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Camila da Silva Rodrigues

EFEITO DO REPOLIMENTO APÓS CLAREAMENTO NA ESTABILIDADE DE COR E RUGOSIDADE DE RESINAS COMPOSTAS

Santa Maria, RS
2016

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Dissertação apresentada ao Curso de Mestrado do Programa de Pós-Graduação em Ciências Odontológicas, Área de Concentração em Odontologia, ênfase em Prótese Dentária, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do grau de **Mestre em Ciências Odontológicas.**

Orientadora: Profª. Drª. Liliana Gressler May
Co-orientadora: Profª. Drª. Letícia Borges Jacques

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mas da tentativa ao longo da vida para adquiri-la.

(Albert Einstein)

RESUMO

EFEITO DO REPOLIMENTO APÓS CLAREAMENTO NA ESTABILIDADE DE COR E RUGOSIDADE DE RESINAS COMPOSTAS

AUTORA: Camila da Silva Rodrigues
ORIENTADORA: Liliana Gressler May
CO-ORIENTADORA: Letícia Borges Jacques

Este trabalho avaliou o efeito do repolimento após clareamento na estabilidade de cor e na rugosidade de duas resinas compostas ao serem expostas à solução de alto potencial pigmentante. Foram confeccionados 61 corpos de prova em forma de disco (8 mm diâmetro x 2 mm espessura) de cada resina (microhíbrida vs. nanoparticulada), que foram divididos conforme tratamento recebido: clareados ou não clareados. Após, os grupos foram subdivididos de acordo com o tratamento de superfície, com repolimento ou sem repolimento, usando discos de lixa na granulação extrafina e feltro com pasta diamantada extrafina. Nova subdivisão foi realizada baseada no meio de armazenamento: 15 min/dia em vinho tinto ou 24 h/dia em saliva artificial durante 30 dias. Sucessivas leituras de cor e rugosidade (Ra) foram efetuadas após 24 h da confecção dos cps (P0), após tratamento clareador (P1), após tratamento de superfície (P2) e após imersão (P3). A alteração de cor (ΔE_{00}) foi calculada pela equação CIEDE2000. Em cada fase do estudo, um corpo de prova de cada grupo foi removido e analisado por microscopia eletrônica de varredura (MEV). A análise estatística foi realizada pelo Teste de Análise de Variância para medidas repetidas seguido do Teste de Tukey como *post-hoc* (nível de significância de 5%). Os grupos clareados repolidos apresentaram menor alteração de cor que os grupos clareados não repolidos das duas resinas compostas quando imersas em vinho tinto. O repolimento (P2 vs. P1) promoveu diminuição dos valores de rugosidade de quase todos os grupos. A resina nanoparticulada apresentou valores maiores de alteração de cor que a resina microhíbrida nos grupos imersos em vinho. As imagens de MEV mostraram maior número de porosidades nos grupos clareados não repolidos. Portanto, o repolimento imediatamente após o clareamento aumenta a estabilidade de cor de resinas compostas quando há contato com agentes corantes, e também pode diminuir a rugosidade desses materiais.

Palavras-chave: Alteração de cor. Agentes clareadores. Resinas compostas. Rugosidade.

