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MICROLEAKAGE OF LOW SHRINKAGE RESIN BASED COMPOSITE WITH AND WITHOUT LINER USING DIFFERENT TYPES OF ADHESIVE SYSTEMS: AN IN VITRO ASSESSMENT

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ABSTRACT

Objective: Polymerization shrinkage stress in composite restorations may lead to microleakage. Clinical methods such as using low-shrinkage composites and using stress breaking liners under composites have been suggested to overcome this problem. **Materials and Methods:** Ninety Standardized cylindrical class V cavities of 2x4 mm (depth × width) were prepared on the gingival third of the buccal surface of the sound human premolars teeth. The teeth were randomly divided into 2 groups. In group A1, Excite, Total etch Adhesive system was applied in one layer. In group A2, G Bond Adhesive system applied Every group was then divided into three subgroups of 15 Specimens each, relative to the type of liner material used, R1:grop for Low shrinkage resin composite restoration without liner, R2:group for Low shrinkage resin composite restoration with flowable resin composite liner and R3: group for Low shrinkage resin composite restoration with- (R.M.G.I) liner, Each subgroup was further divided according to storage time into three divisions of 5 Specimens each, S1: 24 hours, S2: three month and S3: six months.The samples were thermocycled and immersed in an aqueous solution of 2 % methylene blue for 24h. The restorations were sectioned in buccolingual direction. Then they were evaluated for microleakage by using a stereomicroscope. **Results:** The groups were not significantly different regarding the microleakage in the Low shrinkage resin composite restoration with flowable resin composite liner yielded the best results. **Conclusion:** The results suggested that use low-shrinkage resin composites alone may not reduce the marginal microleakage. The proper use of low-shrinkage resin composites with liner may offer better comparable clinical results.

KEYWORDS: Microleakage, Low shrinkage resin Composites, liner.

INTRODUCTION

One major drawback of resin composite restorative materials is the polymerization shrinkage, caused by the dimensional rearrangement of monomers into polymer chains during polymerization reaction [(1)]. This Polymerization shrinkage is one of the important factors leading to microleakage, Microleakage of posterior resin composite restorations is a matter of concern to the clinician as it leads to staining at the margins of restorations, recurrent caries, hypersensitivity and pulp pathology [(2)].

Numerous approaches have been proposed to minimize the shrinkage by; change the concept of both curing protocols and placement techniques.eg; Altered light curing cycles, Three sited light curing techniques, Incremental curing of composites-layering techniques, Intermediate elastic bonding concept, and Stress breaking liners under composites[(3)]. The use of liners has been considered as it may act as a flexible intermediate layer, relieving the stresses of polymerization shrinkage [(4)].

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Flowable resin composites have been recommended as liners beneath resin composites because they have low viscosity, increased modulus of elasticity and wettability. This results in an intimate union with the floors and walls of the cavity preparations [5, 6].

Resin-modified glass ionomer liners have the ability to both micromechanically and chemically interact with dentin[7]. They are easy to mix and place, release high sustained levels of fluoride[8]; have: antimicrobial properties[9,10], very low solubility [11, 12] and favorable modulus of elasticity and coefficient of thermal expansion and contraction similar to that of dentin.

This has prompted study was to evaluate the microleakage of low shrinkage resin based composite GC KALORE™ with and without liner using two different adhesive systems G- bond (one step self etch adhesive system) and Excite ®, (two step etch-and rinse Adhesive system).

MATERIALS AND METHODS

1- The restorative material used was:

GC KALORE™ ; shade A3, it is visible cured Nano-sized hybrid resin composite

2-The underlying materials used were:

1. Vertise™ Flow, shade A3, it is a self-adhering flowable composite.
2. Riva Light Cure HV it is light-cured, resin reinforced glass ionomer restorative cement.

2- The adhesive systems were:

1. G - bond, one step self etch adhesive.
2. Excite, Total etch Adhesive system (two steps etch-and rinse Adhesive system).

I- Methods:

I. Teeth selection:

A total number of 90 sound human premolars freshly extracted were used for the present study; the selected teeth were free from decay, cracks, developmental defects and restorations, any extrinsic stains or deposited calculus should be removed using ultra sonic scaler. Then the teeth were cleaned with pumice and stored in 0.1% thymol solution at 4° C for one week .This solution was used as a topical antiseptic for the extracted teeth. The specimens were stored in normal saline until time of test. The teeth had regular occlusal anatomy and almost standard crown sizes.

