Full Length Research Paper

Effect of different bleaching methods on stained composites

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This study aims to examine the whitening effect of three different bleaching methods on three different stained composite resins. Forty discs (5 mm diameter × 2 mm thick) from each tested material (ESTHET.X HD micro-matrix Restorative, Dentsply, Paradigm Nano-Hybrid Universal-Restorative, 3M/ESPE, and Artiste Nano-Composite, Pentron-Clinical) were made. The 40 discs of each tested material were immersed in coffee, 3 h a day for 21 days in order to be stained and then divided into four subgroups (n=10): non-bleached subgroup (color changes examined immediately after staining); bleached using Crest 3D-White Whitestrips Advanced Vivid (30 min once a day for 14 days); bleached using Colgate Visible White (30 min once a day for 14 days) and bleached using Pola Paint (30 min twice a day for 14 days). Between bleaching periods, specimens were immersed in artificial saliva. Specimens were tested for quantitative color changes using Quanta Environmental Scanning Electron Microscope. Data was statistically analyzed using three-way analysis of variance (ANOVA) and Tukey's post-hoc test (P ≤ 0.05). Pola Paint did not bleach stained samples effectively as it showed the highest mean color change value (117.47 pixel). Meanwhile, Colgate gel and Crest Strips showed better bleaching and no significant difference was found between them (112.59 and 113.04 pixel, respectively). No significant difference was found between the three tested composites. The result showed that the three tested composites performed similar under the test conditions. The use of Colgate bleaching gel and the Crest 3D-White Strips could effectively eliminate the discoloration that resulted from staining of the tested materials.

Key words: Bleaching, nano-composite, staining.

INTRODUCTION

Nowadays, a major concern for patients is the aesthetic appearance of their anterior teeth. Therefore, resin composites have gained wide popularity as esthetic restorative materials. However, their color may change over time as a result of surface and marginal staining, in addition to intrinsic material deterioration (Schulze et al., 2003; Janda et al., 2004). It was reported that, natural coloring agents as coffee and tea or mouth rinse agents have staining effect on resin composites to varying degrees (Yousef and Abo El Naga, 2012; Ertas et al.,

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Trist different restorative materials (ESTHET.X HD Micro-Matrix, 2006; Bagheri et al., 2005; Fujita et al., 2006).

Previously, microfilled or hybrid formulations were used for anterior composite restorations depending on the need for their use, whether more polishesability or more mechanical properties. Recently, nanotechnology is used to introduce resin composites that combined both high esthetic and high mechanical properties (Yousef and El Naga, 2012). These nano-composites claimed to be similar to ceramics in color stability and gloss retention (Celik et al., 2008).

However, following polymerization reaction, water molecules in the oral cavity get incorporated into the resin composite resulting in mobilization of ions within the resin matrix and leaching out of the unreacted monomers and ions from the fillers and the activators (Braden and Pearson, 1981; Fan et al., 1985; Ferracane, 1994). Subsequently, the stain resistance of resin composite will be reduced significantly (Soderholm et al., 1984; Yap et al., 2000). Therefore, by time, resin composites become easily discolored by extrinsic stains.

Earlier, any discolored teeth were treated with different aggressive approaches, including direct and indirect veneers, and crowns. Recently, more conservative approach has been used which includes bleaching. Both home and in-office bleaching techniques are used in teeth whitening (Kugel and Kastali, 2000; Dahl and Pallesen, 2003). In the bleaching mechanism for teeth, the active ingredient (peroxide solutions) can diffuse easily through enamel and dentin and this oxidize the stains in teeth (Greenwall, 2001). However, the color change of resin composites after bleaching results from superficial cleansing of the specimens, not by intrinsic color change (Villalta et al., 2006). Although, in-office bleaching with hydrogen peroxide had the benefit of producing instant results; it was reported that there were a profound color change with carbamide peroxide (Rao et al., 2009).

The literature is rich with research evaluating the effects of in-office bleaching on natural teeth and restoratives (Rao et al., 2009), but the effect of home bleaching on tooth-colored restorations is not fully clarified. Therefore, this study was conducted to determine effect of different home bleaching methods on stained nano-filled resin composites using Quanta environmental scanning electron microscope.

MATERIALS AND METHODS

Preparation of the specimens

A specially fabricated split cylindrical Teflon mold of 5 mm internal diameter and 2 mm thickness was used for making disc specimens of three tested restorative materials.

