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Comparative Evaluation of the Spectrophotometric Effect of External Bleaching on Natural Teeth and Composite Restoration (Omnichroma Resin)

F. Abdul Razzaq (DDS, MS)[*1], M. Mohamed Refaat (DDS, MS)[2], R. M. Al-Badr (PhD)[3]

1.Department of Conservative and Aesthetic Dentistry, College of Dentistry, University of Basrah, Basrah, Iraq.

2.Department of Prosthodontics, College of Dentistry, University of Basrah, Basrah, Iraq.

3.Department of Basic Sciences, College of Dentistry, University of Basrah, Basrah, Iraq.

•Corresponding Author: F. Abdul Razzaq (DDS, MS)

Address: Department of Conservative and Aesthetic Dentistry, College of Dentistry, University of Basrah, Basrah, Iraq.

Tel: +964 (773) 8399266. **E-mail:** farah.abdulrazzaq@uobasrah.edu.iq

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ABSTRACT

Background and Objective: In recent years, bleaching materials have been used in many clinics, which may have different effects on natural teeth and composite restorations (omnichroma). The aim of this study is to determine the spectrophotometric effect of external bleaching on natural tooth structure and composite restoration.

Methods: In this study, cavities were first created on 26 extracted teeth, and then, omnichroma composite restorations were completed for all these teeth. The color of each tooth sample was evaluated with a colorimeter device. Measurements were obtained before the application of the bleaching agent for initial lightness (L0), after the bleaching agent's first application (L1), and after the second application of the bleaching agent (L2). Total color change difference (ΔE) values between the restorations and natural tooth during first (ΔE1) and second (ΔE2) treatment intervals were compared.

Findings: This study found that, as lightness values between natural tooth and composite were compared, there are changes of lightness value; L1 (p=0.000) and L2 (p=0.006) showed that there is a significant difference in lightness value (L) between natural tooth and composite restoration during the first and second treatments. However, the comparisons of total color change (ΔE) found no substantial differences between the composite restoration and natural tooth structure during the first and second treatment intervals ΔE1 (p=0.479) and ΔE2 (p=0.821).

Conclusion: According to the results of this study, the value of ΔE decreased significantly from L0 to L2 bleaching treatments. As the tooth becomes brighter, it is clear that there is less of a color difference between the omnichroma restoration and the tooth structure.

Keywords: *Omnichroma, Hydrogen Peroxide, Bleaching, Shade, Natural Tooth Surface, Composite*.

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Introduction

The huge esthetic success of direct resin composite restoration depends strongly on its optical appearance and color matching with the natural dental structure surrounding it; to render an imperceptible restoration, composite restoration materials should mimic the color of a natural tooth and maintain stability in color for a long time with resistance to future discoloration (1). Many parameters may affect the stability of composite restorative materials shade, like the manufacturer of composite, volume of restoration, size, and types of composite filler particles, and the agents of coloring. Also, food accumulation, smoking habits, and absorption of stain soluble in water by the composite organic matrix lead to extrinsic restoration discoloration (2).

By using toothpaste and brush, teeth polishing, and whitening methods, many stains can be completely or partially removed. One of the simple, affordable, and effective teeth-whitening techniques is bleaching, which is now a common treatment option at dental offices. The appearance of dark teeth can be lightened with the application of bleaching chemicals, but it also has the potential to alter the color of any existing composite that may be present on these teeth (3-5). Also, the bleaching agent's softening effects may result in alterations in the material of restoration, which ultimately affect their clinical durability (6-8). With the introduction of nanotechnology to the field of dental restorations, nanohybrid composites have been used as dental restoration materials due to their great characteristics. Nevertheless, there is a huge controversy regarding their shade stability following bleaching procedures (9). For this reason, this study considered the changes in the shade of omnichroma composite restorative material after bleaching by 40% hydrogen peroxide bleaching agent. The null hypothesis suggests that bleaching will not change the shade of the tested composite samples. The purpose of the study is to determine and compare the spectrophotometric impact of external bleaching on both the omnichroma-estelite composite and the natural tooth structure.

Methods

The research was submitted to the analysis of research Ethics and Scientific Committee at the collage of dentistry/university of Basrah and after approval, it was registered under the protocol of the collage research plan number BDC-7-049-22-3. Twenty-six previously extracted teeth were included in this experimental study. Each of the chosen teeth was sound, and teeth with caries, crack, or fracture were excluded. Each chosen tooth was autoclaved in distilled water and a glycerin solution (Equate, Wal-Mart Stores Inc. AK, USA). Throughout the course of the experiment, a moist piece of special cotton was used to rub each tooth that was kept in a particular compartment within a tube. Then, in order to speed up the process, these samples were put into a numbered slot made of silicone putty (Vonflex polyvinyl siloxane, Korea) (Figure 1).