ABSTRACT

EFFECT OF REPOLISHING AFTER BLEACHING ON COLOR STABILITY AND ROUGHNESS OF COMPOSITE RESINS

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ADVISOR: LILIANA GRESSLER MAY
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This study aimed to evaluate the effect of repolishing after bleaching on color stability and roughness of two composite resins aged in high staining beverage. Sixty-one disc-shaped specimens (8 mm diameter x 2 mm thickness) of each composite resin were fabricated (microhybrid vs. nanoparticle), then divided according to treatment: bleached or non-bleached. After bleaching phase, groups were subdivided according to surface treatment, repolished or unrepolished, using extrafine sandpaper discs and felt with diamond paste. A new subdivision was performed according to aging conditions: immersion in red wine 15 min/day or in artificial saliva 24 h/day during 30 days. Color (CIE L*a*b* system) and roughness (Ra) were assessed at baseline (P0), after bleaching procedures (P1), after surface treatment (P2) and after aging (P3). Color change (ΔE_{00}) was calculated with CIEDE2000 formula. One specimen per group was removed from each study phase, in order to be analyzed in Scanning Electron Microscope (SEM). Statistical analysis was performed using repeated measures ANOVA and Tukey’s test as *post-hoc* (significance level was set at 5%). Bleached repolished groups presented lower color alteration than the bleached unrepolished groups of both composite resins when aged in red wine. Repolishing (P1 vs. P2) promoted a decrease in roughness values of almost all groups. Nanoparticle resin presented greater ΔE_{00} values than microhybrid one when aged in red wine. SEM images reveled more porosities in bleached unrepolished groups. Therefore, repolishing immediately after bleaching improves color stability of composite resins when exposed to staining agents, and it is capable to improve smoothness.

Keywords: Bleaching agents. Color change. Composite resins. Smoothness.

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1 INTRODUÇÃO

As resinas compostas são materiais amplamente utilizados em Odontologia devido a sua facilidade de manipulação e por reunir propriedades ópticas e desempenho mecânico satisfatórios. O sucesso estético das restaurações de resina composta está relacionado à capacidade do material de reproduzir características importantes na aparência do tecido dental, como cor, translucidez, opacidade, brilho e fluorescência.

Com o passar do tempo na cavidade bucal, as resinas compostas apresentam alteração na sua cor, que é acentuada quando a dieta do indivíduo inclui agentes corantes. Estudos anteriores mostraram que bebidas como chá, café e bebidas à base de cola promovem significativa alteração de cor nesses materiais, no entanto, o vinho tinto tem se destacado como meio de maior potencial pigmentante (ARDU et al., 2010; BARUTCIGIL; YILDIZ, 2012; TOPCU et al., 2009). Segundo Barutcigil e Yildiz (2012), o álcool que está presente no vinho tinto, bem como seu pH ácido, causam degradação na superfície desses materiais. Isto pode proporcionar uma maior área de superfície para adsorção de pigmentos, conduzindo à coloração mais intensa (AZER; HAGUE; JOHNSTON, 2011). Além disso, a alteração de cor também é material dependente, pois está relacionada com o tipo de matriz resinosa, tipo de partícula de carga e agente de coloração (TOPCU et al., 2009).

As resinas compostas podem ser classificadas conforme o tamanhos de suas partículas de carga. As resinas chamadas microhíbridas são consideradas universais, por serem usadas em restaurações anteriores e posteriores devido a sua combinação de resistência e boa capacidade de polimento. As últimas a entrarem no mercado foram as resinas de nanopartículas (FERRACANE, 2011). Apesar de os fabricantes desses materiais afirmarem que as resinas nanoparticuladas possuam menor rugosidade devido ao menor tamanho das partículas de carga, não há evidencias sólidas que, de fato, elas apresentem melhor lisura e brilho que as tradicionais microhíbridas (KAIZER et al., 2014).

A rugosidade também tem impacto importante na estética e descoloração das restaurações de resina composta (ALAWJALI; LUI, 2013; ERGÜCÜ; TÜRKÜN; ALADAG, 2008; JANUS et al., 2010). Uma técnica de acabamento e polimento de qualidade proporciona longevidade e boa aparência às resinas compostas, enquanto superfícies rugosas contribuem para manchamento, acúmulo de placa, inflamação gengival e cárie recorrente (GÖNÜLOL; YILMAZ, 2012; MORGAN, 2004), além de causar desconforto e dificuldade de higienização para o paciente (JEFFERIES, 2007). Em seus trabalhos, Gönülol e Yilmaz (2012), Alawjali e Lui (2013) e Barakah e Taher (2014) avaliaram a influência de diferentes técnicas de polimento na estabilidade de cor de diferentes resinas e observaram uma importante relação entre esses fatores.

