Original Article

Effects of 35% Carbamide Peroxide Gel on Surface Roughness and Hardness of Composite Resins

F. Sharafeddin [1], GR. Jamalipour [2]

[1] Associate Professor, Department of Operative Dentistry, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran
[2] Dentist, Private Practice

Corresponding author:
F. Sharafeddin, Associate Professor, Department of Operative Dentistry, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran.
sharaff@sums.ac.ir

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Abstract:

Objective: Bleaching agents may not be safe for dental materials. The purpose of this in-vitro study was to evaluate the effects of Opalescent Quick "in-office bleaching gel" containing 35% carbamide peroxide on the surface roughness and hardness of microfilled (Heliomolar) and hybride (Spectrum TPH) composite resins.
Materials and Methods: Twenty specimens of Spectrum TPH composite resins and twenty Heliomolar composite resins were fabricated using a metallic ring (6.5 mm diameter and 2.5 mm thickness) and light cured, then their surfaces were polished. Specimens of each composite resin were divided into two equal groups. Ten specimens of each type of composite were stored in water at 37°C as the control groups and 35% carbamide peroxide gel (Opalescence Quick) as the other group for 30 minutes a week for 3 weeks. Then the specimens were subject to roughness and hardness tests.
Results: This study revealed that using 35% carbamide peroxide bleaching gels had no significant effect on the surface roughness of Spectrum TPH "hybrid" and Heliomolar "microfilled" composite resins. The surface hardness of Spectrum TPH composite treated with the subject gel significantly increased compared to heliomolar, which had no significant change after treatment with this bleaching gel.
Conclusion: If tooth color matching of the composite had been satisfactory after office bleaching with 35% carbamide peroxide gel, this material would have been acceptable because it has no adverse effect on Heliomolar and Spectrum TPH composite resins.

Key Words: Tooth Bleaching; Composite Resins; carbamide peroxide

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INTRODUCTION

Bleaching was first used to whiten teeth in the late 1870s [1]. The bleaching technique may be classified as the vital and nonvital bleaching or the office and home bleaching. The use of bleaching for improving the aesthetics of natural dentition has widened only after the introduction of home bleaching systems in the 1990s [2-5].
Although from the procedure standpoint, bleaching is safe for soft tissues, it may not be safe for dental materials that have high erosive or degradation characteristics [4]. This may be more significant in the case of home bleaching gels, because patients may not follow professional recommendations but instead apply these products more often in order to increase the "bleaching power" and speed of action. The use of bleaching agents on restorative materials has not been tested comprehensively.

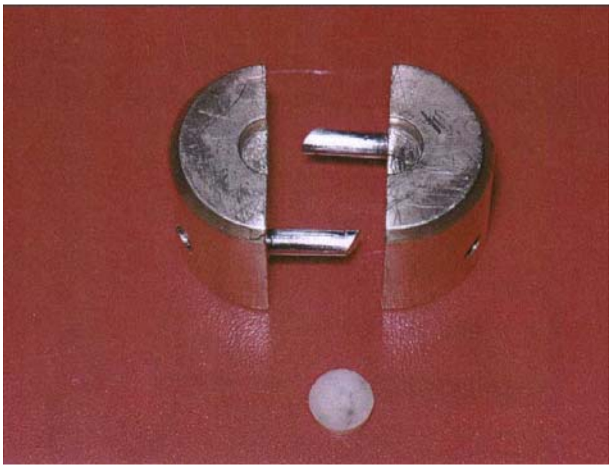

Fig 1. The metallic mold used for preparing the specimens.

Restorative materials may have different reactions by application of bleaching agents. One of the adverse effects of this material is mercury release from amalgam restoration and the bleaching agent may roughen the resin-based composite, although this may have no clinical significance [6-9].

Interestingly, some studies reported an increase, a decrease, or no change in composite surface hardness after application of carbamide peroxide gels [8,9]. This shows that the effect of carbamide peroxide gels may depend on the composite material.

Some materials, such as high-viscosity glass ionomer cements and polyacid-modified resin-based composites used by patients with a high caries risk, have been affected by preventive treatments such as acidulated phosphate fluoride gels or foams that could alter their surface roughness, micromorphology and hardness [10-13].

The purpose of this study was to determine whether in-office tooth whiteners with strong oxidizing agents cause chemical softening of microfilled and hybrid composite resins. The surface hardness of the composites were also compared after treatment.

MATERIALS AND METHODS

Two resin-based composites, Spectrum TPH (Dentsply-De Trey, Konstanz, Germany) a hybrid composite and Heliomolar (Vivadent, Schaan, Liechtenstein) a microfilled composite (Table 1), were used to represent a microfilled anterior and a hybrid composite, respectively.

