Original Article

HOME BLEACHING EFFECT ON THE SURFACE TEXTURE OF DENTAL COSMETIC BIOMATERIAL - AN IN VITRO STUDY

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ABSTRACT

When the whitening or bleaching procedure is anticipated, either direct or indirect tooth-colored restorative material that matches the tooth must be utilized. Therefore, the current study aimed to identify the impact of home-based bleaching agents on the surface texture of matched tooth color materials (analysis of the restorative dental biomaterial). Two types of commercially available packable and flowable resin composites were used as one of the matched tooth color materials in this study. The study was carried out on 40 specimens. The resin composites were modified as per the guidelines to measure the influence of various bleaching material concentrations on the surface roughness before and after application. A significant difference in the roughness of the surface was detected in a total between before the application of bleaching agents and after the application (101.30 ±11.32) from (7.18±4.62). It was observed that packable composite is not significantly different in roughness compared to flowable composite. The effects of bleaching agent concentration were not significantly different either. The study confirms that the adverse effect related to bleaching agents (gels) are associated with the damage of tooth-colored dental materials and the increase in roughness after the application from the baseline roughness. The flowable composites were similarly susceptible to the bleaching agents in comparison to the packable composite. The two tested different concentrations in bleaching agents. Meanwhile, the two tested resin-based composites have similar amounts of increase in surface roughness.

Key words: Dental biomaterial, Bleaching agents, Resin-based composite, Packable composite, Flowable composites.

Introduction

The demand for bleaching teeth as an alternative for the remedy of teeth discoloration is growing in current dental approaches. The use of home-based whitening agents under all precautions is useful, as it is considered an instant method, cost-effective, limits continuous visits to the dentist, and carries minimum risk than the dental office techniques [1, 2]. The continuous utilization of these bleaching products with the increased concentrations of chemicals makes it challenging for the practitioner to decide on the possible treatment options. Nevertheless, the office procedures consist of the utilization of personalized trays with carrying gels of 6% HP (hydrogen peroxide) or 16% CP (carbamide peroxidase). These are the foremost common type of applications in the dental office or home [3].

The roughness of teeth and reduced indentation hardness are the main problems that are directly served by the continuous use of bleaching agents. Rough teeth provide a surface for the oral flora and food particles to accumulate. The attachment of oral flora is capable to aggregate and form biofilms whereas; the accumulated food particles create an environment where biofilm flora can nourish. Therefore, it is crucial to evaluate the quality and the texture of the matched tooth color materials [4-6]. There are various contradictory results reported on the effects of bleaching agents on the roughness of teeth [7]. The utilization of resin dental composite is most favorable due to its binding with enamel which is lacking in amalgam restorations. The health side effects of amalgam cannot be ignored due to the presence of mercury in it [8]. However, various studies suggested that the quality of resin-based dental composite relies on the resin type, composition of the gel, and exposure events [7, 9, 10].

Resin-based dental composites are predominantly utilized because they mimic tooth color in the esthetic areas. The maintenance of morphological and mechanical properties is considered one of the limitations associated with resin-based restorations. Mechanical properties play an essential role in the clinical expectancy and performance of resin restoration materials [11]. The quality of resin-based dental composite restoration relies on the surface texture because various dependent factors including, type of filler, size of filler, type of monomer, and its percentage are related to the surface texture qualities [12, 13]. If the requirements of surface texture are not met, food accumulation and biofilm formation occur which enhances the risk of periodontal disease, oral opportunistic infections, and progression of dental caries [6, 14]. Various researchers prepare smooth resin-based restoration against the matrix band. Surface texture can be altered during the restoration procedure via tooth brushing or bleaching. Moreover, studies revealed that the nano-filled resin-based composite must be utilized for restoration when a whitening or bleaching procedure is anticipated [15]. Therefore, the current study hypothesized that the surface of resin composite (packable and flowable)

is not to be altered by the application of a home bleaching agent.

Materials and Methods

Collection of resin composites and beaching agents
Two types of commercially available packable and flowable resin composites were used in this study throughout the experiment CHARISMA Diamond nano-hybrid / CHARISMA FLOW by KULZER German. Two types of home bleaching agents Opalescence 35% and Fläsh 16%, Carbamide Peroxide.

were used for the comparative analyses of composites.

