Influence of Different Bleaching Agents on Surface Roughness of Composite Resins Filling

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The aim of this study was to evaluate the effects of one in-office and two home bleaching agents on the surface roughness of a hybrid, microhybrid and nanohybrid composite resin. Three composite resins (Valux Plus, 3M ESPE, Filtek Z 250, 3M ESPE, and Herculite XRV Ultra, Kerr) and three bleaching agents (Opalescence PF, Ultradent Products, Perfect Bleach, Voco, and Perfect BleachOffice +, Voco) were chosen for this study. Twenty eight samples of each composite resin were prepared and were equally split in 4 groups: 7 samples were stored in distilled water (control group), 7 samples were subject to 17% carbamide peroxide gel (Perfect Bleach) action for 3 h a day, 7 days, 7 samples were subject to 15% carbamide peroxide gel (Opalescence PF) action for 3 h a day, 7 days and 7 samples were subject to 35% hydrogen peroxide gel (Perfect BleachOffice +) action two times for 15 min . After cleaning the samples were submitted to roughness evaluation using atomic force microscopy (AFM). Bleaching agents that contain 35% hydrogen peroxide and 17% or 15% carbamide peroxide increased the composite resins surface roughness. The hybrid resin recorded the highest roughness after bleaching, followed in descending order by microhybrid and nanohybrid composite resins.

Keywords: bleaching agent, composite resin, roughness evaluation, carbamide peroxide, atomic force microscopy

In dentistry bleaching refers to products that contain some form of hydrogen peroxide. Most of the bleaching agents work by oxidation by which organic materials are converted into carbid dioxide and water. Bleaching agents contain liquid (aqueous) solvents that might decrease the organical matrix solubility by themselves or in combination with other components. As a result of decomposing, carbamide peroxide releases urea and hydrogen peroxide. Hydrogen peroxide that decomposes in free radicals that further combine resulting oxygen and water. Some of these chemical processes might accelerate the degradation of the organic matrix of composite resins [1]. Hydrogen peroxide and free radicals influence the interface between the resin matrix and inorganic particles in composite resins by breaking the adhesion of the two components, which can cause an increase of surface roughness [2].

Studies developed in the late few years evaluated the effects of bleaching agents on hardness, surface roughness, susceptibility of color changes and microleakage of composite resins. Some of these studies concluded that 15% carbamide peroxide is capable to induce some changes on nanocomposite resins [3]. Other studies showed that the changes became significant only when hydrogen peroxide (35%) was used [4]. Some authors indicated a significant decrease of composite roughness not only in the superficial layer [5-9].

The aim of this study was to evaluate the effects of one in-office and two home bleaching agents on a hybrid, microhybrid and nanohybrid composite resin.

Experimental part

A hybrid composite resin (Valux Plus, 3M ESPE), a microhybrid composite resin (Filtek Z 250, 3M ESPE) and a nonohybrid composite resin (Herculite XRV Ultra, Kerr) and three bleaching agents (Opalescence PF, Ultradent Products, Perfect Bleach, Voco and Perfect BleachOffice +, Voco) were chosen for this study. The colour corresponding to shade A2 was used to prepare the samples of each material. Twenty eight samples having 10 mm in length, 7 mm in width and 2 mm in hight of each composite resin were prepared by placing the composite resin in contact with plastic matrix strips between two glass slabs in order to flatten the surface. The samples were built-up in one increment of 2mm. Every sample was lightcured for 40 seconds in one step, using a halogen curing light (Ledent, Ivoclar and Vivadent). The mean intensity of the light source was $1000 mW/cm^2$. The samples of each composite resin were equally split in 4 groups: 7 samples were stored in distilled water (control group), 7 samples were subject to 17% carbamide peroxide gel (Perfect Bleach) action for 3 h a day, 7 days, 7 samples were subject to 15% carbamide peroxide gel (Opalescence PF) action for 3 h a day, 7 days, and 7 samples were subject to 35% hydrogen peroxide gel (Perfect BleachOffice +) action two times for 15 min. 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 samples were submitted to roughness evaluation using Atomic Force Microscopy (AFM). AFM images were taken in air, at room temperature, on a SPM SOLVER PRO-M instrument (producer: NT-MDT Moscow, Russia). A NSG10/Au Silicon tip with a 6 nm radius of curvature, semi-contact mode was used. The results were expressed as root mean square roughness. Statistical analysis was performed using ANOVA and post hoc Bonferroni test at the significance level of $p < 0.05$.