Application of the restorative material

Three different restorative materials (ESTHET.X HD Micro-Matrix Restorative, Dentsply, Paradigm Nano-Hybrid Universal-Restorative, 3M/ESPE, and Artiste Nano-Composite, Pentron- Clinical) were tested in this study (Table 1). Forty discs of each tested material were made. Each disc was fabricated by carefully inserting an increment of tested restorative material using a nitride plated resin-composite instrument (Aescolap, Germany) into a circumferential Teflon mold with 5 mm of internal diameter and 2 mm of height positioned onto a 0.051 mm thick transparent polyester film strip (Mylar, DuPont, Wilmington, Del.) over a glass slide. The first increment was light cured for 20 s using Optilux 501 (Kerr Corp, Orange, CA). The second increment was inserted then another 0.051 mm thick transparent polyester film strip was applied on top of the Teflon mold filled with the tested material. An additional glass slide was placed over the previously positioned polyester film strip, and a 1 kg weight applied for 1 min to extrude the excess material and to obtain a uniformly smooth specimen surface. Afterwards, the weight was removed and the second increment of tested restorative material light was cured for 20 s through the polyester film strip. The output light intensity was continuously monitored with a radiometer (SDS Demetron, Orange, CA) to ensure a constant value of 600 mW/cm². The top surface of the disc against which the load was applied was marked by a notch from the side to be examined for color changes. For the purpose of surface standardization, the side to be examined for color changes of all specimens were wet ground with 600-grit silicon carbide abrasive papers for 10 s on a 300-rpm grinding machine (Buehler Metaserv, Buehler, Germany) (El Seoud et al., 2009).

Grouping of specimens

After fabrication of the discs, 40 were immersed in freshly prepared coffee for 3 h a day for 21 days at room temperature in order to be stained. Coffee was prepared by mixing 12 g of natural coffee powder (Nescafe) and 10 g of white sugar with 200 ml of boiling water. The 40 stained discs were then divided into four subgroups (n=10) according to the bleaching method (Table 2);

(1) Non-bleached subgroup (color changes examined immediately after staining).
(2) Bleached using Crest 3D-White Whitestrips Advanced Vivid (30 min once a day for 14 days).
(3) Bleached using Colgate Visible White (30 min once a day for 14 days).
(4) Bleached using Pola Paint (30 min twice a day for 14 days).

The discs of each assigned subgroup were immersed in a fresh amount of the bleaching agent for 30 min. Between bleaching periods, specimens were immersed in freshly prepared artificial saliva. The composition of the artificial saliva was as follows: 2.0 mM Ca²⁺, 1.2 mM phosphate, 130 mM KCl and 60 mM Tris (pH 7.0).

Color assessment

The process of measuring the color properties of the three tested materials used in this study was done by using Quanta Environmental Scanning Electron Microscope (QESEM) (Quanta 200, FEI Company, Philips) and a specific computer software (Yousef and Abo El Naga, 2012). The scanning photomicrograph taken by QESEM (Figure 1a) is converted to have quantitative computerized image analysis using digital scanner with a special computer program. The program divided the surface of all specimens’ images on computer monitor into points. Each point has a pixel value at the two coordinates (x, y) as shown in the excel sheet. From the data of the two coordinates, the gray value for each point can be calculated (Figure 1b) to get the statistics sheet.
Table 1. Manufacturers and compositions of materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Principal components</th>
<th>Manufacturer</th>
</tr>
</thead>
</table>
| ESTHET.X HD (Micro-Matrix Restorative) | **Resin matrix:** Bis-GMA adduct, a Bis-EMA adduct and TEGDMA camphorquinone, photoinitiator, stabilizer, pigments.  
**Filler:** Barium fluoroborosilicate glass with a mean particle size below 1 µm and nano-filler silica (particle size 0.04 µm). | Dentsply Caulk, Milford, DE, USA |
| Paradigm (Nano-Hybrid Universal-Restorative) | **Resin system:** BIS-GMA, UDMA, BIS-EMA, PEGDMA and TEGDMA  
**Filler system:** 1. Surface-modified zirconia/silica with a median particle size of approximately 3 microns or less; 2. Non-agglomerated/non-aggregated 20 nm surface-modified silica particles; 3. The filler loading is 82% by weight (68% by volume). | 3M/ESPE, St. Paul, USA |
| Artiste (Nano-Composite) | **Resin matrix:** PCBisGMA, BisGMA, UDMA and HDDMA; photoinitiator, accelerator, stabilizer, silane and pigments.  
**Filler:** Barium boro-silicate glass, nano-particulated silica, zirconium silicate and a small amount of Al2O3. Filler particle range 0.02 to 0.7 average µm, 75% by weight | Pentron Clinical, USA |

Table 2. Bleaching materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Manufacturer</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest 3D Whitestrips</td>
<td>Crest, Proctor and Gamble, USA</td>
<td>10% Hydrogen peroxide</td>
</tr>
<tr>
<td>Colgate Visible White Chairside</td>
<td>Colgate Palmolive Company, USA</td>
<td>9% w/w Hydrogen peroxide</td>
</tr>
<tr>
<td>Pola Paint</td>
<td>SDI, Australia</td>
<td>8% Carbamide peroxide</td>
</tr>
</tbody>
</table>

Table 3. Comparison between color values of the three resin composites.

<table>
<thead>
<tr>
<th>Esthet.X HD</th>
<th>Paradigm</th>
<th>Artiste</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>119.9</td>
<td>10.3</td>
<td>120.9</td>
<td>11.4</td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05.

Table 4. Comparison between color values before and after bleaching.

