

EVALUATION OF SURFACE ROUGHNESS OF RESIN-BASED COMPOSITES SUBMITTED TO DIFFERENT LIGHT-ACTIVATION PROTOCOLS AND BLEACHING AGENTS

ABSTRACT

This study evaluated the surface roughness (Ra) of methacrylate and silorane-based composites submitted to different light-activation protocols and bleaching agents. The samples were divided into 12 groups (n=10) according to the composite (Filtek Z250 - 3M Espe, Filtek P90 - 3M Espe and Opallis - FGM); to the light-activation protocol (1000 mW/cm² X 18 s (S) and 3200 mW/cm² X 6 seconds (PE)); and bleaching agent (hydrogen peroxide at 6% and hydrogen peroxide at 35%). Roughness test were carried out at the following set times: initial (R1), after polishing (R2) and 24 hours after bleaching (R3). Data obtained were submitted to the statistical analysis. The results showed that higher values of Ra in R1 were obtained by Filtek P90 composite, differing significantly of the other samples, which showed similar results among them. There was significant decrease of Ra in R2 under all the conditions, except by the Opallis composite, independently on the light-activation protocol, and Filtek Z250 light-activated by PE protocol. There were no difference between R2 and R3 for all the composites and any light-activation protocol. It was possible conclude that bleaching agents did not interfere in significant way on surface roughness of the composite evaluated.

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INTRODUCTION

From their introduction in the market, dental composites have become popular and object of several researches that aimed their improvement.¹ Nowadays they have been the material of choice not only for anterior restorations, but also for posterior restorations, because aesthetic is a requirement more and more demanded by the society and due to the considerable improvements in the composite properties, there is a higher durability of adhesive procedures in direct restorations.²

However, some clinical aspects may determine the success or failure of these restorations. One of these aspects is related to the degradation of the composite matrix along the time. In a clinical situation, degradation of composites should not be attributed to a single factor or a chemical substance; on the contrary, it is the result of complex reactions among several factors.³ The water is directly related to the deterioration of the organic matrix composites. The sorption of this liquid results in a process of diffusion in the composite resin matrix, and may cause its degradation and result in inferior mechanical and physical properties, mainly in relation to the hardness and roughness of resins.⁴

About the effects of hydrogen peroxide in the composite matrix, it is known that acid solutions may provoke changes in the organic composition of composite resins. It is

speculated that the higher oxidative power of bleaching agents, when in contact with organic molecules could provoke damages to the polymer linkages, what make the composite more susceptible to degradation. Besides, changes in the organic phase may lead to a decrease of physical properties of material.⁵

Thus, the aim of this study was to evaluate the influence of light-activation protocol and bleaching agents on the superficial roughness of composites.

MATERIAL AND METHODS

The composite resins used in this experiment are presented in table 1.

Sample preparation:

In order to perform this study, 120 samples were prepared according to experimental groups (n=10). For this, a Teflon mold with a central cylindrical cavity of 5 mm of diameter and 2 mm of height were used.

A transparent polyester strip was positioned on the bottom of the mold and then the cavity was filled in one increment and covered the top with another polyester strip. A glass plate was positioned above the polyester strip during 10 seconds in order to provide a flat surface. The increment of composite was light-activated according to the experimental group using a LED third generation device (Valo-Ultradent) in two distinct protocols: Standard (S): 1000 mW/cm² during 18 s (18 J/cm²) and Plasma Emulation (PE): 3200 mW/cm² during 2 cycles of 3 s (19.2 J/cm²).

After the confection, the samples were removed from the mold, identified and stored

properly at 37°C and 95% of relative humidity of environmental air for a period of 24 hours.

Table 1 - Composition and characteristics of materials.