Results and discussions

3D aspects of the composite resins samples after bleaching with the three tested bleaching agents (figs. 2a-c, 3a-c, 4a-c) showed higher surface roughness when

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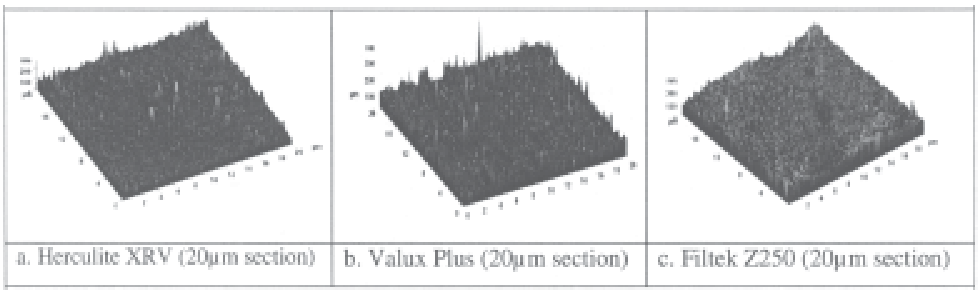

Fig. 1. AFM 3D aspects of some samples from control groups

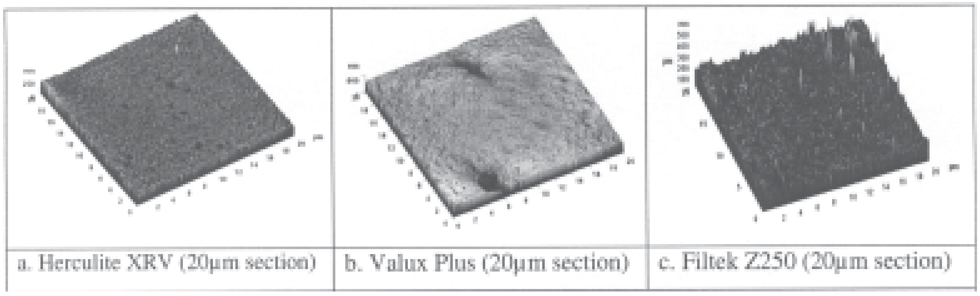

Fig. 2. AFM 3D aspects of the samples when 15% carbamide peroxide was used

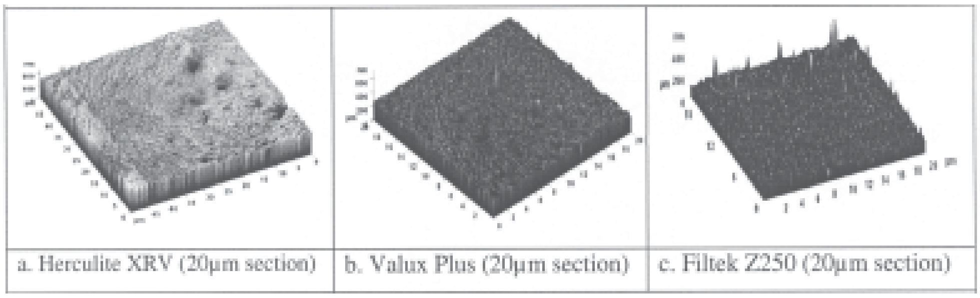

Fig. 3..AFM 3D aspects of the samples when 17% carbamide peroxide was used

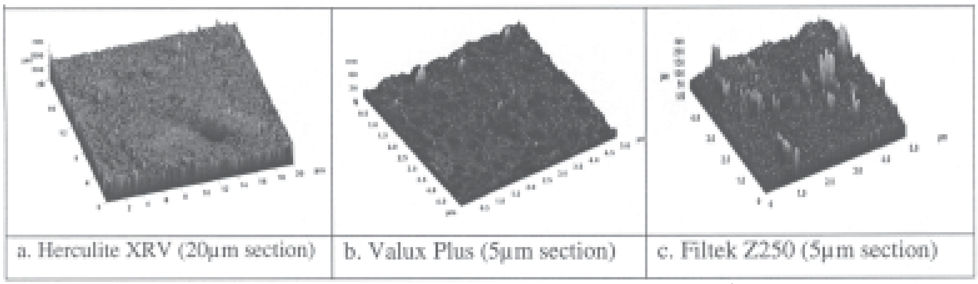

Fig. 4..AFM 3D aspects of the samples when 35% hydrogen peroxide was used

comparing to control group (fig. 1a-c). When hydrogen peroxide 35% was used, the surface roughness of all three composite resins appeared to be higher than surface roughness of the samples when hydrogen peroxide 15% or hydrogen peroxide 17% were used (fig. 4a-c). In control group and in all the groups where bleaching agents were used, Valux Plus samples (fig. 1-4 a) seemed to have higher surface roughness when comparing to Filtek Z 250 (figs. 1-4c) samples and Herculite XRV samples (figs. 1-4b).

The mean surface roughness of all the composite resins that have been tested increased after bleaching using all three bleaching agents (table 1). For all three composite resins used in the study, the highest mean values of surface roughness were recorded when 35% hydrogen peroxide gel was used, followed in descending order by 17% carbamide peroxide gel and 15% carbamide peroxide gel (table 1). Samples of Herculite XRV presented the lowest surface roughness in control group and after bleaching with all three bleaching agents, followed in increasing order by Filtek Z 250 and Valux Plus.

