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The Effect of Bleaching Treatment and Tea on Color Stability of Two Different Resin Composites

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ABSTRACT

Aim: The aim of this study was to evaluate the staining susceptibility of two resin composites after bleaching procedure.

Materials and Methods: Twenty four specimens were prepared from GC Kalore (GC Dental, Tokyo, Japan) and Filtek Z550 (3M ESPE, Seefeld, Germany). Twelve of the specimens were bleached with an office bleaching agent (Perfection White, Premier Dental, USA) whereas twelve of them were not. Color measurement was done using reflectance spectrophotometer based on the CIE L*a*b* color scale at baseline. All the specimens were immersed ice tea (Lipton Ice Tea, Turkey) and at the end of 1 and 7 days, color values were obtained again. After tea immersion procedure office bleaching was applied to all specimens and the color values were measured again. Analysis of variance and Bonferroni Correction were used for statistical analysis.

Results: Both resin composites showed color change after a period 1 to 7 days however no significant differences were found between 1 and 7 days immersion ($p>0.05$). Z550 exhibited significantly higher color change than GC Kalore ($p<0.05$).

Conclusion: The results of this study concluded that bleaching treatment did not caused any color change for both restorative groups. However the repeated bleaching procedure which was done following staining protocol had a favorable effect on the elimination of discoloration.

Keywords: *bleaching, resin composite, color, discoloration*

ÖZET

Amaç: Bu çalışmanın amacı beyazlatma tedavisinin iki farklı rezin kompozitin renklenmesi üzerine etkisini değerlendirmektir.

Gereç ve Yöntem: GC Kalore (GC Dental, Tokyo, Japan) ve Filtek Z550 (3M ESPE, Seefeld, Germany) kullanılarak yirmidört adet örnek hazırlanmıştır. Örneklerin on iki tanesine ofis tipi beyazlatma (Perfection White, Premier Dental, USA) yapılırken, kalan on iki örneğe yapılmamıştır. Spektrofotometre kullanılarak CIE L*a*b* renk aralığında başlangıç renk ölçümleri yapılmıştır. Tüm örnekler ice tea (Lipton Ice Tea, Turkey) içinde bekletilmiş, 1. ve 7. gün sonunda renk değerleri tekrar elde edilmiştir. Çayda bekletme prosedürü sonunda tüm örneklere ev tipi beyazlatma uygulaması yapılarak renk ölçümü yapılmıştır. İstatiksel analiz için Varyans analizi ve Bonferroni düzeltmesi kullanılmıştır.

Bulgular: Her iki rezin kompozitte 1. ve 7. gün sonunda renk değişimi olmuştur fakat 1. ve 7. gün yapılan ölçümler arasında istatiksel olarak anlamlı bir farklılık yoktur ($p>0.05$). Z550'nin renk değişimi GC Kalore'den istatiksel olarak anlamlı derecede yüksektir. ($p<0.05$).

Sonuç: Bu çalışmanın sonuçları ev tipi beyazlatma tedavisinin her iki restoratif grubunda renk değişimine etkisi olmadığını göstermiştir. Fakat renklenme sonrası tekrarlanan beyazlatmanın renklenmesinin giderilmesine olumlu etkisi olmuştur.

Anahtar Kelimeler: *beyazlatma, rezin kompozit, renk, renklenme*

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INTRODUCTION

Advancements in adhesive dentistry have resulted in the development of resin based composite materials which are most commonly used anterior esthetic restorative materials in contemporary dentistry. During the last two decades, the use of resin composites for aesthetic restorative procedures has increased. For anterior teeth, direct laminate veneer applications with resin composites are usually quick, inexpensive and easy to repair compared to ceramic veneers and they can provide acceptable esthetic results.[1] Esthetic restorative materials must simulate the natural tooth in color, translucency and texture.

However, a major disadvantage of these materials is discoloration after prolonged exposure to the oral environment. Resin composites undergo a series of physical changes as a result of the polymerization reaction and the subsequent interaction with the oral environment.[2] Discoloration is a multifactorial phenomenon and can be caused by intrinsic and extrinsic factors. Intrinsic factors involve the discoloration of the resin material itself, it is permanent and related to polymer quality, type, quantity of inorganic filler and the type of accelerator added to photoinitator system.[3] The intrinsic color of esthetic materials may change when materials are aged under various physical-chemical conditions such as thermal changes and humidity.[4] Extrinsic staining depends on the individual's diet, hygiene, and the chemical properties of the composite.[5] The discoloration is mainly caused by colorants contained in beverages and foods through adsorption and absorption. Several studies *in vitro* have demonstrated that common drinks and food ingredients, such as coffee, tea or red wine,[6] fruit juices,[7] cola drinks[8] could cause significant change in surface color of the composite resin materials. Extrinsic discoloration is an important factor affecting the color stability and long term success of composite resin restorations, which highlights the needs for dental researchers and material scientists to improve the resistance to discoloration of new resin-based materials for esthetic restorations.

