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LEAKAGE OF LOW SHRINKAGE COMPOSITE WITH PRE AND POST-RESTORATIVE TOOTH BLEACHING PROTOCOLS

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ABSTRACT

Purpose: To compare the effect of pre and post-restorative bleaching on the microleakage of low shrinkage resin composite.

Materials and Methods: Standardized class V cavities were prepared in the facial surfaces of seventy human upper anterior teeth**.** Cavities were randomly divided into three main groups: (1) no bleaching (control) (n=10); (2) pre-restorative bleaching (n=30) and (3) post-restorative bleaching (n=30). Second and third groups were divided into three subgroups (10 each) according to the bleaching protocol either in office (LumaCool systems, LumaLite, Spring Valley, CA, USA), at home (Stay Bright LumaLite, Spring Valley, CA, USA) or combination. Each subgroup was subdivided into two classes (n=5) according to the restorative time either immediately after/ before bleaching or after two weeks storage in artificial saliva. Cavities were restored with the Filtek LS system (3M-ESPE, St. Paul, MN, USA) and thermocycled. Specimens were prepared and examined using stereomicroscope to assess microleakage. Data were analyzed by Cross tabulation and Chi square analysis.

Results: Immediate pre-restorative bleaching deteriorated the marginal seal of the restorations significantly with the different protocols. Postponing placement of the restoration 2 weeks eliminated this negative effect. Post-restorative bleaching protocols either immediately or after 2 weeks showed no significant difference statistically in microleakage scores.

Conclusions: Tooth bleaching immediately before placement of low shrinkage composite deteriorated its marginal sealing significantly. It is advisable to postpone its placement 2 weeks after bleaching. Already placed low shrinkage composite does not get affected by any bleaching protocol when being bleached either immediately or after 2 weeks..

KEYWORDS: Tooth bleaching, leakage, low shrinkage resin

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INTRODUCTION

The demand for having more esthetic teeth and restorations has led several studies to be done in the field of tooth bleaching and its effects on the properties of teeth and the quality of dental restorations. [1, 2] Tooth bleaching is considered a conservative technique for tooth whiting. Categories of whitening products include at-home bleaching, in-office bleaching, and over-the counter in a variety of material concentrations. [3] The key ingredient in the majority of bleaching agents is hydrogen peroxide. [4]

Intimate contact between the tooth structure and bleaching agent must be achieved. This is for its active ingredient, which is the hydrogen peroxide, to be decomposed into oxygen (O^+) and peroxyl (HO_2^-) radicals. [5] These end products react with the stains molecules and transform them into simpler non-visible molecules. [6-8] Unfortunately, this reaction is not selective and it induces some unwanted effects on both tooth and restoration. [9] Some researchers have investigated the effects of preoperative bleaching on microleakage and sealing ability of tooth colored restorative materials. [10-12] Others have studied the effects of bleaching agents on microleakage of existence restorations. [13]

The effect of bleaching agent on the sealing ability of the resin composite restorations either if they are intended to be placed or they are already placed might vary according to its time of application. Time lapse between tooth bleaching and its restoration could give a chance for the bleaching end products to be neutralized representing harmless effect on the tooth restoration interface. Also immediate bleaching of the freshly placed resin composite might induce negative effects on it as it is not fully cured. On the other hand postponing bleaching for a certain time after restoration placement could be beneficial for keeping its sealing ability. Also the type of resin composite used plays an important role on the sealing quality of the restorative material to cavity walls and margins.

Varieties of resin composite materials are available to be used in the dental clinics. Most of them have the same main problem which is the polymerization shrinkage. It is an intrinsic property of resin which cannot be eliminated totally. Upon curing, the single methacrylate resin molecules move towards each other and are linked by chemical bonds to form a polymer network. This reaction leads to a significant volume contraction. Silorane system has been developed to minimize polymerization shrinkage and subsequently the stress induced, while providing a high performance bond to the tooth. [14]

Therefore, this study was conducted to compare the effect of pre and post restorative tooth bleaching protocols (In office, at home or combination) on the microleakage of low shrinkage composite either if they are applied immediately before/after restoration or before/after two weeks.

