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Effect of Home Bleaching on Surface Roughness of Novel Composite Resins Subjected to One Step Polishing System: An In Vitro Study

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Abstract

The aims of this in vitro study was to evaluate surface roughness (Ra) of four contemporary composite resin materials after applying home bleaching agent.

Materials and Methods: Forty-eight composite specimens were made from four groups of different types composite resins (one-submicron hybrid, one microhybrid and two nanohybrid) of 12 specimens each: Group 1: Brilliant EverGlow, group 2: G-ænial from GC, group 3: Evetric and group 4: Ice, SDI. All the samples were polished with one step polishing system OptraPol. Each group was further subdivided into two subgroups (A&B) (n=6). Subgroups A were stored in distilled water as control, while subgroups B were bleached with 20% carbamide peroxide home bleaching agent for 14 day. Surface roughness analysis was then performed for all the samples using atomic force microscopy (AFM). Results were statistically analyzed using One-way ANOVA/LSD test analyzing the differences between the subgroups at $p<0.05$.

Results: Surface roughness of all the groups increased after bleaching; however, LSD test showed significant differences that were only recorded between the subgroups of groups 3 & 4.

Conclusion: 20% at-home bleaching treatment significantly affected surface roughness of both nanohybrid composite groups, while, it did not produce a significant surface changes for microhybrid and submicron composite resin.

Keywords: At home bleaching, surface roughness, contemporary composite resin.

Introduction

Pretty smile is considered an exceptionally serious subject nowadays. As esthetics being progressively more appreciated, practitioner dentists prefer to use resin composite material as a first choice in restorative field since these materials have both super appearance and appropriated mechanical properties[1].

Dental bleaching, on the other hand, has similar evolution in which it became in wide range types & techniques, and seems to be highly efficient and secure to treat teeth discoloration [2]. Since the introduction of at home bleaching technique by Haywood and Heymann in 1989, the development has become more trendy

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[3]. Based on bleaching principle; hydrogen peroxide (HP) or its precursor, carbamide peroxide (CP) is an oxidizing agent that in contact with the tooth surface dissociates to produce unstable free radicals. These radicals attack the organic pigmented molecules by attacking double bonds of chromophore molecules within tooth tissues. The change in the double-bond conjugation results in smaller, less heavily pigmented constituents, thereby changing the color of the teeth [4]. With the increasing demand for dental bleaching and esthetic valorization, several researchers have investigated the potential alterations resulting from the influence of bleaching agents on composite material. Different alterations have been reported such as increase in surface roughness, reduction in adhesive interface strength, decrease in microhardness and changes in opacity and color [5]. Resin composite mechanical and aesthetic properties related mainly to their structure, also on the finishing and polishing aspects in which they have the importance of restoration success. Roughness of the composite surface causes debris adherence which resulted in bacterial plaque retention, that later may cause periodontal disease [6]. Since finishing and polishing are important steps for reduction of plaque accumulation and decreasing discoloration of the restorations; as these procedures participate in recurrent caries & wear reduction, influence the marginal and periodontal integrity, thus ensuring the cosmetic restorations longevity [7]. Bleaching materials effects on the properties of restorative materials after polishing step is an essential issue, hence numerous researches have evaluated its consequence both on the physical and mechanical properties of tooth colored restorations[8-12]. Attin ***et al*** **in 2004** in their review on the effect of bleaching agents on dental restorative materials indicated that bleaching may exert a negative impact on existing restorations[8]. **Hannig *et al* in 2007** reported that bleaching with the tested bleaching agents softens the adhesive restorative materials examined. Polishing of the surface may not suffice for re-establishing the physical properties of the surface of the fillings due to the fact that subsurface layers are also affected[9]. **Yu H *et al*. in 2008** evaluated the effects of a home bleaching gel containing 15% carbamide peroxide on the surface microhardness of four tooth-colored restorative materials in situ ;they reported effects of 15% CP on surface microhardness were material dependent[10]. In a study of **Atali and Topbasi in 2011** using a 2-week bleaching regimen with high peroxide concentrations either in a dental office or at home, they showed that the bleaching agents used affected the roughness and hardness of hybrids, nano hybrids, nano super filled, and silorane composites[11]. **Cengiz *et al*. in 2016** concluded that there was no significant difference between Ra values after HP and CP application within five composite groups while SEM micrographs showed higher surface alterations with HP group compared to CP[12]. However, up-to-date no study has investigated the surface roughness of recently marketed novel composite materials in association with at-home bleaching agents after polishing with one step polishing system OptraPol using AFM device. Therefore, the aim of the current in vitro study was to evaluate the effect of 20% CP at home bleaching agent on surface roughness of one submicrom hybrid, one micrhybrid and two nanohybrid composite resin after polishing with one step polishing OptraPol polishing system.

