Original Article

Operative Dentistry

Assessment of Microleakage of Three Restorative Materials in Class V Cavities. An in Vitro Study

1. Farah Naz 2. Muhammad Amin 3. Adeel Ahmed 4. Munawar Rahman

1,2,3. Asstt. Profs. & Consultants, Dept. of Operative Dentistry, Dental Section, DIMC, DUHS, Karachi

4. Consultant Dentist, Operative Dentistry, Section of Dentistry, Dept. of Surgery, AKUH, Karachi

ABSTRACT

Objectives: To evaluate the marginal microleakage in class V cavities restored with three different restorative materials using dye penetration scoring system.

Study Design: Cross sectional study.

Place and Duration of Study: This study was conducted at Dental Clinic laboratory, Juma building research laboratory, and Multidisciplinary laboratory, The Aga Khan University, Karachi for a period of six months from April 2008 to September 2008.

Materials and Methods: One hundered and fifty extracted premolars were randomly selected. Standardized class V cavities were prepared and then divided into three equal groups: Group I was restored with composite resin, Group II with glass ionomer cement and group III with resin modified glass ionomers. They were then subjected to thermocycling, immersed in 2% methylene blue dye, sectioned and examined under dissection microscope. Dye penetration for each section was recorded and data was analyzed.

Results: Lowest leakage was found in Group I (composite resin) and maximum in Group II (conventional glass ionomer). Microleakage at gingival margins was significantly more than that at occlusal margins in all groups.

Conclusion: Composite resins and resin modified glass ionomers provide a better seal than glass ionomers in class V cavities. All materials show more microleakage at gingival margins as compared to occlusal margins.

Key Words: Dental-leakage, Composite-Resins, Glass-Ionomer-Cements.

INTRODUCTION

Aesthetic restorative dentistry is based on procedures that approach features resulting in btter marginal seal at tooth restoration interface[1]. The complex morphology of class V cavities with margins partly in enamel, dentin and cementum presents a challenging task for the restorative material to seal properly[1]. Failure of a restoration to seal a cavity will lead to "microleakage".[2]

Microleakage occurs when clinically undetectable oral fluid, bacteria and molecules pass through the tooth-restoration interface[3]. Microgaps created at the margin cause marginal stain, secondary caries, sensitivity, pulpal irritation and possible pulpal pathosis ultimately leading to clinical failure of restoration.[4]

Factors causing microleakage are: temperature variables, moisture absorption during placement of restoration, polymerization shrinkage, operator inability and masticatory forces. These factors lessen the adherence of restorative materials to tooth[3]. Eliminating microleakage around restorations is an important objective in clinical practice[5].

In composite restorations, property of polymerization shrinkage can result in marginal discrepancies leading to microleakage[6]. Stresses are generated within the restoration and at the margins, and if these stresses exceed the bond strength, gap is formed.[7]

Glass ionomers are commonly used as a class V restorative material because they exhibit chemical bonding to tooth structure, release fluoride and have low shrinkage values.[8] Replacing part of the polyacrylic acid in GIC with hydrophilic monomers changes it to light curable resin modified glass ionomer cement.

The lower elastic modulus in lower filler volume composites may be desirable for class V restorations, because this material will strain more with the teeth under load than with stiffer, more heavily filled restorative resins. This material dissipates stress by flow and therefore, compensates for stresses accumulated during polymerization[9,10].

In recent times, several attempts have been made in restorative techniques and materials to reduce microleakage. These include measures in tooth preparation, material handling, layering technique in composites, use of dual cure adhesive before amalgam, curing techniques, choice of restorative material and by changing the nature of the resin. Bicyclic compounds in composites (silorane) cured by ring opening polymerization tend to shrink less as they harden[11,12, 13].

Several studies have evaluated current restorative materials. Few studies have compared group of different materials but the results are still very contradicting regarding choice of the ideal restorative material[2,14,15].

MATERIALS AND METHODS

Sample Size: One hundred and fifty extracted teeth were divided into three groups. Fifty teeth were included in each group.

Sampling Technique: Random selection and assignment: the teeth after being selected with respect

to the inclusion and exclusion criteria, were randomly distributed into three boxes, labeled A, B, and C by the operator blindly. Each box was then assigned one restorative material by a random draw.

Inclusion criteria: Non carious human pre molars extracted for orthodontic or periodontal reasons.

Exclusion criteria: Previously cervically restored teeth and teeth with visible cracks were excluded from the study.

Data Collection procedure: One hundred and fifty teeth, fitting the inclusion criteria were selected, cleaned with ultrasonic scaler, disinfected with hypochlorite and stored in distilled water to prevent dehydration.