Tooth bleaching is popular procedures that can be prone to overuse in an attempt to achieve a whiter tooth color. Dentists are experiencing an increased demand for tooth bleaching from patients. This demand has led to bleaching systems, such as vital tooth bleaching that can be done in the office by the clinician using high concentrations of hydrogen peroxide or a different treatment done at home by the patient with lower concentrations of carbamide peroxide. During the bleaching treatment, not only do these materials contact teeth but also restorative materials for extended periods of time. As discoloration of resin based composites is a common problem, studies also investigated the effect of bleaching agents on surface micro hardness, roughness, and color stability of adhesive restorative materials.[3,9,10] The initial color match of a light-polymerized restoration may be established however it could be changed. Long-term color changes could occur because of surface staining, marginal staining, micro leakage, wear-dependent surface changes, and internal material deterioration. Drastic color changes to existing restorations may compromise esthetics; therefore it is important to understand the effect of bleaching agents on the color of restorative materials. The purpose of this study was to evaluate the staining susceptibility and color stability of two resin composite bleached with 35% hydrogen peroxide office bleaching agent. The null

hypothesis of the study was that bleaching did not have a favorable effect on the color differences of stained resin composites.

MATERIAL AND METHODS

Restorative Materials, Staining Agent and Bleaching System

Restorative materials to be evaluated for their color stability were namely: a nano-sized hybrid resin composite with new monomer technology from DuPont (GC Kalore, GC Dental, Tokyo, Japan) and a nanohybrid universal resin composite (Filtek Z550, 3M ESPE, Seefeld, Germany). Ice Tea (Lipton Ice Tea, Turkey) was served as the staining agent. An in-office 35% hydrogen peroxide bleaching agent (Perfection White, Premier, USA) was used for bleaching treatment. Other details concerning the materials used in this study (e.g., composition and lot number) were listed in Table 1.

Specimen Preparation

Twenty four specimens were prepared for two restorative materials using teflon molds (5 mm in diameter and 2 mm thickness) and placed on a glass plate with Mylar strip. The moulds containing slightly over filled composite resins were covered by a second mylar strip and glass plate. Finger pressure was applied to the covering glass plate to expel excess materials and create a smooth surface. The resin composites were then polymerized in a LED light curing unit (Elipar Free Light, 3 M ESPE, AG, Germany, 1007 mW/cm^2) for 4 min to allow thorough polymerization. The discs were removed from the moulds, stored in distilled water for 24 h at 37^{0}C to ensure complete polymerization. Afterward, all the specimens were polished with Sof-Lex (3M ESPE, St. Paul, MN, USA) polishing discs in sequences of 4 from coarse to superfine using a slow-speed hand piece under dry conditions for 30 s. After each polishing step, the specimens were thoroughly rinsed with water for 10 s to remove debris, air dried for 5 s, and then polished with another disc of lower grit for the same period of time as a final polishing.

Table 1. *Characteristics of materials used in the study*

Materials		**Manufacturer** type	**Properties**		**Batch Number**
			content		
Resin composites	Filtek Z 550 (A2)	(Filtek Z 550 3M ESPE, Seefeld, Germany)	nanohybrid	BIS-GMA, UDMA, BIS-EMA, PEGDMA, TEGDMA	N286648
	GC Kalore (A2)	(GC Kalore, GC Dental, Tokyo, Japan)	nano-sized hybrid	Urethane Dimethacrylate (UDMA), Urethane Dimethacrylate (Dupont), Bisphenol A polyethoxymethacrylate, Camphorquinone	003578 1005141 2013-05
Bleaching system	Perfection White	(Perfection White, Premier, USA)	35% hydrogen peroxide bleaching agent		Pw 102510
Staining solution	Ice Tea	Lipton Ice Tea, Turkey	Tea served as cold		35-00010

Bleaching Process

The test protocol is shown in Figure 1. The specimens in each restorative material groups were divided into two groups according to receive bleaching or not (n=12). The specimens in one group of each restorative material were bleached with an office bleaching agent (Perfection White, Premier Dental, USA). One side of the specimens was coated with translucent nail polish. The bleaching agent was painted on the top surface of the specimen for 2 mm thickness according to the manufacturers' instructions at room temperature. The bleaching gel was leaved for 15 minutes on the specimens then rinse from the specimens. This procedure was applied four times then the specimens were rinsed with tap water for 1 minute to remove the bleaching agents, blotted dry, and stored in distilled water at 37^0C. A repeated bleaching was done for all specimens after 7 days immersion.