II. Cavity preparation:

Standardized cylindrical class V cavities were prepared on the gingival third of the buccal surface of the teeth using a number 6 fissure bur operated at high speed hand piece with air-water coolant. The dimensions of the cavity were standardized using a window-like opening cut in a metallic matrix band; where this window for the width and premarket fissure bur number 6 for depth. The dimensions of the cavity were 2x4 mm. The depth was checked using calibrated periodontal probe. As shown in (Fig.1).

The cavosurface angle of the cavity was beveled to a 45 degree angle with a width1 mm. using flame shaped diamond stone operated at high speed with coolant.

III. Sample grouping:

According to the type of adhesive system the prepared specimens were randomly divided into two main equal groups of 45 specimens, A1: group for self etch adhesive system A2: group for Total etch and rinse adhesive system. Every group was then divided into three subgroups of 15 Specimens each, relative to the type of liner material used , R1:grop for Low shrinkage resin composite restoration without liner, R2:group for Low shrinkage resin composite restoration with flowable resin composite liner and R3: group for Low shrinkage resin composite restoration with- (R.M.G.I) liner . Each subgroup was further divided according to storage time into three divisions of 5 Specimens each, S1: 24 hours, S2: three month and S3: six months.

Restoration procedure:

Application of the adhesive system:

The (90) prepared teeth were washed under running water and gently dried with oil free air to be ready for application of adhesive systems (45) prepared teeth for one step self etch adhesive system using G-bond, and(45) prepared teeth for two- step total etch adhesive system using Excite as following:

one step adhesive system application (G-bond)**:** One drop from the bottle was placed in a mixing pad. The freshly solution was carried into the micro brush, then applied to the dried dentin surface and rubbed in for 20 seconds with the micro brush. This was followed by gentle air thinning to allow evaporation of solvent and remove the excess of bonding agent, then light cured for 10 seconds according to the manufactures instructions .

Total etch and rinse adhesive system application (Excite)**:** The cavity wall and margins was etched with tooth conditioner gel (34 % phosphoric acid) for 20 seconds , rinsed with water for 10 seconds by using oil-free water spray. The cavity was then gently air dried up to just shiny appearance disappeared. Two coat of bonding agent (Excite adhesive) was then applied in to the cavity with a small brush associated with the kit system ,The adhesive was undisturbed for 10 seconds, and gently air-dried for 5 seconds to evaporate any excess solvent. Then light cured for 20 seconds using light curing unit according to manufacture.

Application of resin composite:

Both of the two (A1=15 cavities, A2=15 cavities) are restored with the GC KALORE resin composite.

GC kalore resin composite:

Immediately After application of adhesive system A3 shade colored resin composite paste was applied into the prepared cavity by incremental packing technique and packed by using Teflon condenser instrument. A celluloid matrix strip was finally applied using finger pressure to hold and adapt the restoration in place. The resin composite was light cured for 40 seconds (conventional curing mode) according to the manufacturer's instructions. Direction of light was in buccal aspect with the tip of curing unit was at zero contact distance. The excess filling was removed with sharp plastic instrument then the restoration was finished with soflex discs in a descending order. The polymerizing light intensity was calibrated after finishing of each group periodically insure constancy of light output power according to the manufacturer's instructions.

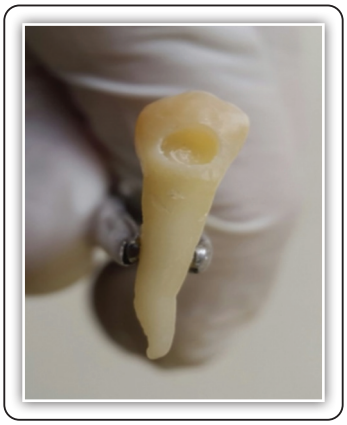

FIG (1) Prepared class v specimens

FIG (2) Restored samples

Storage of Specimens:

The restored specimens were stored in a plastic container containing 20 milliliters of distilled water and preserved in an incubator at 37°C temperature for the specific predetermined storage times (24 hours, three months, and six months), and thermocycled during the period of storage for 1000 cycles (5C/55C, with 30s interval for each temperature using thermocycling testing machine (Haak DC, Germany).