Standardized class V cavities were prepared on buccal surface of each tooth at cementoenamel junction using a high speed tapered fissure carbide bur (FG 700, SS White). The preparation was 4mm x 3 mm and 2mm deep with occlusal margin in enamel and gingival margin in dentin. (16) Same operator performed all work to eliminate inter operator variability.

After cavity preparations, teeth in each group were randomly assigned into three groups. Group I**:** restored with composite resin (Z-100 Restorative™, 3M ESPE).Group II**:** restored with conventional glass ionomer restoration (GC II Fuji™, GC Corporation). Group III: restored with resin modified glass ionomer restorations. (3M Vitremer™, 3M ESPE).

All restoration were placed according to the manufacturers instructions and finished with aluminum oxide disks (Sof-Lex, 3M ESPE). All teeth were thermocycled (Eppendorf Mastercycler) at 200 cycles between 5-55 °C ±2°C with dwell time of 60 seconds at each temperature. All specimens were then sealed with nail polish except 1 mm margins around the restorations and immersed in 2% methylene blue dye for 24 hours. Teeth were then washed, dried and sectioned longitudinally in buccolingual direction through the centre of restoration with slow speed diamond disk (Microdont). The sections were examined under inverted microscope (OLYMPUS) at 40 X magnification. Dye penetration was evaluated for both occlusal and gingival surface based on graded scoring system (Table I). The most severe degree of dye penetration for each section was selected and recorded. Each sample was observed by two examiners.(Figure I).

RESULTS

All data were gathered using statistical package for social sciences (SPSS) version 16.0. Frequencies of dye penetration in all three groups are shown in Table 2.

1. For occlusal surfaces, lowest leakage ranking was found in composite restorations and maximum ranking in glass ionomer restorations The difference in microleakage scores among these groups was statistically highly significant (Table 3).

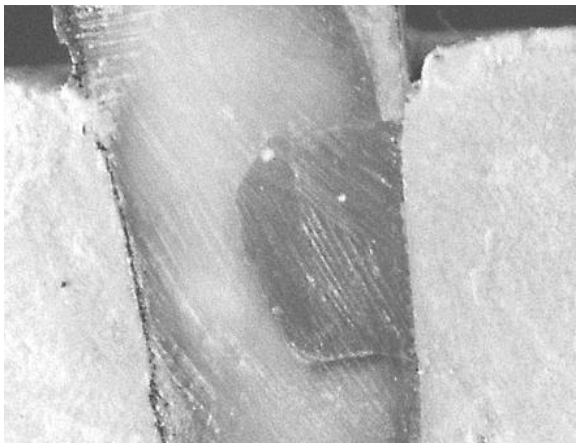

Figure No.I: Magnified view of sectioned tooth restored with composite resin. Showing: no dye penetration at occlusal wall, score:0; dye penetration upto full length and axial wall at gingival wall, score: 3

Table No.I: Microleakage scores - Score Dye penetration

0	No dye penetration
1	Dye penetration involving half the occlusal / gingival wall
2	Dye penetration involving more than half the occlusal / gingival wall
3	Dye penetration involving the axial wall

Table No.2: The frequencies of microleakage scores at the occlusal and gingival margins.

Groups / materials	Observer	N	Microleakage scores at Occlusal margins				Microleakage scores at gingival margins			
			Scores				Scores			
			0	1	2	3	0	1	2	3
I /Z-100	I*	50	46	0	2	2	23	6	15	6
	II**	50	44	1	3	2	25	6	13	6
II / GC II Fuji	I	50	25	4	1	20	2	2	5	41
	II	50	25	6	1	18	3	2	6	39
III Vitremer	I	50	31	7	6	6	5	10	10	25
	II	50	30	9	1	10	13	6	8	23

* Principal investigator. ** Second observer.

Table No.3: Difference in microleakage scores in three groups. (Kruskal Wallis test)

Observer	Group/ Material	Microleakage scores at Occlusal Margins		Microleakage scores at Gingival Margins	
		Mean rank	p-value	Mean rank	p-value
Principal investigator	I / LCC	57.6	<0.001	44.7	<0.001
	II / GIC	91.3		102.4	
	III / RMGIC	77.6		79.4	
Second observer	I / LCC	58.6	<0.001	48.2	<0.001
	II / GIC	89.0		102.3	
	III / RMGIC	78.8		75.9	

2. Similarly, for gingival surfaces, lowest leakage ranking was found in composite restorations and maximum ranking in glass ionomer restorations. The difference in microleakage scores among these groups was statistically highly significant (Table 3).

The inter examiner reliability (as determined by the kappa scores) was acceptable to good (66% - 78%). (Table 4).

Table No.4: Inter examiner reliability scores.