Construction of discs specimens
About 40 specimen discs were prepared in split mold, sized 5mm in diameter and 3mm in thickness. All specimens were divided equally into two packable composite groups (20 discs) and flowable composites (20 discs). The resin-based composites were altered followed by packing and curing as per the written instructions. Once the resin composite is molded mylar strip was utilized followed by the thin glass slide positioned over the mold (mold carrying material) with 100 gm weight at constant pressure to allow direct contact of material with the curing tip of the slide. After the process of curing the mold was taken down to get the composite discs **(Figure 1)**.

Figure 1. Construction of discs specimens

Surface texture analyses
The number was provided to each disc sample for keeping the identity to determine the texture of the surface. The surface texture was analyzed for each specimen via a digital optical roughness tester to measure the baseline roughness average (Ra) value (surface roughness tester, Bruker Company, America). The discs were treated with the bleaching agent for a time interval mentioned in the instructions followed by the removal of the specimen from the bleaching gel container. All the specimens were undergoing a washing procedure followed by drying and assessment of surface texture for the second time via a digital optical roughness tester. The armamentarium used throughout the experimentation is shown in the figure **(Figure 2)**.

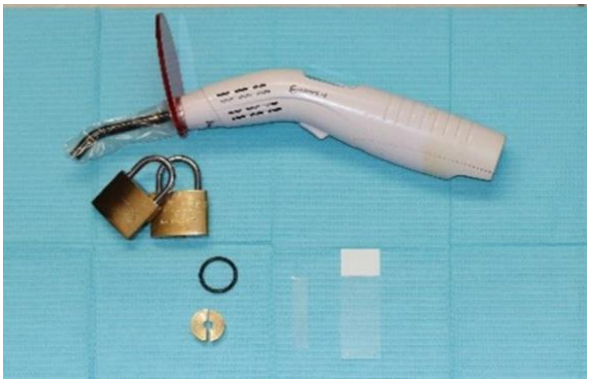

Figure 1. The armamentarium used throughout the experimentation

Statistical analyses
All the data was recorded and tabulated for data analyses using SPSS (Statistical Package for the Social Sciences) software. Assumptions of normality and homoscedasticity were met. Sphericity assumptions do not apply when there are only two repeated measurements. No outliers were detected. A repeated measure mixed model analysis of variance (ANOVA) with one within-subjects factor and two between-subjects factors was conducted to determine whether significant differences exist among Ra before and Ra after between the levels of Resin and Bleaching agent.

Results and Discussion

The means and standard deviation of the two groups are shown in **(Table 1)**. A repeated measure mixed model ANOVA and post hoc tests were applied. The results were examined based on an alpha of .05. The main effect for resin was not significant, F (1, 36) = 0.00, p = .977, representing the levels of resin were all similar for Ra before and Ra after. The main impact for the bleaching agent was significant, F(1, 36) = 4.40, p = .043, representing that there were significant differences in Ra before and Ra after between the levels of the bleaching agent. The interaction effect between resin and bleaching agent was not significant F(1, 36) = 0.58, p = .452, representing there were no significant differences in Ra before and Ra after for each factor level combination of resin and bleaching agent. The main impact for the within-subjects factor was significant, F(1, 36) = 2,601.38, p < .001, representing there were significant differences between the values of Ra before and Ra after. The interaction effect between the within-subjects factor and resin was irrelevant, F(1, 36) = 0.03, p = .873, representing that the relationship between Ra before and Ra after was similar between the levels of resin. The interaction effect between the within-subjects factor and bleaching agent was not significant either, F(1, 36) = 0.17, p = .680, representing that the relationship between Ra before and Ra after was similar between the levels of bleaching agent. The interaction effect between the within-subjects factor and Resin: Bleaching agent was neither significant F (1, 36) = 1.79, p = .189, representing that the relationship between Ra before and Ra after was similar between the factor level

combinations of resin and bleaching agent **(Table 2)** presents the ANOVA results.