Figure 1. The samples on the modified slots to facilitate their manipulation

The study of Braun, et al. was used to help with the study design (10). To match a standard class V cavity preparation, Cl V cavities were prepared in all selected teeth (26 samples), and each cavity preparation was established using a diamond round bur size 19.0/1.6 (Diamond burs, China). Using a marker, the clv cavity's dimensions were recorded as 5 mm in the mesiodistal direction, 4 mm in the occlusogingival direction, and 1.5 mm in the axial direction (11).

To all samples over the created cavity, the universal bond (3M ESPE, Universal adhesive, Germany) was applied in accordance with the manufacturer's instructions. After that, omnichroma composite resin (Tokuyama Dental Company, Japan) was used for restoring the cavity of prepared samples. According to the manufacturer's recommendations, each composite restoration was cured for 20 seconds under an LED light (3M ESPE firm, Elipar deep cure). These composite restorations were refined using needle finishing burs (Kit Composite burs, China), and for finishing and polishing, a two-step polishing system (EVE ECOCOMP, Germany) was employed. In the initial group (G0), both the color of the composite dental restoration and the color of the surrounding natural tooth structure were measured using easy shade VITA device (vivadent company, Germany). Each reading's L, a, and b results were noted. Based on previously recorded shade on the same marked dimension of clv cavity after omnichroma restoration placement, the shade recordings were done on 10:00 pm. In a room with standardized lights, samples were put on a white background to eliminate the light difference effect. The same 26 samples were used in the first application group (G1), which used Power Whitening Gel with a 40% H_2O_2 Concentration (White Smile Company, Germany) on the labial side of tooth/composite restoration. The power bleaching agent washed off after 20 minutes, and the previously described simple shade device promptly recorded the shade. The shades were recorded again after the first and second whitening gel applications (the latter is the second application group G2). The variable ΔE^* was determined using the formula below (12):

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

a= red-green axis on Cie lab system, b= blue-yellow axis on Cie lab system

Data analyses were completed using SPSS computer software (SAS Institute, NC, USA). With the help of a 2-sample paired t-test, the hues were compared between treatment groups. L and ΔE value of the natural tooth and composite restoration was calculated from 0 and 1st to 2nd bleaching applications. Using a paired t-test, ΔE values from each teeth-whitening interval were compared. L values including L0, L1, and L2 related to the natural tooth and composite restoration tooth were compared using pairwise comparisons to analyze differences between their L and ΔE at each whitening treatment interval. There is statistical significance if $p \leq 0.05$.

Results

According to the statistical analysis, table 1 illustrates Mean and the Standard Deviation of the natural tooth structure and composite restorations.

Table 1. The mean and standard deviation of composite restorations and the natural tooth anatomy

Pairs	Tooth Mean±SD	Composite Mean±SD	p-value
L0	79.63±5.13	85.49±2.71	0.000
L1	82.31±5.03	86.56±3.10	0.000
L2	79.84±3.25	87.78±2.86	0.006
ΔE2	4.77±2.44	4.90±2.29	
ΔE1	3.75±2.23	4.12±2.31	

Table 2 clarifies a pairwise comparisons between (L) of the natural tooth structure and composite restorations during the three stages of treatments. It's obvious on table 2 that, tooth L0 differs significantly from tooth structure L1 ($p<0.006$), while composite L0 differs significantly from composite L2 ($p<0.001$).

Table 2. Pairwise comparisons between the L of the natural tooth structure and composite restorations during the three stages of treatments

Sample	Stage	Mean±SD	Stages	Pairwise comparisons	
	L0	79.635±5.13		L1	L2
Tooth	L1	82.319±5.03	L0	0.006	1.000
	L2	79.846±3.25	L1		0.869
	L0	85.496±2.71		L1	L2
Composite	L1	86.562±3.10	L0	0.238	0.001
	L2	87.785±2.86	L1		0.205

It is obvious that there is no significant difference between tooth ΔE1 and tooth ΔE2 ($p=0.148$), and color changes are similar (ΔE1 and ΔE2) in both teeth. Also, there is no significant difference between composite restoration ΔE1 and composite restoration ΔE2 ($p=0.077$), and restoration colors change (ΔE1 and ΔE2) are similar too.