Groups	Surfaces	Kappa%
Resin composite (LCC)	Occlusal	66
	Gingival	61
Resin modified Glass Ionomer	Occlusal	69
	Gingival	65
Glass ionomer cement	Occlusal	70
	Gingival	78

DISCUSSION

In vitro microleakage testing of dental materials is a commonly accepted evaluation technique of marginal integrity of materials[15].

No material evaluated in our study completely resisted microleakage at either occlusal or gingival walls of the tooth. Of the three materials, resin composite exhibited the least dye penetration at both occlusal and gingival margins, followed by resin modified GIC and conventional GIC group respectively.

Leakage in composite resin restoration may be a result of gap produced by polymerization shrinkage and thermocycling. Thermocycling is done for aging of the material to simulate the oral environment. Expansion and contraction with temperature changes in thermocycling causes gap formation because the co-efficient of thermal expansion of composites is quite different from that of the dentin. Similarly, forces of polymerization contraction exceed dentin bond strength leading to gap.[17]

Microleakage scores for resin modified glass ionomer cement fell between those recorded for resin composite restorations and those for conventional glass ionomer restorations. RMGIC contains HEMA that contains similar hydrophilic monomers to resin, which facilitates its bonding with dentin resulting in lesser leakage than GIC.[18,19]

In this research, class V cavity design was chosen because it has a high value of C-factor. This cavity is easier to restore and therefore reduces the operator related variations.[20]

Erdilek N et al (1997) compared the microleakage of GIC, resin composites and glass ionomer resin cement and found that composite resin and glass ionomer resin cement provide better seal than GIC[21]. Study by Gladys et al also support that resin modified glass ionomers performed better than the conventional glass ionomers[22]. Results of our study are consistent with these studies.

Mali et al, assessed the microleakage among GIC, resin composites and compomers. They found that microleakage was evident in all restorative materials with maximum leakage in glass ionomers, and least leakage in compomers[23].

Microleakage is highest in GIC even though it is capable of bonding to tooth structure[24]. Hygroscopic expansion in restorations can compensate for gaps. Water sorption can help to reduce marginal gap.[25,26]

In our study, the GIC restorations were allowed to set first and were later on dipped in distilled water after 24 hours, and then were thermocycled for 24 hours, so, material may not have expanded completely. One possibility of more leakage could be technique sensitivity of restorative procedure. The application of poly acrylic acid, before glass ionomer restorations is advised to increase the surface energy and optimize contact between material and substrate.[26, 27]

In our study, more leakage was observed at gingival margins than occlusal margins in composite and RMGIC than in GIC. The reason for this is that resin component of material adheres poorly to the cervical dentin than to enamel.

More reliability was found among the observers in grading of occlusal margins as compared to the gingival margins in our study, probably because there was a clear “no dye penetration” at occlusal margins. While in gingival, there was mostly some leakage resulting in confusion regarding the grade of depth of penetration.

It is recommended that RMGICs rather than conventional glass Ionomers should be used in Class V cavity to allow immediate finishing and reduce microleakage[27]. Dry finishing of RMGIs with abrasive disks is recommended to produces a smoother surface[27]. There is increased trend of using an intermediate layer of flowable composite in between the cavity floor and restorative material[26].

To date, there is no universally accepted technique to determine the microleakage of restorative materials. Some authors argue that tests conducted with dyes are not clinically relevant. They advocate the use of material as lipopolysaccharides[25,28]. Conversely, it was found that the use of dye was equally effective in demonstrating microleakage[28].

In vitro microleakage tests using dyes demonstrate greater leakage than *in vivo* tests. This is most likely because the dye is more easily diffused than bacteria and their bye-products[28]. So, if a material responds positively to dye tests, it is likely to respond even better on a clinical level.[28, 29]

Although the results obtained from this study may not be directly applied to the clinical situation, they provide some information regarding the performance of the restoratives evaluated.

Limitation: It was an in vitro study. Research has found a weak relation of in vitro study with clinical situation, its results would not necessarily translate to clinical practice, therefore continuation in clinical trials is needed to reach inferences which are clinically more relevant.

Clinical Implication: The study question addresses an important topic, relevant to everyday practice, relating to longevity of a restoration. The data collection method is a validated method and the literature is full of studies with similar methodologies.(30,31)

CONCLUSION

No restorative material included in this study fully eliminates microleakage at gingival as well as occlusal margins. Composite resins and resin modified glass ionomer restorations showing lesser leakage, provide a better seal than glass ionomer restorations in class V cavities. All materials show more microleakage at gingival margins as compared to occlusal margins.

Recommendations:

Independent long- term clinical data is required to evaluate the microleakage of different restorative materials.

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Address for Corresponding Author:
Dr. Farah Naz
A-17/9, Yasinabad, F.B. Area,
Karachi, 75950.
e-mail: farah.biyabani@yahoo.com
Contact No. 0300-2345434