MATERIALS AND METHODS

Selection of teeth and sample grouping

Seventy caries free freshly extracted human upper anterior teeth were selected, carefully hand scaled then cleaned with pumice slurry. Teeth were stored in distilled water at 37ºC until used. They were randomly divided into three main groups: (1) no bleaching (control) (*n=10*); (2) pre-restorative bleaching (*n=30*) and (3) post-restorative bleaching (*n=30*). Control group was divided into two subgroups (n=5) according to the time of the restoration evaluation either immediate or after 2 weeks storage in artificial saliva at 37ºC. Second and third groups were divided into three subgroups (10 each) according to the bleaching technique either in office (LumaCool systems, LumaLite, Spring Valley, CA, USA), at home (Stay bright LumaLite, Spring Valley, CA, USA) or combination. Each subgroup was divided into two classes (*n=5*) according to the time of restorative intervention immediately after / before bleaching or after two weeks storage in artificial saliva at 37ºC (Methyl-P-hydroxybenzoate

2.009/1, Na Carboxy methyl cellulose 10.09/1, MgCl2.6H2O 0.29Mm, $CaCl_2.2H_2O$ 1.13Mm, K_2HPO_4 2.40 Mm, KCL 8.38 Mm, F 0.05 ppm) at PH 7.2. [15]

Cavity preparation

Standardized box-shaped Class V cavities were prepared in the facial surfaces of the teeth using straight fissure carbide bur no. 57 size 010 (Brassler, Savannah, Georgia, USA) rotating at high speed with air/water cooled hand piece. The dimensions of the prepared cavity were 4mm mesio-distally, 3mm occluso-gingivally, 2mm in depth and 1 mm above the cementoenamel junction. All cavity margins were placed in enamel. The insical margin was beveled at a 45 degree angle using a tapered fissure carbide bur no. 699 size 009 rotating at high speed with air/water spray.

Bleaching procedures

Time of bleaching

Teeth in the pre restorative bleaching group were bleached prior to restoration either immediately or before 2 weeks. However, in the post restorative bleaching group teeth were bleached either immediately after restoration or after 2 weeks.

Bleaching steps

Labial surfaces of teeth were bleached using one of three bleaching regimens; an either in office (LumaCool systems, LumaLite, Spring Valley, CA, USA), at home (Stay Bright LumaLite, Spring Valley, CA, USA) or combination in-office/at home bleaching. All bleaching procedures were performed according to manufacturer's instructions. Table 1 outlines the bleaching products used, manufacturers, composition and instructions for use.

Restorative procedures

All prepared cavities were restored with the Filtek LS system (3M-ESPE. St. Paul, MN, USA). Filtek LS system; self-etch primer and bond were used to bond all prepared cavities. Cavities were blot-dried, leaving a moist structure. The primer was applied to the cavity surface and agitated for 15 seconds using a disposable applicator (Cavibrush, Joinville, SC, Brazil), then gently air-dried for 5 seconds and finally cured for 10 s using high-power LED curing light (DENTSPLY, Milford, DE, USA) with an intensity exceeding 950 mW/cm2. The adhesive agent was then applied, air-thinned then cured for 10 s. The prepared cavities were restored with Filtek LS restorative material in one increment and cured for 20 seconds using the same curing unit according to the manufacturer instructions. All restorations were finished using Soflex discs (Sof-Lex Pop-On™ , 3M ESPE, St. Paul, MN, USA). Teeth were preserved at 37°C in artificial saliva that was changed daily. The same operator carried out all standard procedures.

Thermocycling

Restored teeth were placed in separate mesh bags and thermocycled in thermocycling machine (MCT2, Instrumentos de Preciao) for 500 cycles in water baths between 5 ± 2^0C and 55 ± 2^0C with immersion time of 60 seconds in each bath and with a 30 s dwell time.

Microleakage assessment

Apices of teeth were sealed using modelling wax. All tooth surfaces were covered with two coats of nail polish approximately 1 mm away from restoration margin. Microleakage was tested using a standardized dye penetration method. The specimens were immersed in 5% red fuschin at 37ºC for 24 hrs and then thoroughly rinsed with tap water and dried for 24 h to fix the fuchsin. [16] After staining, the teeth were washed with tap water and the nail polish and modeling wax were removed with a scalpel. All teeth were subsequently embedded in cold curing acrylic resin and sectioned through the centre of the restoration in a buccolingual

TABLE (1) Bleaching products used manufacturers, composition and instructions for use.