Assessment of microleakage:

Microleakage was assessed by using dye penetration technique; restored teeth were removed at the end of predetermined storage time, dried initially with clean paper tissues and then dried with oil free compressed air.

Sealing of teeth:

The Restored teeth were coated with two layers of an acid- resistant protective nail varnish except for an area approximately I mm around the margin of the restoration. The nail varnish was allowed to dry for 2hours. Then sealed with green stick compound to prevent dye penetration throughout the apical foramen [13].

Tracing solution:

Teeth were immersed in an aqueous solution of 2 % methylene blue which was used by dissolving 2 grams of methylene blue powder in 100 mL distilled water for six hours. The specimens were then removed, rinsed thoroughly under running water until all dye solution was removed from the surface.

Sectioning of the teeth:

Teeth were sectioned longitudinally in buccolingually direction through the middle of the restoration, using a diamond disc at low speed with water coolants.

The splitted teeth were examined microscopically using stereomicroscope at X 40 to determine the depth degree of dye penetration at the tooth / restoration interface.

Microleakge scoring :

The scoring system used was based on the depth of penetration of the dye in the tooth along the tooth/ restoration interface as following:

0 : No dye penetration.

1 : Dye penetration to enamel wall and up to DEJ.

2 : Dye penetration to dentinal wall but not extending to pulpal wall .

3 : Dye penetration along the pulpal wall.

The obtained data were recorded, tabulated and statistically analyzed.

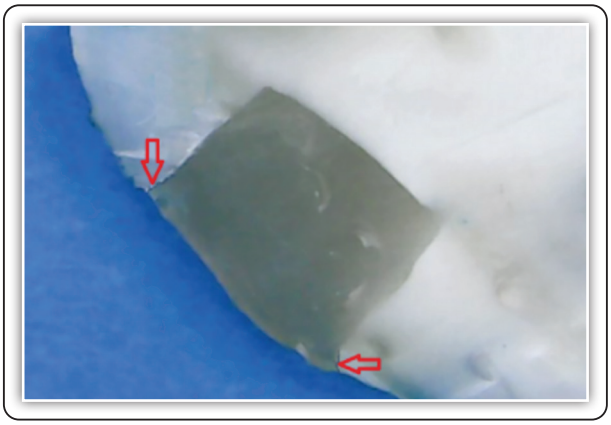

FIG (3) Representative photographs of digital microscope of microleakage for group I using Excite adhesive

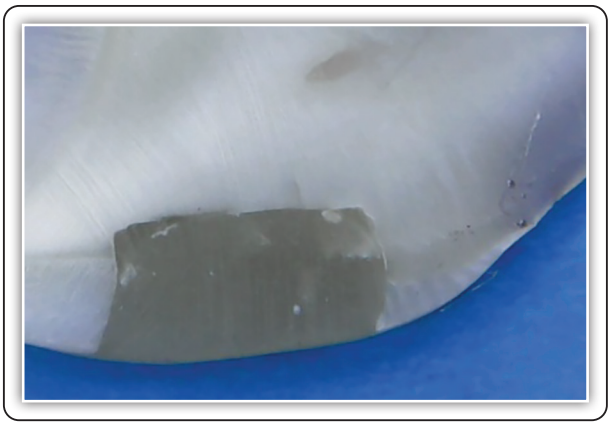

FIG (4) Representative photographs of digital microscope of microleakage for group II using G-bond adhesive

FIG (5) Representative photographs of digital microscope of microleakage for group III using G-bond adhesive

RESULTS

The collected data was tabulated Table (1), illustrated graphically Figure (6) and analyzed statistically using student-t test; to determine if the means of two sets of data are significantly different from each other and ANOVA test; to analyze the differences among group means in a sample.

Student t- test showing the effect of adhesive systems on the microleakage of low shrinkage resin composite without liner (R1: kalore composite) after different storage periods (S1), (S2) and (S3).