The bleaching agent was 35% carbamide peroxide gel Opalescence Quick, (Ultradent Production Inc. USA). For each resin-based composite, 20 cylindrical specimens (6.5 mm in diameter and 2.5 mm thickness) were made. To prepare the specimens, the resin was transferred into a metal mold (Fig 1), then the filling was covered with acetate strips (Hawe Neos Dental, Biggo, Switzerland). A glass slide was then placed over this and pressure was applied to extrude the excess materials. The restoratives were light polymerized according to manufacturers' cure times (40 seconds) through the glass slide with a coltolux II light-cure unit (Coltene/Whaledent Inc. USA) the mean intensity of the light source (510 mW/cm^2, SD=4) was determined with a radiometer (Cure Rite, Efos Inc, Ontario, Canada).

After polishing the surface of the specimens, they were stored for one week in distilled water at 37°C for post-irradiation hardening. Spe-

Table 1. Tested composites.

Composite	Manufacturer	Composition
Spectrum TPH	Dentsply De-Trey, Konstanz, Germany	Bis-GMA, Bis-EMA, TEGDMA, Barium aluminoborosilicate glass (below 1.5 µ) Colloidal silica (0.04 µ) Filler weight: 77%
Heliomolar	Vivadent Schaan Liechtenstein	Bis-GMA, Urethane dimethacrylate and decandiol dimethacrylate, Silicon dioxide, ytterbium trifluoride, copolymer particle (0.04-0.2 µ) Filler weight: 66.7%

cimens were divided into four groups.
Groups 1 and 2: Ten Spectrum TPH composite discs (group 1) and 10 Heliomolar composite discs (group 2), as control groups.
Twenty group 1 and 2 specimens were stored in distilled water at 37°C for three weeks.
Groups 3 and 4: Ten specimens in groups 3 (Spectrum TPH) and 10 specimens in group 4 (Heliomolar) were treated with 35% carbamide peroxide (Opalescence Quick) for 30 minutes/week for three weeks.
The bleaching gels were removed using a water jet and a standardized one-minute rinsing time. Storage medium was distilled water at 37°C during the hiatus periods. The specimens were subjected to hardness and roughness tests.
Surface roughness (Ra) of the composite specimens was determined by mechanical profilometry (Taylor-Hobson, Leicester, England). Ra is the mathematic mean height of the surface roughness irregularities along the traverse length. The traverse speed was set at 0.25 mm per second with a cutoff control of 0.3 mm. The traverse length was 4.0 mm. The profilometric measurements were accomplished on each specimen and then averaged to obtain the surface roughness of the specimen.
Then all specimens were subjected to hardness testing using a digital micro hardness tester (Wolpert, Darmstadt, Germany). Specimens were placed centrally beneath the indenter and a 500 g load was applied through the indenter for a dwell time of 15 seconds.
The knoop hardness number (KHN) corresponding to each indentation was computed by measuring the dimensions of the indentations and using the formula $KHN=1.451(F/d^2)$, where F is the test load in Newton and d is the longer diagonal length of the indentation in millimeters.
Statistical analysis was performed using Kruskal-Wallis, Mann-Whitney and Tukey tests at the significance level of $P<0.05$.

RESULTS

KHN and Ra of the four groups are demonstrated in Tables 2 and 3.
Statistical analysis of the recorded results was conducted using Mann-Whitney, Kruskal Wallis and Tukey tests at a significance level of $P<0.05$. No statistically significant difference was observed in surface roughness between any control and experimental groups. The bleaching gel caused a significant increase in surface hardness of Spectrum TPH "hybrid" composite resin specimens ($P=0.007$). Spectrum TPH specimens were significantly harder than heliomolar specimens ($P=0.001$). No significant change was observed in surface hardness of heliomolar control and experimental groups.

DISCUSSION

Although there is widespread use of bleaching agents, there is no agreement on the effect of bleaching agents on enamel or restorative materials. Under the conditions of this *in vitro* study, Opalesence Quick 35% carbamide peroxide gel had no significant effect on the surface roughness of Heliomolar and Spectrum TPH composite resins.
Little literature exists that addresses the possible detrimental effects on resin-based composites at higher concentrations of carbamide peroxide.

Table 2. Surface roughness (Ra) and surface hardness (KHN) in Spectrum TPH groups (groups 1 and 3).

Specimen		Ra			KHN		
Name	Number	Mean	SD	SE	Mean	SD	SE
Spectrum TPH	10	0.25	0.0527	0.0166	58.66	9.5083	3.0069
Spectrum TPH + Opalescence Quick	10	0.23	0.0411	0.1302	76.06	14.4434	4.5674

SD= Standard Deviation, SE=Standard Error

Yap AU and Wattanapayungkul evaluated the effect of 35% carbamide peroxide gel on the surface roughness of Spectrum TPH and Reactmer and Fuji II LC. The study revealed that this bleaching agent had no significant effect on the surface roughness of the specimens [14], which was similar to this study, suggesting that high concentration carbamide peroxide bleaching does not have a significant effect on surface roughness, either hybrid or microfilled composites.

