cavosurface margins. The results is in agreement with the studies conducted by Rolly Shrivastav Agarwal et al who also proved that stiffer (high viscosity) material may not adequately adapt to internal areas and cavosurface margins at the cervical joint .¹⁶The present study showed COMPOMER (GROUP III) showed lesser microleakage than flowable (GROUP IV) and bulk fill composite (GROUP I). This could be explained due to the sole use of cross-linking methacrylate monomers in combination with a stable, efficient self-cure initiator. Compomer exhibits a high polymer basic network density and degree of polymerization over the complete depth of the restoration. It also includes a special patented filler (Isofiller) which acts as a shrinkage stress reliever minimising the shrinkage force which is responsible for the low volumetric shrinkage leading to least microleakage. Due to its low elastic modulus (10 GPa) the shrinkage stress reliever within Compomer reduces polymerization shrinkage and microleakage which is in accordance to the study conducted by Dr Paul George- et al, whose study showed, Cention N shows lesser microleakage compared to GIC and composite restorations, there by having better sealing ability¹⁷. this is also in agreement with the study conducted by SM Moazzami –et – al who also proved the use of compomer materials for sandwich restorations which showed reduced microleakage .¹⁸In the present

study smart dentine replacement (SDR) (GROUP II) showed least microleakage when compared to all other groups. This is being supported by various studies conducted on SDR with respect to microleakage .Lotfi N, et al –reported that the composition of SDR containing urathane dimethacrylate which attribute to the lower microleakage than other flowable composites group. ¹⁹A 1 year study conducted by Piotr Buczko MD-et al showed high effectiveness and safety of SDR when used as the base layer for fillings of class I and II cavities²⁰ . Ashwini Marurkar et al studied that SDR performed better in reducing micro leakage at the gingival and occlusal level when compared to other flowable composite which is in agreement with the results of our present study.²¹Hence, The test results demonstrated that the mean Micro leakage scores at Gingival region is significantly higher in Group 1 , Group 3 and Group 4 as compared to their counterpart of Occlusal region.However, the mean micro leakage scores in Group 2 did not show any significant change between the Occlusal and Gingival regions. Hence SDR is more favorable which as got good clinical significance.

Conclusion

Within the limitations of this study, all the four experimental materials exhibited some amount of microleakage. Among all the groups SMART DENTINE REPLACEMENT showed the least microleakage both at the gingival and occlusal margin compare to other material.However, many studies are required to prove the microleakage of restorative material by using various method which as higher clarity than confocal microscope and attempting to eliminate the microleakage completely leading to more longevity for the restorations.

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