Devido à crescente demanda pela estética, não só as resinas compostas, mas os géis clareadores se tornaram produtos de uso frequente nos consultórios odontológicos. Métodos distintos são empregados para clarear dentes vitais, utilizando diferentes agentes clareadores, concentrações, tempos e formas de aplicação (JOINER, 2006). No entanto, existem três abordagens fundamentais: 1) produtos vendidos no mercado, com baixa concentração de peróxido, através de fitas clareadoras ou presentes em dentifrícios e colutórios; 2) técnica caseira, em que o paciente utiliza o clareador, geralmente o peróxido de carbamida, de baixa concentração em uma moldeira sob supervisão de um dentista; e 3) técnica de consultório, em que são feitas sessões para aplicação do peróxido de hidrogênio em alta concentração (ALQAHTANI, 2014). Todas apresentam vantagens e desvantagens, porém, a técnica de consultório se destaca por apresentar resultados visíveis de maneira mais rápida e, por isso, se torna uma boa opção para os pacientes que almejam resultados a curto prazo.

Durante o procedimento clareador, dentes e restaurações são expostos à ação dos géis e após esse tratamento, muitas vezes, restaurações são removidas devido a possíveis alterações físicas e mecânicas nas resinas compostas, como a alteração na sua rugosidade, na dureza e na estabilidade de cor (GURGAN; YALCIN, 2007; KURTULMUS-YILMAZ et al., 2013; TORRES et al., 2012). Segundo Rodrigues et al. (2005), a superfície desses materiais quando submetidos a peróxidos clareadores fica mais porosa e com rugosidade aumentada. Isto pode causar descoloração mais facilmente (YU et al., 2009). No entanto, existem situações em que as restaurações podem ser mantidas após o clareamento. Isso é possível quando a interface entre tecido dental e material restaurador em dentes clareados não são afetadas (WHITE;

DUSCHNER; PIOCH, 2008) e a cor do esmalte clareado combine com a cor da restauração de resina composta (VILLALTA et al., 2006).

A consequência do clareamento nas resinas compostas pode variar de acordo com a composição da resina e do gel clareador, assim como a frequência e duração da exposição ao clareador (ATTIN et al., 2004). Yu et al. (2009) estudaram o efeito do peróxido de carbamida 15% na susceptibilidade ao manchamento de materiais resinosos e concluíram que os espécimes clareados pigmentaram mais facilmente. Çelik et al. (2009), em um estudo semelhante, avaliaram a influência do peróxido de carbamida 20% na estabilidade de cor de resinas compostas e não encontraram maior descoloração nos grupos clareados. Polydorou, Hellwig e Auschill (2006) não verificaram mudanças na textura superficial dos espécimes submetidos à polimento e clareamento, quando estudaram o efeito do peróxido de carbamida 15% e peróxido de hidrogênio 38% em três diferentes resinas compostas. Hubbezoglu et al. (2008) encontraram alteração estatisticamente significante na estabilidade de cor de espécimes submetidos a clareamento com peróxido de hidrogênio 35%. Yu et al. (2013) também estudaram o efeito de clareadores na superfície desses materiais e sugerem que possa existir a necessidade de polimento de materiais restauradores que, durante o procedimento clareador, tenham entrado em contato com o gel.

