Effect of a Chemically-Activated Versus Light-Activated Bleaching Agents on Color Stability of Different Resin Composite Filling Materials

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Abstract:

***Objectives*:** To evaluate and compare the effect of chemical and light activated teeth bleaching agents on color stability of three different resin composite restorative materials.

Material and methods: The materials tested include one Nanofilled (Filtek Z350 XT - 3M ESPE), one Nanohybrid (Tetric–N–Ceram - Ivoclar vivadent), and one Microhybrid resin composite (Herculite Classic – KERR). From each material, 20 cylindric specimens were prepared according to the manufacturer's instructions using specially designed Teflon mold (diameter 10 mm and thickness 2 mm), finished and polished. A baseline color measurements were assessed for all the specimens using spectrophotometer (*Vita Easyshade)*. From each material, half of the specimens (n=10) were exposed to chemically activated teeth bleaching agent (Power Whitening YF 40% HP (mixed 32% HP) - WHITE smile GMBH), however the other half exposed to light activated one (Light whitening AC (Mixed 32% HP)- WHITE smile GMBH). A second color assessment were done after bleaching procedures. The data were analyzed using The Kolmogorov-Smirnov test to verify the normality of distribution, Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

Results: There was color change of all groups after bleaching regardless of bleaching material, but that change not detected by naked eye as $\Delta E < 3.3$ for all groups. There was significant difference between two bleaching agents used regardless of composite type. Color change between composite types was non significant different regardless of bleaching type. Nanofilled resin composite showed the lowest color change followed by microhybrid and nanohybrid resin composites.

Conclusion: Teeth bleaching doesn't significantly affect the color of resin composite restorations, that color change not detected by naked eye. Light activated bleaching agents have higher effect than chemical activated bleaching agents.

Key words: Chemical Bleaching, Light bleaching, Microhybrid composite, Nanofilled composite, nanohybrid composite, spectrophotometer

Introduction

Nowadays 'brighter teeth' is the greatest esthetic demand for dental patients and also a crucial factor for an appealing appearance , tooth bleaching is a moderately non-invasive method for attaining this objective(1,2) Tooth color can be improved by a number of methods and approaches.(3) Through the increasing awareness of esthetic choices, there is a bigger claim for resolutions to such unappealing difficulties. Bleaching agents have been acknowledged by the patients as a more preservative and cost-effective technique of improving the look of teeth.(4)

The esthetic characteristics of a present restoration has a major effect on its clinical success.(5,6) Color matching of resin composite restorations with the tooth color is good due to the increase in the number of available color shades.(7) The progress of composite resins which esthetically imitate human dentin and enamel regarding to fluorescence, opacity, and color has been an important influence to restorative dentistry.(8) Improper color match is a main cause for composite resin restorations replacement since the restoration is needed to keep its natural look with adjacent for long time.(9,10)

Color alteration and subsequent damage of the match between the shade of composite restorations and the shade of adjacent teeth is possibly the most common cause for replacement of restoration subsequent to bleaching.(11) Bleaching materials with high concentrations changed the shade of resin composite. Generally, the bleaching materials are capable of providing tooth shade alteration and also may result in alterations in surface and shade of resin composite restorations present in the teeth.(12)

Conflicting opinions and a wealth of contradictory data present difficulties for dentists in choosing which resin composite materials for restoration and bleaching agent for whitening of teeth. So, study the effect of teeth bleaching agents on color stability of resin composite filling materials.

2. Materials and methods:

2.1 Materials

Three types of resin composite restorative materials with uniformed shade enamel A3 were used in this study; Microhybrid (Herculite Classic, KER Scafanti, Italy) Nanohybrid (Tetric–N–Ceram, Ivoclar vivadent, Liechtenstein) and Nanofilled (Filtek Z350 XT, 3M ESPE, USA) beside two available in office bleaching agents, chemically activated bleaching system(Power Whitening YF 40% HP WHITE smile GMBH, Germany) and light activated bleaching system(Light whitening AC, WHITE smile GMBH, Birkenau, Germany) were selected for this study.

2.2 Preparation of the Specimens

A standardized Sixty specimen shaped specimens of A3 enamel shade with diameter 10 mm and thickness 2 mm, twenty from each resin composite restorative material were prepared in a specially fabricated Teflon mold. Thumb pressure done on the glass slide to get the excess of composite out from the mold and give smooth surface. All specimens then cured using LED light curing device with an intensity of 1200mW/cm2 (Elipar, S10, 3M ESPE) Curing done for 20 seconds from top to be sure of fully curing. Each composite type specimen were stored in distilled water in dark jar for 24 hours for complete polymerization and allow thorough leaching of any non-polymerized resins and establish an equilibrium in water uptake. After 24 hrs storage specimens were

finished and polished using low speed handpiece with standardized rpm and time using sof-lex spiral finishing and polishing kit (3M ESPE, USA).