	In office bleaching	**At home bleaching**
Name	LumaCool whitening system	Stay Bright professional whitening enhancer
Manufacturer	LumaLite	LumaLite
Active gradient	Hydrogen peroxide	Hydrogen peroxide
Concentration	35%	7.5%
Activation	Light source	Chemical reaction
pH when in use in the mouth	6	6.5
Treatment period	3-eight minutes sessions for both arches	Two applications /day for 14 days

direction with a water-cooled slow speed diamond saw (Isomet, Buehler, Lake Bluff, IL, USA). Each section was examined under a stereomicroscope (20X Magnification) to assess microleakage at the cervical margins. The microleakage was assessed by two calibrated examiners, who were blind to the treatment groups. An ordinal scale from 0 to 4 was used to score microleakage based on the following criteria. [17]

- Grade 0: No dye penetration,
- Grade 1: Dye penetration up to one third of cavity depth
- Grade 2: Dye penetration up to two thirds of cavity depth
- Grade 3: Dye penetration up to base of the cavity base
- Grade 4: Extensive dye penetration through the axial wall

The occlusal wall and the gingival wall were scored separately and the examiner took the larger score either occlusal or gingival.

Statistical analysis

Statistical analysis was carried out using SAS program (Statistical Analysis Systems, STAT/ User's Guide, Release 6.03 ed., SAS Institute, Cary NC, USA., 1988). Cross tabulation and Chi square analysis (Procedure Frequency of SAS) were used to test the effect of group, technique and time on prevalence of microleakage score.

RESULTS

Application of low shrinkage composite immediately after bleaching revealed a higher microleakage scores compared to control and post restorative bleaching groups (table 2 and figure 1). Pre-restorative in office bleaching showed a higher score values with 60% scored 3 and 40% scored 4 compared to both control with 80% of samples scored 0 and 20% scored 1 and post-restorative bleaching with 80% of samples scored 0 and 20% scored 1 at p=0.02. At home bleaching showed insignificant difference between pre-restorative bleaching with a score values 40% scored 1 ,40% scored 2 and 20% scored 3 compared to both control

with 80% of samples scored 0 and 20% scored 1 and post-restorative bleaching with 80% of samples scored 0 and 20% scored 1 at p=0.105.Combination protocol showed a higher score values when used pre-restoratively with 20% scored 2, 60% scored 3 and 20% of samples scored 4 compared to both control with 80% of samples scored 0 and 20% of samples scored 1 and post-restorative bleaching with 60% of samples scored 0 and 40% scored 1 at p=0.025 (table 2 and figure 1).

On the other hand application of low shrinkage composite 2 weeks before/ after bleaching revealed insignificant difference between control, pre and post restorative bleaching groups at p=0.534 for in office, p=0.741 for at home one and p= 0.147 for combination protocol (table 3 and figure 2).

TABLE (2): Prevalence of microleakage scores in different groups (Immediately).

	Group	Control			Pre-restorative bleaching			Post-restorative bleaching			p-value
Technique	Score	No.	%	P1	No.	%	P1	No.	%	P1	
In office bleaching Luma cool	0	4	80	a	0	0.0	b	4	80.0	a	0.02*
	1	1	20		0	0.0		1	20.0		
	2	0	0.0		0	0.0		0	0.0		
	3	0	0.0		3	60.0		0	0.0		
	4	0	0.0		2	40.0		0	0.0		
	Total	5	100		5	100		5	100		
At home bleaching Stay Bright	0	4	80	a	0	0.0	a	4	80.0	a	0.105 NS
	1	1	20		2	40.0		1	20.0		
	2	0	0.0		2	40.0		0	0.0		
	3	0	0.0		1	20.0		0	0.0		
	4	0	0.0		0	0.0		0	0.0		
	Total	5	100		5	100		5	100		
Combination (Luma cool & Stay Bright)	0	4	80	a	0	0.0	b	3	60.0	a	0.025*
	1	1	20		0	0.0		2	40.0		
	2	0	0.0		1	20.0		0	0.0		
	3	0	0.0		3	60.0		0	0.0		
	4	0	0.0		1	20.0		0	0.0		
	Total	5	100		5	100		5	100		

P1 = Probability level for the effect of group (Chi square test).