A alteração de cor pode ser avaliada por instrumentos como colorímetros e espectrofotômetros, o que elimina a subjetividade da interpretação visual (MEIRELES et al., 2008). Os espectrofotômetros estão entre os instrumentos mais precisos (PAUL et al., 2004). Esse equipamento mede o comprimento de onda através da reflectância ou transmitância de um objeto (JOINER, 2004). Para verificar a alteração de cor (ΔE), as leituras iniciais e finais dos parâmetros de cor obtidos através do espectrofotômetro podem ser aplicadas em equações recomendadas pela Comission Internacionale de l'Eclairage (CIE) e fornecem uma representação quantitativa de diferença de cor. A equação CIEDE2000 é consideravelmente mais sofisticada do que suas antecessoras CIELAB e CIE 94 (SHARMA; WU; DALAL, 2005), pois utiliza os conceitos de croma e matiz, reforçando os desenvolvimentos conceituais de Munsell (GHINEA et al., 2010).

Sabe-se que a troca de restaurações implica em mais perda de tecido dental e maior custo para o paciente, além de que nem sempre é necessário trocá-las após procedimentos clareadores. A literatura tem mostrado a influência dos agentes clareadores em propriedades como dureza (Al-QATANI et al., 2014) e resistência a fratura (FEIZ et al., 2016) de resinas compostas. Porém, em restaurações anteriores, as quais entram em contato direto com o gel clareador, essas propriedades não são tão importantes quanto rugosidade e cor, altamente influentes na estética das restaurações. Alguns estudos (YU et al., 2009; HUBBEZOGLU et al., 2008) relatam que os clareadores influenciam a rugosidade e estabilidade de cor das resinas compostas; outros (ÇELIK et al., 2009; POLYDOROU, HELLWIG e AUSCHILL, 2006) não encontraram influência significativa, indicando não haver consenso sobre o assunto. Considerando esses aspectos e a importância do polimento na estabilidade de cor dos materiais resinosos, faz-se necessário estudos que verifiquem se o repolimento após o procedimento clareador pode exercer influência na estabilidade de cor de diferentes resinas compostas.

2 ARTIGO – Repolishing resin composites after bleaching treatments: effects on color stability and smoothness.

Este artigo será submetido à publicação no periódico *Journal of Dentistry*. As normas para publicação estão descritas no Anexo A.

Repolishing resin composites after bleaching treatments: effects on color stability and smoothness.

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ABSTRACT

Objectives: To evaluate the effect of repolishing after bleaching on color stability and smoothness of two resin composites aged in high staining beverage. **Methods:** Sixty-one disc-shaped specimens (8 mm diameter x 2 mm thickness) of each resin composite were fabricated (microhybrid vs. nanofilled), then divided according to treatment: bleached or non-bleached. After bleaching phase, groups were subdivided according to surface treatment, repolished or unrepolished, using extrafine sandpaper discs and felt with diamond paste. New subdivision as performed according to aging conditions: red wine 15 min/day or artificial saliva 24 h/day during 30 days. Color (CIE L*a*b* system) and roughness (Ra) were assessed at baseline (P0), after bleaching procedures (P1), after surface treatment (P2) and after aging (P3). Color change (ΔE_{00}) was calculated with CIEDE2000 formula. One specimen per group was removed on each study phase, in order to be analyzed in Scanning Electron Microscope (SEM). Statistical analysis was performed using repeated measures ANOVA and Tukey's test as post-hoc. **Results:** Bleached repolished groups presented lower color alteration than the bleached unrepolished groups of both resin composites when aged in red wine. Repolishing (P1 vs. P2) promoted a decrease in roughness values of almost all groups. Nanofilled composite presented greater ΔE_{00} values than microhybrid one when aged in red wine. SEM images reveled more porosites in bleached unrepolished groups. **Conclusions:** Repolishing immediately after bleaching improves color stability of resin composites when exposed to staining agents, and it is capable to improve smoothness.

Clinical significance: When resin composites are exposed to bleaching procedures, repolishing immediately after the last gel application improves its color stability and smoothness.

INTRODUCTION

Resin composites and bleaching agents have been widely used, due to the increasing demand for esthetics. Beaching procedures are common practices to remove intrinsic and extrinsic stain from dental tissue and in-office technique is chosen by those who seek fast results. Thus, it is not uncommon that patients assigned for bleaching treatment have resin composite restoration in the areas to be exposed to bleaching agents.