<table>
<thead>
<tr>
<th>Stained</th>
<th>Crest 3D White Chairside</th>
<th>Colgate visible white Chairside</th>
<th>Pola Paint</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>136.8a</td>
<td>1.7</td>
<td>113c</td>
<td>1.5</td>
<td>112.5c</td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05. Different letters are statistically significantly.

Statistical analysis

Data were calculated and statistically analyzed using IBM® SPSS® Statistics Version 20 (Statistical Package for Scientific Studies) (SPSS, Inc., Chicago, IL, USA). Three-way analysis of variance (ANOVA) was used in testing significance for the effect of resin containing the mean of the gray value for these points which ranges between 0 and 255. The gray value was measured as a linear measurement. Three readings (count, maximum, and minimum values of these points) were obtained. To ensure proper and accurate data, the mean of three readings was calculated as mean gray value of the tested materials.
composite, bleaching, bleaching technique and their interactions on color. Tukey’s post-hoc test was used for pair-wise comparison between the mean values when ANOVA test is significant. The significance level was set at $P \leq 0.05$.

RESULTS

The results of the repeated measures of ANOVA showed that, the regression model is fit to describe the relationship between the studied variables. The results showed that the material had no statistically significant effect on mean color change. Meanwhile, bleaching and the interaction between the two variables had a statistically significant effect on mean color change ($P \leq 0.05$).

Effect of composite resin

Mean color change values obtained from each resin composite are shown in Table 3. Statistical analysis revealed that, there was no statistically significant difference between the three materials.

Effect of bleaching

Table 4 compares the mean color values of bleached and non-bleached subgroups, irrespective of resin composites. It shows that, there was a statistically significant decrease in mean color values after bleaching. The highest
mean color value was found in Pola Paint. Mean-while, there was no statistically significant difference between Colgate Visible White and Crest 3D Whitestrips bleaching; both showed the lowest mean color values (Figure 2).

**DISCUSSION**

The present study evaluated the effect of different three bleaching methods on stained composites. According to the results of the current study, after a staining period with coffee for 3 weeks, all composite specimens of different brands exhibited similar color change and staining staining and there was no significant difference among them. This is probably due to their similar composition as all of the three tested restorative composite materials were nanohybrid. Also, this can be attributed to water sorption since water is considered as a carrier for coloring agents in the water sorption process. Stain adsorption is a consequence of water sorption (Dietzchi et al., 1994). This is in agreement with Catelan et al. (2011), who found that, all artificial aging methods resulted in a change in the color of the tested composite resins. Also, Villalta et al. (2006) found that, nanocomposite changed color as a result of staining in coffee.

Nowadays, different home systems of whitening gels are readily available in the market. Some of these are gels which are meant to be used with trays, or placed directly on teeth for 30 to 60 min. Hydrogen or carbamide peroxide is the main ingredient of these products with varying concentrations. Ten percent carbamide peroxide breaks down to 3.6% hydrogen peroxide. Both courses are the oxidizing agents responsible for removing dental stains and whitening teeth. Other ingredients are added to the mixture to stabilize the product, or reduce teeth sensitivity like potassium nitrate or fluoride. Several studies showed that, indeed using bleaching gels and strips will lighten composite materials whether carbamide or hydrogen peroxide. This however, is largely dependent on the type of stain, composition of the material, and duration of bleaching gel application (Villalta et al., 2006; Ertas et al., 2006; Monaghan et al., 1992; Anagnostou et al., 2010; Kolbeck et al., 2006; Briso et al., 2010; Yalçın and Gurgan, 2005; Yu et al., 2011).

In this study, the effect of three different home-based whitening systems on color change of three different nanohybrid composite materials were compared. While Pola Paint had 8% carbamide peroxide (which corresponds to 2.8 hydrogen peroxide), Crest White had 6% hydrogen peroxide, and finally Colgate Visible White bleaching gel had 9% hydrogen peroxide. Because of the higher percentage of hydrogen peroxide in the latter two systems, they significantly whitened the stained composite specimens compared to the Pola Paint system. However, Pola Paint had significantly whitened the composite specimens compared to the negative control. These results are consistent with Canay and Cehreli (2003) who reported perceptible color change for composite resins bleached with 10% hydrogen peroxide.

However, the result of the current study is different than what was found by Anagnostou et al. (2010) where they reported no color differences between nanohybrid composite specimens after bleaching with 10% carbamide peroxide gel and 6.5 to 14% hydrogen peroxide strips. This discrepancy, however, can be explained by the application time of 3 h for the carbamide peroxide in their study, compared with 30 min application time twice daily for 14 days in our study as per the manufacturer recommendation. Also, Li et al. (2009) reported that 15% of carbamide peroxide gel did not cause changes in the color of the composites (Li et al., 2009).

**Conclusion**

The three tested composites were performed similarly under the test conditions. The use of Colgate bleaching gel and the Crest 3D-White Strips could effectively eliminate the discoloration resulted from staining of the tested materials.

**Conflicts of interest**

The authors declare that they have no conflicts of interest.

**REFERENCES**