Means with the same letter within each row are not significantly different at p≤0.05.

TABLE (3): Prevalence of microleakage scores in different groups (After 2 weeks).

	Group	Control			Pre-restorative bleaching			Post-restorative bleaching			p-value
Technique	Score	No.	%	P1	No.	%	P1	No.	%	P1	
In office bleaching Luma cool	0	3	60	a	1	20.0	a	3	60.0	a	0.534 NS
	1	2	40		3	60.0		1	20.0		
	2	0	0.0		1	20.0		1	20.0		
	3	0	0.0		0	0.0		0	0.0		
	4	0	0.0		0	0.0		0	0.0		
	Total	5	100		5	100		5	100		
At home bleaching Stay Bright	0	3	60	a	3	60.0	a	4	80.0	a	0.741 NS
	1	2	40		2	40.0		1	20.0		
	2	0	0.0		0	0.0		0	0.0		
	3	0	0.0		0	0.0		0	0.0		
	4	0	0.0		0	0.0		0	0.0		
	Total	5	100		5	100		5	100		
Combination (Luma cool & Stay Bright)	0	3	60	a	0	0.0	a	2	40.0	a	0.147 NS
	1	2	40		4	80.0		1	20.0		
	2	0	0.0		1	20.0		2	40.0		
	3	0	0.0		0	0.0		0	0.0		
	4	0	0.0		0	0.0		0	0.0		
	Total	5	100		5	100		5	100		

P1 = Probability level for the effect of group (Chi square test).

Means with the same letter within each row are not significantly different at p≤0.05.

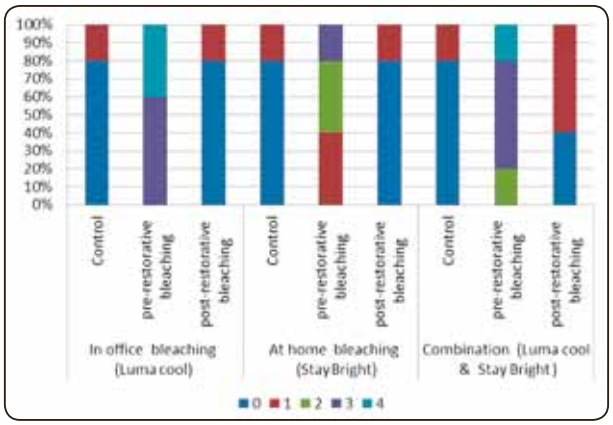

FIG. (1): Prevalence of microleakage scores in different groups (immediately).

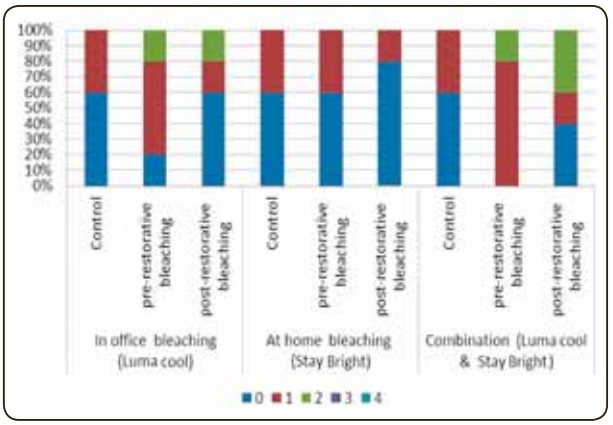

FIG. (2): Prevalence of microleakage scores in different groups (after 2 weeks).