Color change of resin composite is related to factors as matrix and filler types and coloration agent [1], and it is intensified when the material is in contact with diet staining agents, alcoholic media, and acidic media, due to further degradation of the organic matrix ([1–4]. Smoothness is another important factor on composites discoloration [5–7]. High-quality finishing and polishing improve both longevity and appearance of resin composite, whereas rough surfaces contribute to staining, plaque accumulation, recurrent caries and gingival irritation [8], and also cause discomfort and cleaning difficulties to patients [9].

Teeth and restorations are exposed to bleaching action during treatments, and, commonly, these restorations are changed after the treatment due to possible resin composites physical and mechanical alterations, such as in its roughness, hardness and color stability [10–12]. According to Rodrigues et al [13], resin composites surface become more porous and rougher when it is submitted to bleaching procedures, which may facilitate discoloration [14]. Nevertheless, resin composite restorations can be maintained after bleaching in some situations, such as when the dental tissue and restorative material interface in bleached teeth are not affected [15] and the bleached enamel color matches the restoration color [16].

The consequence of bleaching on resin composites depends on both bleaching agent and composites compositions, as well as the frequency and duration of exposure to bleaching [17]. Yu et al [14] evaluated the effect of 15% carbamide peroxide on staining susceptibility of resinous materials and observed that bleached specimens stained easier. Çelik et al [18], in a similar research, analyzed 20% carbamide peroxide influence on resin composites color stability and have not find greater discoloration on bleached groups. Polydorou, Hellwig and Auschill [19] have not verified alteration on surface texture of polished and bleached specimens, while studying the effect of 15% carbamide peroxide and 38% hydrogen peroxide in three different resin composites. Hubbezoglu [20] found statistical significant difference on color stability of specimens bleached with 35% hydrogen peroxide. Yu et al [21] have also studied the effect of bleaching agents on these materials' surfaces and suggested that it may be need to polish the restorations which were in contact with bleaching gel during treatment.

Within this scope, this study aimed to evaluate the effect of repolishing after bleaching on color stability and smoothness of two resin composites (microhybid vs. nanofilled) aged in high staining beverage. Tested hypothesis were: 1) bleaching followed by repolishing promotes a decrease in color change and smoothness of resin composites after aging; 2) bleaching resin composites promotes color change and increase in roughness values, and 3) color stability and smoothness of resin composites are affected by bleaching and repolishing after aging.

MATERIALS AND METHODS

Study design

Analyzed factors of this *in vitro* study were material (2 levels: microhybrid or nanofilled composites), bleaching (2 levels: bleached or non-bleached), surface treatment (2 levels: repolished or unrepolished), aging media (2 levels: red wine or artificial saliva) and study phase (4 levels: P0, P1, P2, and P3). The same specimen within each experimental condition was analyzed in all phases (repeated measures approach): baseline (P0), after bleaching procedure (P1), after surface treatment (P2), and after aging (P3). Primary outcomes under investigation were color difference (ΔE_{00}) and smoothness (Ra).

Figure 1 describes the treatment sequence and groups division and names.

Used materials characteristics are described on Table 1.

Specimen preparation

Sample size was calculated using *www.sealedenvelope.com* site (Sealed Envelope Ltd, London, UK). Means and standard deviations were obtained from a pilot study and were considered of control groups were 0.98, experimental group were 1.10 and standard deviation were 0.08. It was observed that n=7 was sufficient to show statistical difference among groups, considering 5% significance level and 80% statistical power.