Materials and Methods

Forty eight samples from four recently marketed composites materials **(Figure 1)** were prepared to form four groups, twelve specimens of each composite material, as follow:

Group 1: (BRILLIANT EverGlow, Coltène/Whaledent AG), a universal submicrom hybrid composite resin.

Group 2: (G-ænial from GC, GC Corp., Tokyo, Japan), a microfilled hybrid composite resin.

Group 3: (Evetric, Ivoclar Vivadent AG), a nanohybrid composite resin.

Group 4: (Ice, SDI , North America Inc), a nanohybrid composite resin.

The samples were made by packing the composite resin into a plastic mold (8 mm diameter × 2 mm thick) [13] (**figure** 2) which were positioned on a mylar strip. Removing the excess composites material, using another mylar strip on top of the mold in order to obtain smooth publishable surface and then pressed flat with a glass slab. All samples were light-cured for 20 seconds from both top and bottom surfaces using light cure device (light output (850-1000mW/cm2), (Guilin Woodpecker, China) according to instructions of the manufacturer. All samples were then polished using one step OptraPol (Ivoclar-Vivadent AG). The disc shape of OptraPol was used with moderate pressure for 15 sec for each sample. The samples were then stored in 100% humidity at 37°C. The samples of the four groups were then subdivided into subgroups(A) (n=6); serves as control and stored in distilled water for 14 days, while subgroups (B)were treated with 20% CP Opalescence PF at home bleaching agent (Ultradent Product, South Jordan, UT, USA) for two weeks in a humid environment. The bleaching agent was applied onto the samples for 2 hour daily according to the manufacturer's instructions. After the bleaching time all the samples were washed out under running water to remove any bleaching agents residue and then stored back in distilled water for the rest of the day at room temperature. By the end of the bleaching regimen, the surface roughness test (Ra) was performed using atomic force microscopy in the exact center of the specimen at (**25 × 25)** µm surface area was inspected. The data were collected from all groups and their subgroups and results were statistically analyzed using LSD in One-way ANOVA tests at $p<0.05$

Results

Mean and standard deviation of all experimental groups were shown in **(Table1).** Group 3 without bleaching has the least surface roughness value measured by AFM, followed by group 1, the highest surface roughness value seen in group 2.

multiple comparison in One way ANOVA test of total RA (LSD test) was used among all subgroups and revealed that group 1 &2 had non significant difference in (control and 20% CP group),but group 3&4 had been significant different **(Table 2)**.

Surface roughness topography picture of each control and bleached groups of four material specimen from each group shown in (**figure 4)** .

Discussion

After dental bleaching, evaluations of composite restorations characteristics, such as surface roughness, marginal integrity and color change are considered necessary parameters. Surface roughness is critical in which it has maintenance representation as its effect may lead to composite resin wear and discoloration. On the other hand, the biological effect of surface roughness to the periodontium, particularly the occurrence of gingivitis and secondary caries may appear after CP bleaching**[14].**