The results of the current study agree with other researches conducted with 10% and 35% carbamide peroxide gel, confirming the mild effect, if any, that carbamide peroxide has on composite surfaces [15-16]. Most of the studies examining the effect of carbamide peroxide on resin-based composites have used 10% carbamide peroxide [2].

Although Bailey and Swift noted some softening of both hybrid and microfilled composite surfaces, these effects were not significant statistically [9]. Softening of resin based composites is believed to occur chemically in vivo, contributing to wear of the resin in stress-bearing areas [17,18]. Composite matrices composed of Bis-GMA resin polymers may be softened by chemicals with similar solubility parameters [16,19].

Although microfilled composites have higher resin content than hybrids and any difference in surface roughness might be expected to occur in this group, this did not occur in the present study. On the other hand, Soderholm et al [20] explained how the lowest crack density was found in microfilled composites, theorizing that the spherical shape of the filler may decrease stress and reduce the risk of crack growth. From the clinical standpoint, their results are interesting because several clinical studies have demonstrated that microfilled composites are more wear-resistant than other composites [21,22]; however, laboratory studies often indicate the opposite [23-25].

For Spectrum TPH composite, a significant increase in surface hardness was observed in the treated group. It means Opalescence Quick bleaching gel caused significant increase in surface hardness of this hybrid composite. It seems that active ingredients of the bleaching agent can remove the surface layer of Spectrum TPH composite specimens, which are rich of filler particles and have a harder surface. No significant difference was observed in the surface hardness of Heliomolar composite resin in the control and treated groups. In 2002, Garcia-Goody et al evaluated the effect of office bleaching gel on esthet-X, a microfilled composite resin and achieved the same result. They found that office-bleaching gel has no significant effect on esthet-X composite resin [26].

Chemical softening of the restorative materials might also occur if the bleaching products have solubility parameters similar to that of the resin matrix. The Bis-GMA and UDMA resin polymer used in composites may be softened by chemicals with solubility parameters in the range of 1.82×10^4 to 2.97×10^4 J/m^3 [27]. As the bleaching agents and many of their components are not listed in the solvent tables of the polymer handbook [28], it is unclear whether they have solubility parameters similar to that of resins used in various materials.

Although the composites used in this study were UDMA and Bis-GMA resin polymer, the

Table 3. Surface roughness (Ra) and surface hardness (KHN) in Heliomolar groups (groups 2 and 4).

Specimen		Ra			KHN		
Name	Number	Mean	SD	SE	Mean	SD	SE
Heliomolar	10	0.24	0.0843	0.0266	40.73	7.3779	2.3331
Heliomolar+Opalescence Quick	10	0.23	0.1059	0.0335	41.25	4.1212	1.3032

SD= Standard Deviation, SE=Standard Error result revealed that no softening had occurred on the surfaces of treated specimens.

The surface hardness of composite resins has been reported to increase [8], decrease [9,29] or remain unchanged [14,26,30-34] after using carbamide gels. Such wide variations in data suggest that some tooth-colored restorative materials may be more susceptible to alterations and some bleaching agents are more likely to cause those alterations. The latter may be attributed to differences in pH between the bleaching agents [35]. Bleaching gels contain a variety of aqueous solvents, any of which could contribute alone or in combination with other components to decrease the solubility of the resin matrix. The pH of the bleaching gel evaluated in this study was close to neutral and had minimal effect on the surface roughness of specimens. The pHs of most current bleaching products are close to neutral. The bleaching gel evaluated in this study falls into this category. In this study, Spectrum TPH composite resin without any gel treatment was significantly harder than Heliomolar composite resin. This result may be related to the type of the composites, as Spectrum is a hybrid and Heliomolar is a microfilled composite resin.

The clinical relevance of this project would indicate that high concentration carbamide peroxide bleaching gel, used as intended by the manufacturers, poses minimal risk to composite restorations. Risk of damage to soft tissues and accidental ingestion of bleaching gels also need to be investigated.

CONCLUSION

Under the conditions of this *in vitro* study, the effects of the in-office tooth whitener (35% carbamide peroxide gel) on surface hardness of microfilled and hybrid composite resins were material dependent. For Heliomolar composite, which is a microfilled composite, no significant effect on surface hardness was observed, but for Spectrum TPH composite, which is a hybrid composite, surface hardness was increased.

This study showed no significant differences in the surface roughness of the tested control and treated composites. There is no evidence to suggest that high-concentration carbamide peroxide bleaching gel causes significant changes in the surface roughness of either hybrid (Spectrum TPH) or microfilled (heliomolar) composite.

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