Table 1. Mean and Standard Deviation for Ra before and Ra after the application of tested bleaching agents

				Ra Before		Ra After	
				Mean	**SD**	**Mean**	**SD**
Composite Resin	**Packable resin composite**	**Bleaching Agent**	**35% CP Bleaching Agent**	5.14	2.49	100.70	10.08
			16% CP Bleaching Agent	9.50	5.91	101.65	7.77
			Total	7.32	4.95	101.18	8.78
	Flowable Resin Composite	**Bleaching Agent**	**35% CP Bleaching Agent**	5.90	5.28	96.96	16.81
			16% CP Bleaching Agent	8.18	3.12	105.87	8.12
			Total	7.04	4.38	101.42	13.64
	Total	**Bleaching Agent**	**35% CP Bleaching Agent**	5.52	4.04	98.83	13.63
			16% CP Bleaching Agent	8.84	4.65	103.76	8.03
			Total	7.18	4.62	101.30	11.32

Ra=rough average mean, SD=Standard deviation bold value indicates statistical significance, CP= Carbamide Peroxide.

Table 2. Mixed Model ANOVA Results

Source	df	SS	MS	F	p	$\eta_p 2$
Between-Subjects						
Resin	1	0.07	0.07	0.00	.977	0.00002
Bleaching agent	1	346.43	346.43	4.40	.043	0.11
Resin: Bleaching agent	1	45.51	45.51	0.58	.452	0.02
Residuals	36	2,837.18	78.81			
Within-Subjects						
Within Factor	1	177,308.55	177,308.55	2,601.38	< .001	0.99
Resin: Within. Factor	1	1.76	1.76	0.03	.873	0.0007
Bleaching agent: Within. Factor	1	11.78	11.78	0.17	.680	0.005
Resin: Bleaching agent: Within. Factor	1	122.13	122.13	1.79	.189	0.05
Residuals	36	2,453.74	68.16			

Post-hoc

The mean contrasts utilized Tukey comparisons based on an alpha of .05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of between-subject and within-subject effects **(Figure 3)**.

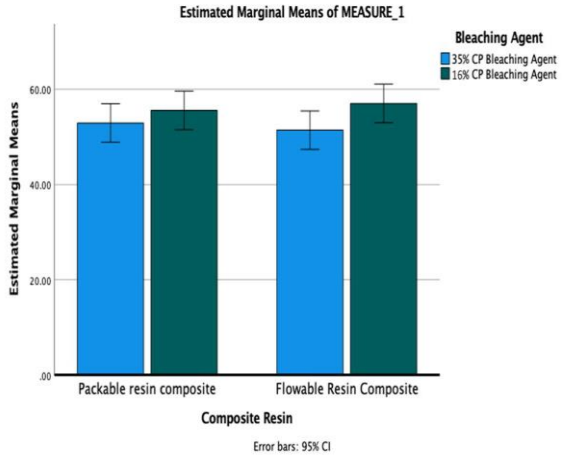

Figure 3. Estimated marginal Means of Ra for studied composite resin and bleaching agents

Between effects

For the flowable resin composite category of resin, Ra before was significantly less than Ra after, $t(36) = -36.18$, $p < .001$. For the packable resin composite category of resin, Ra before was significantly less than Ra after, $t(36) = -35.95$, $p < .001$. For the 16% CP bleaching agent category of bleaching agent, Ra before was significantly less than Ra after, $t(36) = -36.36$, $p < .001$. For the 35% CP bleaching agent category of bleaching agent, Ra before was significantly less than Ra after, $t(36) = -35.77$, $p < .001$ **(Table 3)** presents the marginal means contrasts for the Mixed Model ANOVA.

Table 3. The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Mixed Model ANOVA

Contrast	Difference	SE	df	t	p
Resin|Flowable Resin Composite					
Ra before - Ra after	-94.45	2.61	36	-36.18	< .001
Resin|Packable resin composite					
Ra before - Ra after	-93.86	2.61	36	-35.95	< .001
Bleaching agent|16% CP Bleaching Agent					
Ra before - Ra after	-94.92	2.61	36	-36.36	< .001
Bleaching agent|35% CP Bleaching Agent					
Ra before - Ra after	-93.39	2.61	36	-35.77	< .001

Between effect interactions

For the combination of the flowable resin composite category of resin and the 16% CP bleaching agent category of bleaching agent, Ra before was significantly less than Ra after, $t(36) = -26.46$, $p < .001$. For the combination of the packable resin composite category of resin and the 16% CP bleaching agent category of bleaching agent, Ra before was significantly less than Ra after, $t(36) = -24.96$, $p < .001$. For the combination of the flowable resin composite category of resin and the 35% CP bleaching agent category of bleaching agent, Ra before was significantly less than Ra after, $t(36) = -24.71$, $p < .001$. For the combination of the packable resin composite category of resin and the 35% CP bleaching agent category of bleaching agent, Ra before was significantly less than Ra after, $t(36) = -25.88$, $p < .001$ **(Table 4)** presents the marginal means contrasts for each combination of the between effect interactions and within-subjects factor.