TABLE (1) One way analysis of variance (ANOVA test) showing the effect of adhesive systems (A1: etch& rinse adhesive system and A2 :self etch adhesive system) on the microleakage of resin composite and after different storage periods (24 hours, three months and six months).

		A1						A2						P-value
		R1		R2		R3		R1		R2		R3		
	grade	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
S1	0	5	100	5	100	5	100	5	100	5	100	5	100	000
	1	-	-	-	-	-	-	-	-	-	-	-	-	
	2	-	-	-	-	-	-	-	-	-	-	-	-	
	3	-	-	-	-	-	-	-	-	-	-	-	-	
	Mean±Sd	0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		
S2	0	5	100	5	100	5	100	5	100	5	100	5	100	0.00
	1	-	-	-	-	-	-	-	-	-	-	-	-	
	2	-	-	-	-	-	-	-	-	-	-	-	-	
	3	-	-	-	-	-	-	-	-	-	-	-	-	
	Mean±Sd	0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		0.0±0.00[a]		
S3	0	4	80	5	100	5	100	4	80	4	80	4	80	0.05
	1	1	20	-	-	-	-	1	20	1	20	1	20	
	2	-	-	-	-	-	-	-	-	-	-	-	-	
	3	-	-	-		-	-	-	-	-	-	-	-	
	Mean±Sd	0.4±0.44[b]		0.0±0.00[a]		0.0±0.00[a]		0.4±0.44[b]		0.4±0.44[b]		0.4±0.44[b]		

- Means with the different letters are statistically significant differences

- Means with the same letters are not statistically significant differences

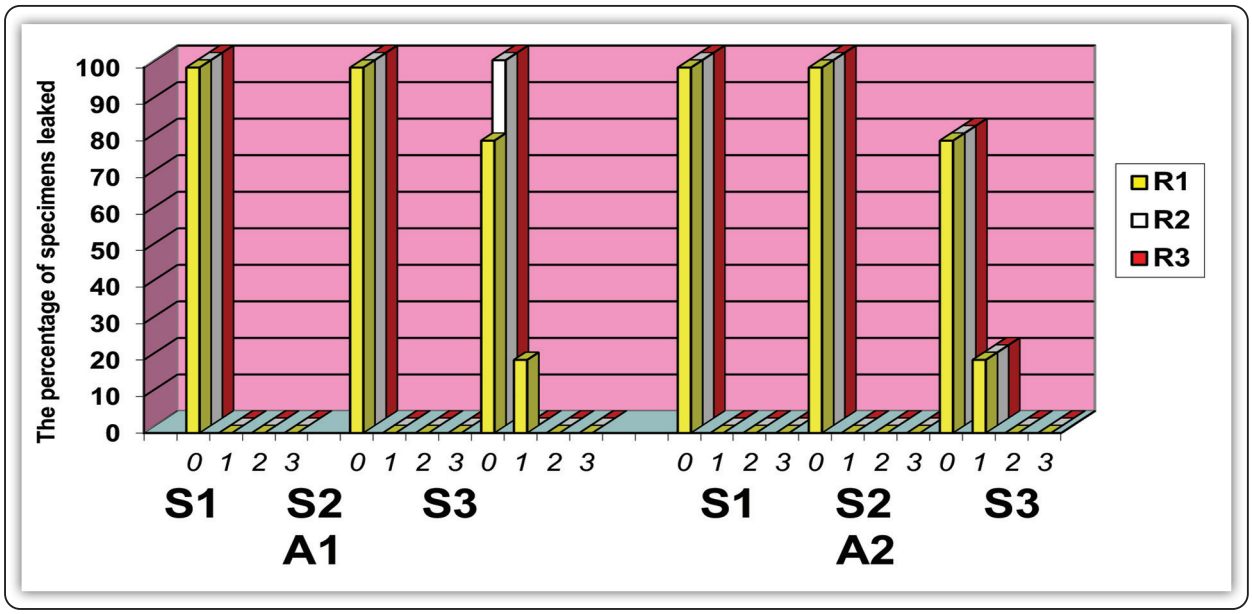

FIG (6) Bar-chat showing the distribution of microleakage grades for low shrinkage resin composite (R1) ,low shrinkage resin composite lined with flowable composite (R2) and low shrinkage resin composite lined with RMGIC (R3) and the effect of storage time (S1: 24 hours, S2 : three months and S3 : six months). using two types of adhesive systems (A1: etch& rinse adhesive system and A2 :self etch adhesive system).