Material	Manufacturer	Composition	Particle size
Filtek P90	3M ESPE, Dental Products, St. Paul, MN, USA	Silorane (ECHCPMS, bis-3, 4- epoxy cyclohexyl methyl-phenyl-ethyl silane, camphorquinone), Silanized quartz/ Yttrium fluoride. Load content (weight): 76 wt%. Inorganic load volume: 53 vol%	0.04 - 1.7 µm
Filtek Z250	3M ESPE, Dental Products, St. Paul, MN, USA	UDMA), Zirconia/Silica. Load content (weight): 82% wt%. Inorganic load volume: 60 vol%	0.01 - 3.5 µm
Opallis	FGM Dental Products, Joinville, SC, Brazil	Methacrylate (Bis-GMA, Bis-EMA, TEGDMA), Silanized barium-aluminum glass/Nanoparticle. Load content (weight): 79 wt%. Inorganic load volume: 57,5 vol%	0.02 - 3 µm

*Information provided by manufacturer

Surface roughness test:

Surface roughness was determined with the profilometer (Surftest 211; Mitutoyo Corp., Tokyo, Japan). Each sample was fixed individually in an acrylic base and the profilometer-measuring tip was positioned on the sample surface. The values of Ra (arithmetic average of surface roughness) were measured using cut-off of 0.25mm, at 0.05 mm/s of speed. Three readings were performed on each surface in different positions and the average was calculated. Each reading was obtained after spin the sample in 120 degrees.

The samples were stored in dark recipient at 37°C of temperature for a period of 24 hours.

After this period, the finishing and polishing procedures of composites were performed with aluminum oxide disks SofLex (3M Espe) with four decreasing granulations in low rotation. Each disk was elapsed after thirty seconds of application.

Next, a second reading of surface roughness (R2) was performed, according to the method previously described.

Bleaching process:

In samples treated with White Class 6% (hydrogen peroxide 6%) (FGM Dental Products, Joinville, SC, Brazil), the bleaching agent was in contact with the sample for 2 hours a day during 2 weeks. The samples submitted to Whiteness HP Maxx 35% (hydrogen peroxide 35%) (FGM Dental

Products, Joinville, SC, Brazil) were in contact with it for 2 sessions of 3 applying of 15 minutes each one with intermediate washing.

After the bleaching process, all the samples were washed and the last measurement of surface roughness (R3) was performed according to the method previously described.

RESULTS

After exploratory analysis and selection of the better covariance structure, the data were analyzed by a statistical consultant through mixed models for repeated measures by PROC MIXED procedure of statistical program SAS. Multiple comparisons were performed through the Tukey-Kramer test considering the level of significance of 5%. The results are presented in Table 2, where it is observed that Filtek P90 presented higher values of initial surface roughness when compared to Filtek Z250 and Opallis. Those, however, obtained similar results among them. There was significant decrease of surface roughness after the finishing and polishing process in all the conditions, except for the Opallis composite, independent on the light-activation mode, and Filtek Z250 light-activated by Plasma Emulation protocol. There was not difference of surface roughness between R2 (after finishing and polishing) and R3 (after bleaching) for three resins tested, in all the light-activation protocols.

DISCUSSION

The aim of this work was evaluate the surface roughness of three composites: two methacrylate-based and one silorane-based,

submitted to different light-activation protocols and bleaching agents.

It was observed that higher values of initial surface roughness (R1) was obtained by the silorane-based composite Filtek P90, differing significantly of the others, Filtek Z250 and Opallis, which presented similar results between them.

Inorganic content of Filtek P90 is composed by quartz particles, which spatial orientation may be described as a crystalline solid SiO₄ tetrahedron interconnected. On the other hand, Filtek Z250 consists in glass, which silica structures (SiO₂) have amorphous orientation (no crystalline). Besides, Filtek Z250 present load particles of glass and zircon in its composition. According to Lien & Vandewalle (2010),⁶ it is not clear how the molecular dynamic of matrix particle and spatial configuration of chemical bonds among atoms SiO₄ may dictate the macroscopic rigidity of the material. Material composition may also affect its properties before polymerization. During the manipulation and insertion of the material in the matrix, it was possible realize a more viscous characteristic of the material P90, what may interfere in adaptation and accommodation of the material in the mold and interfere in the initial surface roughness, even after digital pressure. Therefore, this material presented higher initial roughness.