A hundred and twenty two specimens (sixty one of each composite) were fabricated. One specimen per group was randomly selected after each study phase (baseline, bleaching, surface treatment and aging period) to being analyzed in Scanning Electron Microscopy (SEM). Last phase was finalized with n=7. A stainless steel matrix with a central hole of 2 mm thickness and 10 mm diameter was positioned over a glass plate and a polyester strip. Resin composite was placed in one increment into the matrix and covered by another polyester strip and a glass plate. An axial load of 500 g was applied for 20 s to promote smoothness and extrude the excess of resin composite. The specimen was then photoactivated for 20 s through the glass plate, plus 20 s without it, by a LED light source (Raddi, SDI, Bayswater, Victoria, Australia) with approximately 1000 mW/cm^2. Immediately after photoactivation, all specimens' faces were finished and polished with medium, fine and extra fine sandpaper discs (Diamond Pro, FGM Produtos Odontológicos, Joinville, Brazil) for 20 s per disc. A felt disc (Diamond Flex, FGM Produtos Odontológicos, Joinville, Brazil) with extra-fine (2-4 μm) diamond paste (Diamond Excel; FGM Produtos Odontológicos, Joinvile, Brazil) was also used for 20 s to achieve the final polishing. One previously trained operator, blinded for the group to which each specimen belonged, carried out all procedures, and in every disc exchange specimens were rinsed and gently dried with gauze. A digital caliper (Absolute Digimatic, Mitutoyo, Tokyo, Japan) was used to measure specimens' thickness, and those that varied more than 0.05 mm were discarded. Specimens were lightly marked on *x* and *y* axes at the bottom surface so that measurements were always carried out on the same position. Specimens of each composite were numbered according to the fabrication order and a random number sequence in two columns was generated by *www.random.org* site, aiming to divide two groups (n=30) for the first study phase (bleached or non-bleached). Groups were kept in artificial saliva at 37 °C during 24 h to initial hydration.

Bleaching procedure

A standard Teflon mold (with cylindrical holes of 3 mm depth and 10 mm diameter) was designed to hold the specimens, in order to get fixed and to standardize the bleaching procedures. Specimens were inserted in the mold with the top surface exposed 1 mm downward from the mold surface. Bleaching gel was manipulated according to manufacturer's recommendations and applied over the top surface of each specimen. During each gel application, the device containing specimens was placed over humid gauzes inside a plastic pot and kept at 37 °C, aiming to maintain relative humidity until next application. Groups were submitted to two bleaching applications of 20 min per session in three sessions with 7-day intervals. After each session, specimens were rinsed, dried with absorbent paper and returned to closed bottles containing artificial saliva.

Non-bleached groups were kept immersed in artificial saliva at 37 °C during bleaching phase. Saliva bottles were refilled every two days.

Surface treatment

After bleaching procedures, groups were subdivided into two groups according to the top surface treatment (repolished or unrepolished). A random number sequence in two columns (one corresponding to each treatment) was generated through *www.random.org* site. Repolished groups had top surface repolished with extrafine sandpaper discs and felt with diamond paste, as described earlier. Unrepolished groups were kept in closed saliva bottles at 37 °C. Saliva bottles was refilled every two days. Specimens thickness were assessed after repolishing with a digital caliper and about 0.02 mm of wear were caused by the procedure.

Aging procedure

After surface treatment, all groups were subdivided again according to aging conditions (red wine or artificial saliva). A number sequence in two columns (one corresponding to each aging condition) was generated through *www.random.org* site. Red wine was chosen because it is an acidic and alcoholic media rich in staining agents, which could somewhat represent the complex association of erosion, degradation, and pigment sorption. Groups aged in red wine remained in contact with the beverage during 15 min a day (at 37 °C) per 30 days. After the immersion period, specimens were rinsed and dried with gauze and were maintained in closed saliva bottles at 37 °C until next contact with wine. The other groups remained immersed in artificial saliva, which was refilled every two days. Red wine and saliva pH were assessed with pHmeter (400-QA – Quimis, Diadema, Brazil). Red wine pH was measured when the bottle was opened (pH = 3.55) and 7 days after (estimated duration of the bottle) (pH = 3.56). Artificial saliva pH was assessed at study first day (pH = 6.38), after 14 days (bleaching phase, pH = 6.32), and after 30 days (aging phase, pH = 6.28).