ANOVA and post hoc Bonferroni statistical test were used to compare the mean values of composite resins surface roughness in control group and in groups after bleaching (the mean difference was significant at the 0.05 level). Significant statistical results were obtained when comparing the results in control group and when comparing the roughness values after bleaching with 35% hydrogen peroxide, 17% carbamide peroxide and 15% carbamide peroxide to roughness values in control group for all three composite resins (table 1).

Clinically, the surface topography is an important factor that influences the esthetic aspect and the oral tissues health [10]. Many factors could influence the surface morphology: finishing and polishing materials and techniques, the type, pH and concentration of the bleaching agents [11]. The surface roughness of composite resins could be modified after an exposure to bleaching agents. Changes in surface topography could be related to the type and composition of composite resins and the composition of bleaching agents and their time of action. Bleaching agents can affect the organic matrix and can increase the surface roughness due to the loss of organic matrix rather than inorganic loss [2]. That might be due to the high oxidation and degradation of resin matrix. Changes in

Table 1
MEAN SURFACE ROUGHNESS OF COMPOSITE RESINS AFTER BLEACHING WITH THE TREE BLEACHING AGENTS

	Mean surface roughness (μm) ± SD		
	Valux Plus	Filtek Z250	Herculite XRV
Control	16.87(±0.04)*	10.90(±0.03)*	9.53(±0.03)*
35% hydrogen peroxide	36.58 (±0.15)*	24.35 (±0.04)*	21.86 (±0.05)*
17% carbamide peroxide	22.45 (±0.02)*	20.51 (±0.04)*	15.19 (±0.02)*
15% carbamide peroxide	20.14 (±0.03)*	13.86 (±0.02)*	11.33 (±0.03)*

*Significant statistical difference

surface roughness depend on the type of composite resin and making procedures [12-16]. The organic matrix which contains Bis-GMA might be weaken by chemical substances [17, 18]. The organic matrix of Valux Plus is a mixture of Bis-GMA and TEGDMA, and for Filtek Z 250 it is represented by Bis-GMA, UDMA and Bis-EMA. This could explain why all composites used in the study recorded an increase of surface roughness after bleaching. Changes in the surface of composite resins having a high organic component could also appear.

The differences regarding the effect of bleaching agent on various types of composite resins are also due to inorganic fillers [2]. The load of composite resins in inorganic fillers is directly related to the proportion between the surface occupated by inorganic particles and the surface occupated by the organic matrix. The surface roughness of a composite resin is given by the biggest fillers [19]. The increase of surface roughness is due to the erosion of organic matrix and the loss of adhesion between organic matrix and inorganic filler. In this way, the more particles are lost, the higher the surface roughness will be [10]. Microhybrid composite resins have a rougher surface when comparing to microfilled composite due to higher particle sizes [4]. In this study the hybrid composite (Valux Plus), which recorded the highest values of surface roughness before and after bleaching, had the highest value of inorganic particles in volume (66%) and the biggest size of the particles (varying between 0.01 μm and 3.5 μm). The microhybrid composite resin (Filtek Z 250) had the mean inorganic particles size of 0.6 μm and recorded a lower surface roughness comparing to the hybrid composite. Nanohybrid composite resin (Herculite XRV Ultra) had the lowest size of particles (submicronic particles of 0.4 μm, nanoparticles of 50 μm) and the lowest surface roughness. The same tendency of variation in surface roughness of different types of composite resins was recorded in other studies [20, 21].

In our study 35% hydrogen peroxide, 17% carbamide peroxide gel and 15% carbamide peroxide increased the surface roughness of composite resins. In contrast with the results of the present study, other studies showed no changes in surface roughness of the composite resins after bleaching using carbamide peroxide [22, 23] or a lower effect on surface roughness of hybrid, microhybrid and nanohybrid composite resins when carbamide peroxide 15% was used (when compared to hydrogen peroxide 38%) [24].

The results of this study are similar to those of other studies [12, 21, 25-28]. When lower concentrations of hydrogen peroxide were used, no significant effects on surface roughness of composite resins were found [26]. On the other hand, high concentration of carbamide peroxide used according to the producer intructions had no risk on composite resins surface [29].

The lack of correspondence in the results of these studies could be explained by the experimental methods used and by the type of bleaching agents that have been tested. In some studies the bleaching agent was applied continuously during a specific period of time [30-32]. In our study every bleaching agent that has been tested was used according to the producer instructions, in order to guarantee the clinical relevance of the study.

Conclusions

Bleaching agents that contain 35% hydrogen peroxide and 17 or 15% carbamide peroxide increase the composite resins surface roughness. From the three types of bleaching agents that have been tested, the higher increase of surface roughness was recorded after 35% hydrogen peroxide action, followed in descending order by 17 and 15% carbamide peroxide action. The hybrid resin recorded the highest roughness before and after bleaching, followed in descending order by microhybrid and nanohybrid composite resins.

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