AFM cantilever sensor has been used to record any irregularity at composite surface. However, all the composites samples were polished with the same polishing system (one-step OptraPol disks) in order to achieve surface finish similarity before bleaching treatment. In this study, two of study groups were statistically non significant but at the same time group A which represent restoration roughness without bleaching have Ra values lower than that of group B[11]. This will be agree with recently reported research assuming that bleaching may cause increased surface roughness on composite materials[15]. As seen in subgroups of groups 3&4; in which it was significantly different $p<0.05$; bleaching agents may resulted in a softening and reduction in micro-hardness and free radicals induced by peroxides may affect the resin-filler-interface and cause filler-matrix debonding[16]. In other words, explanation of increasing Ra in post bleaching group was that; as bleaching agent used in the study was CP- based, which breaks down into urea and hydrogen peroxide. This in turn forms free radicals that can eventually form water and accelerate the hydrolytic degradation of the composite, resulting in bonding failure between the resinous matrix and load particles, increasing the surface roughness of the composite [17].Another parameter explain increase of surface roughness in these nanohybrid groups was related to increase of monomer or matrix elution ; water accumulated at the aggregated zirconium/silica cluster filler-organic matrix interface this can create paths in nanofilled composite for water diffusion towards the inside of aggregates, where probably microvoids are present,due to lack of 5–20 nm-sized primary in the polymeric matrix particles may be impregnated [18]. The diffusion occurred in a Part of absorbed water in composites through the network and is trapped in polymer nano-voids; so the amount of absorbed water dictated the total void amount in the polymer network [19].

Initially, polymer softening caused by water sorption as a result of reducing the frictional forces between the polymer network[20]. unreacted monomers trapped in the polymer chains are released at a rate controlled by the relaxation capacity and polymer's swelling [21].This phenomenon possibly explains the greater release of monomers from nanofilled composite[22].But this increase in Ra after bleaching statistically non significant different as previously mentioned in other two subgroups.

In which group 1 (Brilliant ever glow which was considered submicron hybrid composite) had close result Ra values in both subgroups that mean bleaching agent didn’t affect composite polished surface in which this will make the material to be valuable &good quality characteristic feature as it had 74% inorganic filler by weight and had filler size of about 20-1500 nm which considered as highly filled composite type[23] . The inorganic content of resin composites however, offers resistance to bleaching. shape, distribution and amount of fillers are all aspects that determine the clinical performance of these restorative materials[24,25].Despite advances in the evolution of composites, no material yet exists that is totally resistant to erosion/corrosion. Recent studies have reported that the durability of resin-based materials can be assured by polishing the restorations after bleaching [26,27] .As **Wattanapayungkul and others in 2004** suggested that differences between the materials could be a result of the difference in resin matrix components and filler size[16].

Group 2 G-ænial which is microfilled hybrid composite type the results were non significantly affected by bleaching which is come to be agree with **Turker and Biskin in 2003**, research findings showed that the surface roughness of the microfilled composite was not affected by different CP concentrations[28]. Studies had been suggested that roughening can be resulted from the loss of matrix, rather than filler particles [29,30].

In control group, the least Ra value was recorded for nanohybrid composite evetric group. This result is in accordance with the results reported by **Ergücü et *al* in 2008**; they suggested that One-step polishing systems could be used successfully for polishing nanocomposites [31]. Nano-sized particles composites can retain a uniform texture after polishing process (Filler loading 80-81 wt. %, 55-57 vol. %).The adequate polishing protocols have a major role in the final surface quality[32]. However, final surface texture is material and technique dependent [33,34] .

All groups Ra values were under 1µm ; As to Chung in 1994 study, when Ra was lower than 1µm, smooth surfaces were visibly seen. As a result, all composites resin material surfaces evaluated after bleaching treatment have verified a smooth surface, which from the clinical point of view, there were no risk of increase of plaque accumulations [35,36] . It is essential to note that this is an *in vitro* study, with its limitations, only the surface roughness of composite materials was determined & evaluated, without concerning with aesthetic factors; composite restorations color which probably affected by bleaching [37,38].

Conclusion

Within the limitations of the current study, it can be concluded that:

1- The effect of 20% CP home bleaching agent on the surface roughness of tooth-colored restorative materials is material dependent.

2- 20% CP home bleaching agent home bleaching increased Ra of polished surface of - nanohybrid composite groups. However, it did not affect the polished surface of neither Brilliant, nor G-ænial composite resin materials.