After 24 hours storage time (S1):

100 % of specimens showed no leakage (grade 0) for both of total and self etch adhesive systems.

After three months storage time (S2):

100 % of specimens restored with low shrinkage composite (R1) showed no leakage (grade 0) for both of total etch and self etch adhesive systems.

Where no statistical significant differences between the mean microleakage grades of both of total etch adhesive and the mean microleakage grades of self etch adhesive systems after about (S1) and (S2). While After six months storage time (S3):

80% of specimens (R1) showed no leakage (grade 0) while 20 % of specimens showed leakage at enamel only (grade 1) for both of total etch and self etch adhesive systems.

There were no statistical significant differences at $p \leq 0.05$ [p=0.053] between the mean microleakage grades of total etch adhesive systems and the mean microleakage grades of self etch adhesive systems.

DISCUSSION

Evaluation of microleakage is the most common image used to assess the sealing efficiency of a restorative material.

In order to prevent microleakage, attention has to be given to the mechanism that may reduce polymerization shrinkage. Polymerization shrinkage resulted due to the contraction of the resin material during curing. This polymerization shrinkage results in the formation of a marginal gap which can ultimately lead to increased microleakage [(14)].

The influencing factors on polymerization shrinkage are resin formulation, amount of filler loading, filler type and size. The higher molecular weight of the resin results in less shrinkage [(15)].

An important factor in avoiding microleakage seems to be the capacity of the bonding agent to compensate for the polymerization forces of the restorative material during light curing [(16)].

Effect of lining material on the microleakage:

In present study, the concept of using various liners as stress absorbing cushions to minimize polymerization shrinkage was proposed; two types of materials (resin modified glass ionomer cement and flowable composites) were tested as stress absorbing liners.

A statistical significant difference was found between the three technique of resin composites restorations (low shrinkage resin composite without liner, low shrinkage resin composite lined by flowable risen composite and low shrinkage resin composite lined by (RMGIC) where the highest marginal adaptation was for low shrinkage resin composite lined by flowable resin composite, followed by low shrinkage composite resin lined by RMGIC and lastly the low shrinkage composite without underlining material.

The improved performance of the resin liner restoration was attributed to the stress absorption by this elastic layer. Yet, the reduction of the volume of restorative composite applied to the cavity cannot be neglected. It causes a reduction in polymerization shrinkage volume, provoking some decrease in contraction stress and allowing better marginal adaptation[17,18,19].

Effect of adhesive systems on the microleakage:

There is no statistical significant difference was found between the two types of adhesive systems (2-steps etch and rinse and one step self etch) where the best marginal adaptation was for etch and rinse 2-steps followed by the self etch one step that gave the highest score of microleakage.

However, in this study, the increased dye penetration and so decreasing the degree of adaptation obtained by the self etch adhesive system (G- bond) could be due to its limited ability to permeate through the formed smear layer, the limited demineralization and penetration power of the bonding system formulation or due to its limited acidity. This will lead to just permeation within the smear layer incorporating the demineralized component into the developed bond without rinsing [20,21,22].

Explanations for the improved adaptations of etch and rinse adhesive system in this study might be related to its composition.

CONCLUSIONS

Under the conditions of the present study, the following conclusions can be suggested:

1. The adhesive systems are not influenced by the type of resin composite materials used in this study.
2. Using the flowable composite as a liner not prevent but reduce the microleakage level at cervical margins.
3. The use of etch and rinse adhesive system rather than the use of self-etching adhesive system improve marginal adaptation.
4. None of the restorative techniques completely sealed the tooth/restoration interface at cervical margins.

RECOMMENDATIONS

1. The use of etch and rinse adhesive system rather than the use of self-etching adhesive system is recommended to reduce resin composite restoration microleakage.
2. The use of flowable resin composite as a liner rather than the use RMGIC as a liner is recommended to reduce resin composite restoration microleakage.
3. Further studies should be conducted in order to determine which restorative material and techniques produce the best tooth / restoration interface.

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