2.3 Grouping of specimens

Specimens were randomly subdivided into two subgroups which contain 10 specimens. First subgroup specimens were subjected to light activated in-office bleaching material, while the second subgroup specimens were subjected to chemically activated in-office bleaching material.

2.4 Baseline measurement

Initial color measurements were done using vita easy shade spectrophotometer (Vita Easyshade, Vita Zahnfabrik, Bad Säckingen; Germany). Each specimen was measured twice against a white background and the average values of L*, a*, and b* were calculated Mean values for each specimen were tabulated as initial values.

2.5 Application of bleaching agents

For chemically activated bleaching system, the bleaching gel was injected over the specimen using automix syringe tip which supplied with the bleaching kit. Bleaching gel stayed over the specimen for 15 minutes. After 15 mins the bleaching gel was removed by high volume suction. These steps were repeated three times following the manufacturer instructions. Total application time was 45 mins.

For light activated bleaching system, light activation device was used for activation of bleaching gel (WhitenMax BR800, Monitex industrial co., New Taipei City, Taiwan) After the third time plastic syringe was used in rinsing specimens with distilled water using air water spray for standardized time (one minute) to wash all bleaching gel from the specimens. After bleaching processes all specimens were stored in distilled water +for 48 hrs to rehydrate

2.6 Color assessment

Final color measurements done to all specimens after bleaching following the same standardized steps followed in the baseline measurements in the same place and light effects to standardize all effects. Mean L*, a*, and b* values were calculated for every specimen and the total color change before and after was calculated using the equation

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

Where ΔL^*, Δa^*, Δb^* are the changes in the L*, a* and b* values after the second measurement respectively.

2.7 Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

3. Results

3.1 Regression analysis using two way analysis of variance (ANOVA) was performed to show the effect of both variables "resin composite material and bleaching system" it revealed that the effect of bleaching system on the color change (ΔE) values was statistically significant ($p < 0.05$) as shown in table (1).on the other hand the effect of resin composite type on the color change(ΔE) values was statistically non significant. In addition to that, the interaction between the two variables was also statistically-non significant ($p > 0.05$).

Table (1): Two way ANOVA showing significant effects of both variables on ΔE, and significant interaction between the two variables

Source of variation	df	SS	MS	F	p
Type of bleaching	1	29.619	29.619	61.448	<0.001*
Type of composite	2	1.261	0.630	1.308	0.279
Interaction	2	0.553	0.276	0.573	0.567

df: Degree of freedom SS: Sum of square MS: Mean square

***: Statistically significant at $p \leq 0.05$**

3.3 Color change (ΔE) results for all groups

The mean (ΔL^*), (Δa^*), (Δb^*) and (ΔE) values for different groups are presented in table (2) Tukey's post-hoc multiple comparison test revealed that the three light bleached groups were significantly different compared to chemically bleached groups but statistically non significant within the group. Firstly Nanohybrid composite bleached with light activated bleaching (BL) exhibited the highest mean color change with a mean ΔE value of (2.88 ± 0.41) and mean ΔL^*, Δa^* and Δb^* values of (-1.80), (-0.05) and (2.08) respectively. This was followed by Microhybrid composite exposed to the light activated bleaching with mean ΔE value of (2.82±0.43) and mean ΔL^*, Δa^* and Δb^* values of (-0.22), (0.29) and (2.59) respectively. Nanofilled composite exposed to light activated bleaching came next with mean ΔE value of (2.76±0.84) and mean ΔL^*, Δa^* and Δb^* values of (-(1.19), (-0.16) and (2.42) respectively. Finally, the three chemically bleached groups which were non significant with each other in that order nanohybrid, Microhybrid and nanofilled composite with mean ΔE values of (1.72±0.78, 1.40±0.47 and 1.13±1.0 respectively) and mean ΔL^*, Δa^* and Δb^* values of (-1.57, 0.04 and -0.49), (0.09, 0.58 and 1.04) and (-1.06, 0.22 and -0.09) respectively.

Table (2): Mean and standard deviation of ΔL*, Δa*, Δb* and ΔE for different tested groups

	Δl	Δa	Δb	ΔE
Chemical				
Nanofilled	-1.06±0.98	0.22±0.11	-0.09±0.48	1.13a ± 1.0
Microhybrid	0.09±0.48	0.58±0.14	1.04±0.81	1.40a ± 0.47
Nanohybrid	-1.57±0.68	0.04±0.23	-0.49±0.68	1.72a ± 0.78
Light				
Nanofilled	-1.19±0.73	-0.16±0.13	2.42±0.81	2.76b ± 0.84
Microhybrid	-0.22±1.08	0.29±0.23	2.59±0.48	2.82b ± 0.43
Nanohybrid	-1.80±0.83	-0.05±0.28	2.08±0.65	2.88b ± 0.41

Different letters indicate statistical significance between different groups according to Tukey's Post–hoc multiple comparison test.