DISCUSSION

Silorane was developed as a low-shrinkage composite in order to minimize the amount of interfacial generated stresses due to polymerization shrinkage of composite. In spite of all trials that have been done to minimize the amount of shrinkage, it was mentioned that the decrease in shrinkage is not mandatory to be accompanied with improved marginal adaptation. However, it is well documented that the induced interfacial stresses is multifactorial. Speed of curing, modulus of elasticity of the restoration, configuration factor and polymerization shrinkage are example for factors that share in determining the amount of the induced stresses at the interface. Low shrinkage composite termed silorane has low modulus of elasticity and a unique polymerization process which is cationic ring-opening. This type of polymerization is associated with lower amount of shrinkage and subsequently improved marginal adaptation. [18]

Sealing ability of the dental restorations can be assessed successfully by measuring the degree of microleakage using dye penetration method. In the current study basic fuchsin dye was selected to test the microleakage as this dye has similar bacterial particle size. [19] In addition standardization of cavity location and dimensions was based on the ISO specification for adhesion tests number 11405. Artificial aging of the specimens were done by using thermocycling process as enamel, dentin and composite restorations respond differently to the thermal fluctuation. [20]

Reviewing the literature revealed that tooth bleaching induced degree of demineralization in the form of calcium and phosphorus loss. These changes take place in the bleached enamel up to 50 μm depth. [21,22]

A lot of controversies are present about the influence of the microstructural changes of the bleached enamel on the adaptation of resin composite which is going to be placed or that one which was placed in the tooth. Crim [10],Klukowsha [23] and White [24] found that bleaching agents based of hydrogen, carbamide peroxide, and perborate did not cause an increase in microleakage at the resin-tooth interface. In contrast Ulukapi et al, [25] studied microleakage rates of resin composite restorations with enamel margins and they found that microleakage scores were significantly increased when they were placed after 10% carbamide peroxide bleaching. Also Turkun and Turkun, [26], reported a decrease in the sealing ability of resin composite when it is placed after 10% carbamide peroxide by one week. Regarding post restorative bleaching Ulukapi et al, [25], revealed that bleaching with 35% hydrogen peroxide or 10–16% carbamide peroxide adversely affected the marginal seal of resin composite. [25]

Some authors have suggested that the adverse effects of bleaching on resin-tooth bonds are caused by residual peroxides and oxygen that could inhibit the polymerization process of the adhesive systems. [27] However, a more recent research study did not detect oxygen on the surface of bleached enamel, thus rejecting the hypothesis that residual oxygen leached from bleaching agents may interfere in the adhesive polymerization process. [28] Moreover, bleaching can induce changes in the ultra-morphology of enamel-resin bonded interfaces, changing the organic and inorganic component ratios and increasing the solubility of dental structures.[1,27] Barkhordar et al. [1] stated that at home bleaching had a minimum effect on the marginal seal of the existing resin restoration within the first 2 days and a significant effect after 4 to 7 days of bleaching, and concluded that the micro-leakage increased with the extent of bleaching time.

In this study the results demonstrated that pre-restorative in-office bleaching alone and when combined with at home bleaching affected the marginal seal of class V composite restorations when immediately placed after bleaching while

the at-home bleaching had a very minor effect on the same restorations. This might be attributed to low concentration of the hydrogen peroxide (HP) in the at-home system (7.5 % HP) in comparison to the high concentration of the in-office systems used (35%HP). [28] In two weeks pre-restorative bleaching groups, the marginal seal of the composite restorations did not get affected significantly even with the in-office and combined bleaching techniques. This result might be due to the reparative effect of artificial saliva which eliminates the negative effects of the bleaching or due to leaching out of the peroxide remnants from the bleached tooth structures which takes about one week after bleaching. [29,30] On the other hand post restorative bleaching did not adversely affect the sealing ability of the low shrinkage composite either immediately or after 2 weeks and this could be attributed to the inherent ring opening polymerization of the silorane monomers which can compensate the volume reduction. This is accompanied with an improvement of the restoration adaptation due to reduced stresses at the tooth/restoration interface. [31]

CONCLUSION

Side effect of pre-restorative bleaching was approved in this study in the form of reduced sealing ability of low shrinkage composite. However, this effect was not observed when restoration placement was postponed 2 weeks after bleaching procedure. Additionally, the bleaching techniques don't adversely affect the sealing ability of the already placed low shrinkage composite even if it is bleached immediately or after 2 weeks.

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