There is no significant difference between tooth structure Δ E1 and composite ΔE1 ($p=0.479$), and these colors are identical. Also, there is no significant difference between tooth structure ΔE2 and composite ΔE2 ($p=0.821$). Color change of tooth structure ΔE2 and composite ΔE2 are identical too.

Discussion

The null hypothesis stated that the color of composite restoration materials was unaffected by the use of bleaching agents. The results of the previous experiment, which showed that bleaching causes a change in the color of both natural teeth and composite restorations, reject the null hypothesis. By using a colorimeter, this was assessed. After measurement performed with the colorimeter, when comparing the results of the first and second H_2O_2 bleaching treatments, a substantial reduction in the ΔE of the tooth structure to the composite restoration was discovered, illustrating that the color match between the restoration and natural teeth improved after the bleaching procedure. Each variable at each time interval was examined using the VITA Easy shade 4.0, and it was evident that at 1st treatment interval, the L1 of the treated tooth structure was statistically significant, while the composite restoration was non-significant. This clarifies that the tooth's natural structure bleached more successfully than the composite filling did, and the rate at which the tooth becomes lighter was not proportional to the rate at which the restoration appears lighter; this totally agreed with Evans' study (2020) (11).

A plausible explanation for this study's data process could be found in the way by which dental structure whitening functions (13-15). The absence of hydroxyapatite crystals within the composite restoration could mean that the tooth is actively being whitened while the resulting color change in the restoration is due to the surrounding change in enamel/dentin color, which could explain why the bleaching action on composite restoration during the first treatment interval may be delayed; this was in agreement with Swift's study (16), who discovered that bleaching chemicals do not change the shade of tooth-colored restorations themselves. According to Kim et al. (17), the effect of tooth bleaching film and strip on the color of the dental composite was deemed to be negligible. During the second treatment, there was a significant change in the lightness of restoration, and it is imperative to underline the therapeutic significance of the interaction

between bleaching chemicals and restorative dental materials; this study's whitening material system was chemically activated with 40% hydrogen peroxide. Hydrogen peroxide material is considered a strong oxidizing material that generates free radicals with extensive penetration and diffusion ability on the surface of composite dental restorative materials, reducing polymer network degradation. Because of that, a composite resin restoration containing higher resin is expected to be more liable to color change and degradation (18).

Our study's findings are consistent with numerous investigations who found that bleaching treatments changed the shade (lightness) of resin composites to a level that is clinically acceptable. This explanation is provided by another study by Monaghan et al. (19), which asserted that the composite resin color was influenced by the extremely concentrated office bleaching agent. These studies attributed the findings to the bleaching material's surface effect on the specimens, not to interior bleaching (20, 21). In contrast, other studies stated that whitening agent with a high H_2O_2 concentration results in high shade change ($\Delta E>3.3$) for the examined materials and their findings demonstrate that high concentrations of hydrogen peroxide may have the physical and chemical properties of composite restorative materials that lead to shade change (1, 22). Such huge data differences suggest that tooth color restorative materials may be liable to change by the usage of the bleaching chemical materials (23).

The disparities between these studies can be attributed to the variations in their experimental designs, the whitening material applied (24), and the type of composite restorative materials used (25). The frequency of the applied whitening material may also be related to the disparity between the findings of the related studies (26).

During the second application, there was a non-significant change of L of the natural tooth structure that may be explained by the bleaching action time; bleaching process needs more time to give a lighter color, which is in agreement with Bersezio et al, (27) who found significant differences in ΔE (including the L factor which have a great effect of the color) measured in all follow-up time points during the 1st weak, the 1st month and the 2nd year. Our study results show that the natural tooth becomes lighter (higher L* VALUE) compared to composite restoration.

Table 3 illustrates a non-significant difference between ΔE of the dental restoration and natural tooth structure at 0, 1st and 2nd bleaching procedure, which demonstrates the composite restoration ability to modify its color, allowing a patient to go for external dental bleaching while lowering the possibility of a discernible composite shade difference with the whitened tooth structure; this agreed with Evans et al, 2020 (11).

There is no detectable final shade difference between the tooth structure and composite restoration in this study (non-significant difference of delta E^*), since delta E includes many factors L, a, and b that produce the shade of the tooth structure. From these findings, omnichroma composite restoration can change its shade according to the shade of the natural tooth after external bleaching application.

According to the results of this study, comparing tooth structure to omnichroma composite, tooth structure bleaches more efficiently. The color of the composite Omnichroma resin may change after bleaching the neighboring tooth structure. Further investigation regarding the effectiveness of different bleaching modalities is required.

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