4. Discussion

Currently dentistry is experiencing a trend of increasing demand from patients for superior dental esthetics. Dental resin composite restorations make their success and popularity from their ability to simulate natural form and color of tooth structure(13,14) According to development of composite materials, several types of composites material are existent. In our study three available types of composite restorations were used (Microhybrid, nanohybrid and Nanofilled), composite materials. Some previous studies evaluated color stability of those types after bleaching application (12,15,16)
There are in-office bleaching and home bleaching, as in-office bleaching contain more concentration of the active bleaching ingredient HP (25-40%)(17)9 it give superior result than home bleaching thus in office bleaching was used to participate in the current study. Other researchers suggested that in-office bleaching reduces the color change of composites restorations due to aging of the restoration and consequence exposure to foods and drinks stains.(18–20) In-office bleaching may be chemically activated or light activated, both of them are still in use. Chemically activated and light activated In-office bleaching agents were used in other studies to evaluate its effect on the change of color of composite resin.12,16,59
The color change is measured by the ΔE value, which is representative for the color difference for either the tooth or the restorative material before and after the bleaching application. Also visual evaluation of shade is subjective and may lack both accuracy and repeatability that can be achieved using electronic methods so imaging system was rolled out. Colorimeters depending on color filters which are subjected to aging by time causing a decrease in repetapilty(28).
On the other hand spectrophotometers allow for more accurate measures as it measures the amount of reflected light over the full spectral wave length(29)89. So spectrophotometers was chosen to measure the ΔE value in the current study in accordance with,(5,10,22,30) In our study Vita Easy shade (Vita Easyshade, Vita Zahnfabrik, Bad Säckingen; Germany) was used as it has higher accueracy and reliability than other types of spectrophotometer (28,31). Also other researchers use the devise in their work(26,32–34)
The CIE L* a* b* color system is sensitive that under uniformly controlled environment a slight change in the ΔE value even by 1 unit can be detected by human eye(35–37) Thus, ΔE is more meaningful than individual L* a* b* values(38).
Our result demonstrated that there were changes in the ΔE value of each group before and after bleaching agent application. Those changes were found regardless of both the type of bleaching agent or the composite used. In all tested groups the color after bleaching was lighter than the color before the bleaching gel application. Although that change was not detectable to the naked human eye as the mean ΔE was < 3.3 for all tested groups. Regardless of the type of composite used there was statistically significant difference between the bleaching agents used. Our result showed that the mean ΔE value of groups exposed to light activated bleaching agents was higher than that for groups exposed to chemical activated agents. So that specimens exposed to light activated bleaching agent showed more color change than that exposed to chemical activated bleaching agent.
That change in the color may be caused by the using of the light source that accelerate the bleaching reaction allowing for more bleaching effect that was expressed by the increasing in ΔE(39). Also the absorption of light energy increase the temperature of the HP which increase its effectiveness. Another possible cause that the light activated bleaching gel used in the current study contained active chlorophyll which is claimed by the manufacturer to enhance the absorption of light energy.
Color change between the three types of composite used in our study regardless type of bleaching agents used was statistically non significant. Although there was non significant change the lowest change in color was for nanofilled resin composite followed by Microhybrid resin composite while the greater change was for nanohybrid resin composite.
The change in color between the three composite groups may be because, the difference in the composition of the composite resins monomer structure, and volume of the resin matrix as well as the

filler which have a significant influence on the color stability of the material.

Our study results found that chemical and light activated bleaching materials changed the color of different resin composites, but that effect not detected by naked eye.

5. Conclusion

Based on the results of the current study, and despite of the limitation of this study, it seems reasonable to conclude the following:

- Color stability of resin composite is influenced by both the type of resin composite and the bleaching system used.
- Nanofilled resin composites are more color stable compared to Microhybrid and nanohybrid resin composites.
- Light activated bleaching agents leads to more detectable color change of resin composite in comparison to chemically activated bleaching agents.

6. Recommendations

- The use of light activated bleaching agents in the presence of composite resins can result in clinically acceptable color changes that may not need replacement of such restorations.
- Further studies are needed to investigate other properties of composite resins in response to bleaching other than color change to reach sound clinical decisions on whether to keep or replace such restorations after bleaching treatment
- Further studies should be applied to test the color stability of different types of resin composites after the application of different types of bleaching at different application times.

Conflicts of interest

None of the authors has any conflicts of interest that should be declared.

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