During the finishing process, restoration is contoured to equate it to the tooth shape and to establish marginal integrity to the interface tooth-restoration. Thereunto, cutting particles used to finishing should be harder than load particles of composite resin. Otherwise, these particles may provoke abrasion of the organic matrix and rounding of load particles, resulting in higher surface roughness.⁷ Generally, the finishing process of

restorations improves the contour of dental restored element, but leaves scratches from moderate to profound or surface irregularities on the material. The polish is a stage that involves application of sequential abrasives with particles each time more thin in order to reduce significantly or remove the extent and depth of these scratches⁸, making the surface flatter and bright.

Table 2 - Ra in function of bleaching agent, composite resin, light-activation protocol and reading.

Light-activation protocol	Bleaching agent	Composite Resin	Reading		
			R1	R2	R3
Standart	Hydrogen Peroxide 6%	Filtek Z250	0.56 (0.39) Ab	0.14 (0.07) Ba	0.14 (0.03) Ba
		Filtek P90	0.82 (0.45) Aa	0.19 (0.08) Ba	0.20 (0.12) Ba
		Opallis	0.40 (0.24) Ab	0.21 (0.10) Aa	0.21 (0.14) Aa
	Hydrogen Peroxide 35%	Filtek Z250	0.36 (0.29) Ab	0.21 (0.09) Ba	0.20 (0.07) Ba
		Filtek P90	0.66 (0.41) Aa	0.21 (0.06) Ba	0.28 (0.19) Ba
		Opallis	0.25 (0.14) Ab	0.20 (0.08) Aa	0.28 (0.14) Aa
Plasma Emulation	Hydrogen Peroxide 6%	Filtek Z250	0.28 (0.19) Ab	0.23 (0.13) Aa	0.19 (0.09) Aa
		Filtek P90	0.99 (0.54) Aa	0.19 (0.13) Ba	0.22 (0.10) Ba
		Opallis	0.42 (0.32) Ab	0.21 (0.10) Aa	0.20 (0.09) Aa
	Hydrogen Peroxide 35%	Filtek Z250	0.31 (0.30) Ab	0.22 (0.08) Aa	0.22 (0.08) Aa
		Filtek P90	0.68 (0.34) Aa	0.20 (0.07) Ba	0.31 (0.29) Ba
		Opallis	0.20 (0.20) Ab	0.21 (0.09) Aa	0.20 (0.09) Aa

Averages followed by distinct letters (capital on horizontal and lower case on vertical sense comparing composite resin within each light-activation protocol and bleaching agent) are different between them ($p \leq 0.05$).

In the present study, the abrasive chosen were Soflex disks (3M Espe), composed by aluminum oxide, since it has been reported in the literature that the use of these flexible disks result in lower surface roughness of

composite resins of hybrid and nanoparticulate micro-particles.⁷

In general way, in R2 the surface roughness decreases in all the conditions; this finding is according to Marghalani 2010⁹ and Schmitt et al 2011¹⁰. For Opallis resin, there

was not significant statistically difference between R1 and R2. This material presents higher content of organic matrix, what give lower values of Ra for R1, and they were not different after perform of polish, maintaining the same satisfactory smooth surface.

Although tooth bleaching is very popular, there is not a consensus about the effects of bleaching gel on restorative materials. There are few reports in the literature, especially about the effects of bleaching gels in high concentration on restorative materials. Clinically, the concerning is related to the process of oxidation and its effect on the organic matrix of composite resin, what may facilitate water absorption and provide the loss of load particles, reducing the surface integrity and micro-hardness.

In the present study, it was observed that there was not change in the surface roughness after bleaching in all the experimental conditions. This result matches with Yap & Wattanapayungkul (2004)¹¹, when evaluated the effect of carbamide peroxide at 35% in the roughness of composite resins and cements of glass ionomer modified by resin, they observed that there was not changes in the roughness. It is also according to the results of works in which were tested the effect of carbamide peroxide at 10% and 35%^{12,13} about composite resin, and they observed that, when the effect occurs, it is soft.

CONCLUSION

It was possible conclude that bleaching agents did not interfere in the surface roughness of composite evaluated.

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