Table 4. The Marginal Means Contrasts for each Combination of the Between-Subject Interactions and Within-Subject Factor for the Mixed Model ANOVA

Contrast	Difference	SE	df	t	p
Resin|Flowable Resin Composite: Bleaching agent|16% CP Bleaching Agent					
Ra before - Ra after	-97.69	3.69	36	-26.46	< .001
Resin|Packable resin composite: Bleaching agent|16% CP Bleaching Agent					
Ra before - Ra after	-92.16	3.69	36	-24.96	< .001
Resin|Flowable Resin Composite: Bleaching agent|35% CP Bleaching Agent					
Ra before - Ra after	-91.21	3.69	36	-24.71	< .001
Resin|Packable resin composite: Bleaching agent|35% CP Bleaching Agent					
Ra before - Ra after	-95.56	3.69	36	-25.88	< .001

Note. Tukey Comparisons were used to test the differences in estimated marginal means.

The hypothesis was rejected because the main effects of resin type and bleaching agent concentration are significantly different.

In the field of esthetics, resin composites are predominantly utilized as dental restorative materials specifically for the mouth region. The increased use of this restorative material is due to various reasons including, its biocompatibility nature, better mechanical properties, and fewer side effects in comparison to amalgam-based restorative materials. Packable composites are frequently used for the restoration of carious and non-carious tooth problems that fall in the III,

IV, and V class cavities. However, flowable composites are predominantly used for the treatment of cavities that lie in category V, and III cavities [16]. Therefore, the current study aimed to identify the impact of home bleaching agents on packable and flowable composite surface texture.

The current study was conducted on the charisma flow and charisma smart resin composites, whereas in the bleaching group, two concentrations of 35% and 16% CP (carbamide peroxide) were used. The surface texture testing revealed that bleaching agents play a significant role in altering resin-based composite surface texture irrespective of the type of bleach and composite nature [17]. As per the ISO (International Organization for Standardization) cut off maximum force exerted on the tooth ranges from 50-250g which might also affect the surface of the dental composite. Continuous tooth brushing is also associated with resin degradation due to the presence of bleaching agents [18]. It was observed that packable composite is resistant to surface degradation from bleaching agents irrespective of its type [19]. On the other hand, the flowable composite was susceptible to surface degradation from bleaching agents irrespective of their type due to less viscosity. It was observed that 35% CP plays a significant role in enhancing surface roughness among both types of targeted composites whereas, 16% of the surface roughness is not significant. This also confirms that an increased concentration of bleaching agents is associated with an increase in surface roughness. Comparable results were also reported where the bleaching agent at certain concentrations also affects the color stability, resin composite, and surface roughness [20]. Furthermore, conventional toothpaste carries polishing and bleaching agents like hydrogen peroxide, silica, pyrophosphates, and carbamide peroxide to lighten the teeth but also enhance the roughness of teeth which results in sensitivity issues. Therefore, pharmaceutical and R&D experts must work in this field to overcome the issue and provide better substitutes.

Özduman *et al.* [21] in their paper, they studied the surface roughness of two different packable composites exposed to different light cure times (10, 20 30 seconds) after and before applying home bleaching agents among 72 samples under the SEM. Results of the study showed there is a significant difference in the surface roughness among all the samples before and after applying the home bleaching agents regardless of the exposure curing light, these findings aligned with our result in this study. Many studies find that the surface roughness increased with the home bleaching kit among the restorative materials; [22] On the other hand, some studies show there is no significant difference in the surface roughness of the restorative materials, and can be used safely [23].

Conclusion

The study confirms that the adverse effects related to bleaching agents (gels) are related to the damage of resin-based restorative dental materials by the increase in roughness after the application from the baseline roughness. The flowable composites were similarly susceptible to the bleaching agents in comparison to the packable composite. The two tested different concentrations of bleaching agents and have similar amounts of increase in surface roughness when applied to the two tested resin-based composites. Further study of different bleaching agents with different restorative material compositions versus different time intervals is recommended.

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