Staining Process

The specimens of each groups were individually immersed in 300 mL of Ice Tea (Lipton Ice Tea, Turkey) for 7 days at room temperature. The vials were sealed to prevent the evaporation of the solutions and the solutions were renewed daily.

Assessment of Color Change

Color measurement was done at baseline, after 1 and 7 days immersion and repeated bleaching using reflectance spectrophotometer (Vita Easyshade Compact, Vident, Canada) based on the CIE L*a*b* color scale against a white background. The color differences (ΔEab*) between the 4 measurements were calculated as follows:

ΔEab*=[(ΔL*)2+(Δa*)2+(Δb*)2]1/2

Where L* is lightness, a* is green-red (-a*=green; +a*=red), and b* is blue-yellow (-b*=blue; +b*=yellow).

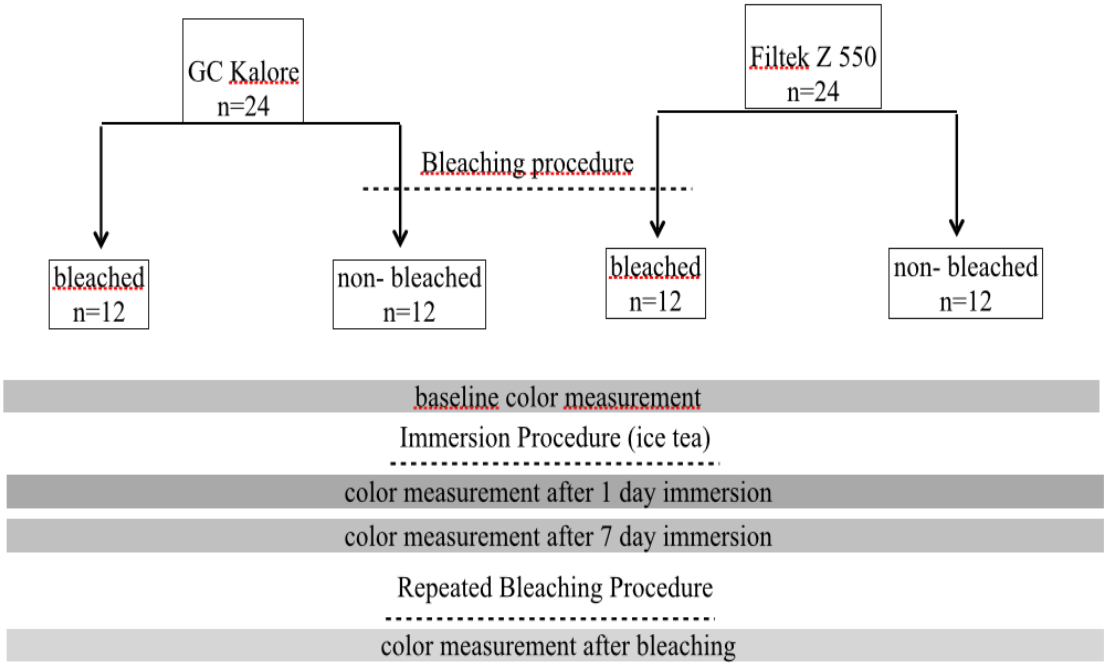

Figure 1. *Flow chart of the study*

Statistical analysis

A perceptible discoloration that is ΔEab * >1.0 will be referred to as acceptable up to the value ΔEab *= 3.3 in subjective visual evaluations made *in vitro* under optimal lighting conditions.[3] All comparisons of color change for bleaching and immersion periods were subjected to repeated measurements of analysis of variance ($p<0.05$) and the significant color changes (delta E*) occurred during immersion in different time intervals were tested with Bonferroni Correction.

RESULTS

Results of this *in vitro* study were summarized in Table 2. Bleaching treatment did not caused any color change for both restorative groups. Both resin composites showed color change after a period 1 to 7 days however no significant differences were found between 1 and 7 days immersion in staining solution ($p>0.05$). Z550 exhibited significantly higher color change than GC Kalore ($p<0.05$). Discoloration of the specimens after 1 and 7 days immersion in ice tea was recognized by naked eye. A limit of ΔEab * >3.3 was interpreted as a clinically acceptable difference in this study. Repeated bleaching procedure after the staining protocol had a favorable effect on the color differences of two resin composites.