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Tables

Table 1. Mean values of surface roughness for all groups

Groups		Means (µm)	Std. Dev.
G1	A(control)	0.53	0.09
	B(bleached)	0.63	0.04
G 2	A(control)	0.86	0.11
	B(bleached)	0.90	0.06
G3	A(control)	0.23	0.04
	B(bleached)	0.73	0.16
G4	A(control)	0.56	0.18
	B(bleached)	0.85	0.04

Table .2results taken from LSD test among all subgroups

Sig	**P value**	**CP Group B**	**Control Group A**
N.S	0.584	1	1
N.S	0.539	2	2
H.S	0.000	3	3
H.S	0.000	4	4

***Highly significant difference; N.S Non-significant difference

Figures

Figure 1.Four types of composite materials used

Figure 2.Cylinder shape sample material

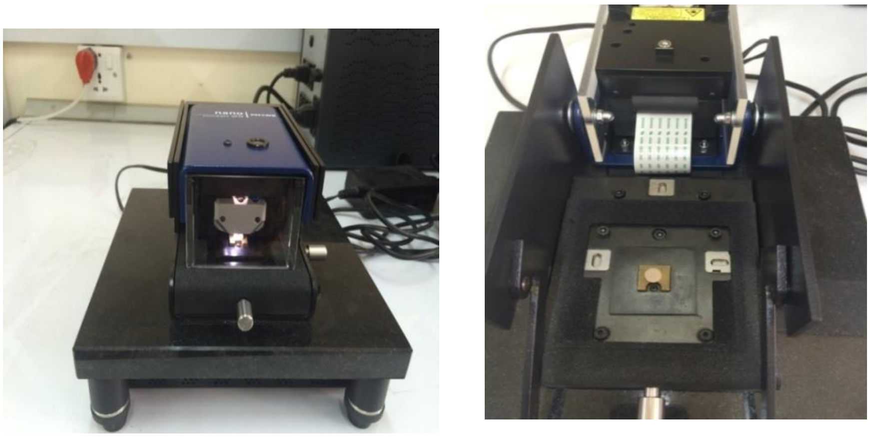

Figure 3. Sample positioned inside AFM device

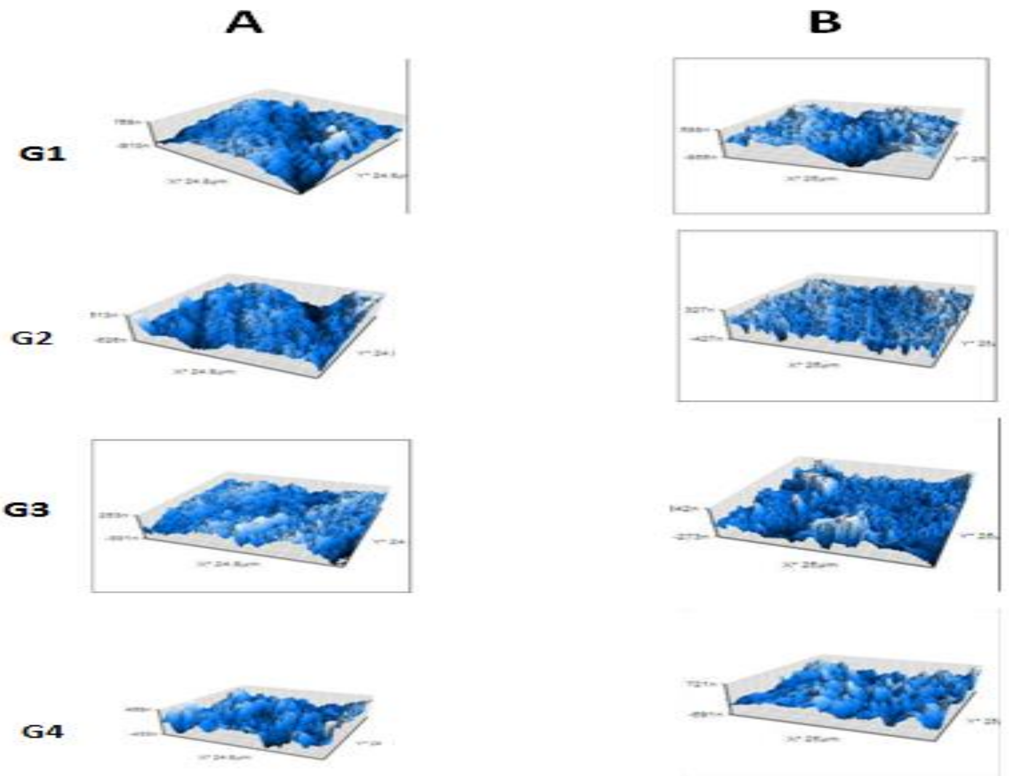

Figure 4 A: Ra topography in control group B:Ra topography in bleached group