DISCUSSION

Discoloration of composite resin remains a major cause for the esthetic failure of materials and this can be a reason for the replacement of restorations in esthetic areas. Once staining occurs, repolishing and bleaching procedures are presumed as whitening procedures can partially and totally remove stains.[11] Bleaching has become a routine treatment for improving esthetics. However, it is unavoidable to prevent restorations from bleaching agent exposure during bleaching treatments. Therefore, it was decided to investigate the effects of bleaching agents on the staining susceptibility of resin composites. As it had been mostly reported that bleaching increases the surface roughness of resin composites,[9,12,13] it might be expected that composite restorations would stain more easily after bleaching because rough surfaces mechanically tend to retain surface stains more than smoother surfaces.[14] Although, in the present study, bleached specimens showed similar color differences with non-bleached specimens groups after the immersion procedure.

According to Fontes et al[15] the pigmented layer of the composite (~40 mm) or the absorbed stains could theoretically be removed by polishing. Garoushi et al[11] was compared repolishing and bleaching procedures on the color differences of stained resin composites and observed a superior whitening effect with repolishing technique compared to bleaching. However, Fay et al[16] suggested that discoloration of resin composites can be partially removed by in-office bleaching and repolishing procedures. In the present *in vitro* study we had already observed that repeated bleaching procedure after the staining protocol had a favorable effect on the color differences of two resin composites. The discoloration observed after repeated bleaching procedures were higher 3.3 value which reported as threshold for the clinically unacceptable restorations. Thus the null hypothesis of the study was regretted.

Visual color assessment is a combination of physiological and psychological responses to radiant-energy stimulation. Alterations in perception can occur as a result of a number of uncontrolled factors, such as fatigue, aging, emotions, lighting conditions and

metamerism.[17] The use of spectrophotometers and colorimeters to quantify tooth color could potentially eliminate the subjective aspects of color assessment. In our laboratory study we used spectrophotometer (Vita Easyshade Compact, Vident, Canada) based on the CIE L*a*b* to assess the color differences. The ΔE value represents relative color changes that an observer might report when evaluating adhesive restorative materials. In dentistry, it has been reported that value ΔEab* of 3.3 is the critical value for visual perception.[18] In our *in vitro* observation it was found that after immersion in staining solution procedures, majority of tested groups had perceptible color changes (ΔEab* between 2,44 and 12,83). It could also been concluded that ice tea had a visually perceptible staining effect on GC Kalore and Filtek Z550 specimens.

It was revealed in the literature that the amount of color change of resin composites after bleaching procedures may be related to the materials' matrix content, filler type, and volume.[12] According to the data of our investigation, GC Kalore specimens showed higher ΔEab* than Filtek Z 550. The nanoybrid resin composite Filtek Z 550 includes bisphenol A-glycidyl methacrylate Bis-GMA in addition to the monomer Urethane Dimethacrylate (UDMA) that provides higher resistance to staining susceptibility. The lower ΔEab * values of GC Kalore also could be related to the monomer ingredient UDMA with a new monomer technology from DuPont.

There were some limitations in the current study that should be noted. Undoubtedly, 1 and 7 days of exposure periods could be highly unlikely to be reached during the normal consumption of beverages. Under clinical conditions, the pattern of staining solutions on restorative materials may be different. The other limitation is the lack of the determination of possible color mismatch on teeth restored with composites. Because teeth also become lighter and brighter as a result of bleaching, spectrophotometric evaluation of teeth restored with composites is indicated to gain more insight into the clinical relevance of color changes of these restoratives. In the present study it could be thought that bleaching procedures bleach the specimens instead of only removing the exterior staining from resin composites. It could be also revealed similar with an another literature that after bleaching, the composite resin restoration may not match the surrounding bleached tooth structure.[19] In addition to these we only evaluated just A2 shades of both materials; thus, the results may not be applicable to other shades.

CONCLUSIONS

Within the limitations of this *in vitro* study the following conclusions were drawn.

1) Bleaching procedures did not affect the staining susceptibility of two tested resin composites.

2) The UDMA monomer ingredient could lead the lower staining of nano hybrid resin composite tested.

3) Repeated bleaching procedures could be accepted as an alternative solution just for external staining of resin composites and patients should be advised that existing composite restorations may not match the natural teeth after bleaching, and replacement may be required.

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