Color evaluation

Color parameter measurements were assessed in four moments: 24 h after specimen fabrication and hydration in artificial saliva (P0), after bleaching procedures (P1), after surface treatment (P2), and after aging (P3). Color parameter was measured over a neutral gray background (CIE-L*= 50.30, a*= -1.41, b*= -2.37) (Mennon gray cards, Mennon photographic and technical Co., Beijing, China). A spectrophotometer SP60 (X-Rite, Grand Rapids, USA) was used for measurements on analysis mode, using D-65 illuminant, 10° observer angle and CIE*L*a*b** color system (*Commission Internationale de l'Éclairage*). In this system, *L** is the luminosity axis with values varying from zero (black) to one hundred (white), and *a** and *b** are the color coordinates on green-red axis and in blue-yellow axis, respectively. A coupling substance [glycerol $C_3H_8O_3$] (Vetec Química Fina Ltda, Rio de Janeiro, Brazil) with a refraction index of 1.47 was used to minimize light scattering by avoiding the presence of an air layer between specimen and background [22]. Firstly, the spectrophotometer was calibrated according to manufacturer guidelines. For each specimen, the readings of *L**, *a**, and *b** coordinates were repeated three times and the median of those readings was used for the statistical analysis. Color change (ΔE_{00}) was calculated in all phases with CIEDE2000 formula (Equation 1).

$$\Delta E_{00} = \left[\left(\frac{\Delta L'}{K_L S_L}\right)^2 + \left(\frac{\Delta C'}{K_C S_C}\right)^2 + \left(\frac{\Delta H'}{K_H S_H}\right)^2 + R_T\left(\frac{\Delta C'}{K_C S_C}\right)\left(\frac{\Delta H'}{K_H S_H}\right)\right]^{\frac{1}{2}} \quad (1)$$

where *ΔL*, *ΔC,* and *ΔH* are the differences in lightness, chroma, and hue for a pair of samples, and R_T is a function (the so-called rotation function) that accounts for the interaction between chroma and hue differences in the blue region. Weighting functions, S_L, S_C, and S_H adjust the total color difference for variation in the location of the color difference pair in *L', a', b'* coordinates, and the parametric factors, k_L, k_C, and k_H are correction terms for deviation from reference experimental conditions. In the present study, these parametric factors of CIEDE2000 color difference formula were set to 1.

Values described by Paravina et al [23] were considered as clinical thresholds, which defined perceptibility and acceptability thresholds through ΔE_{00} as, respectively, 0.8 and 1.8.

After each measurement, specimens were rinsed to coupling removal and dried with gauze.

Smoothness evaluation

Smoothness parameter measurements were assessed along with color measurements, at P0, P1, P2, and P3. Quantitative measurement were performed with a roughness tester SJ-410 Series (Mitutoyo, Takatsu-Ku, Japan) previously calibrated. Ra parameter (average roughness in µm) were assessed with a 0.80 mm cut off, resolution 0.0001 µm (8 µm range), speed 0.5 mm/s, and total length of 4 mm, according to ISO 4287 (1997). Three measurements of x and y axis of each specimen were performed and the average of those readings was used in the analysis. As resin composites roughness have no agreed clinical threshold for unacceptable values, this study considered two thresholds: Ra value below 0.2 µm associated to reduced plaque accumulation, risk for caries, and periodontal inflammation [24]; and, Ra values bellow 0.3 µm associated to the comfort of the patient, since most of them could not detect rough surfaces bellow this threshold [25].

Morphologic analysis

Morphological analysis was performed in randomly selected specimens of all study's phases: baseline, after bleaching procedures, after surface treatment, and after aging. Specimens were gold-sputtered before mounting on the stub of Scanning Electron Microscope (SEM) (JSM 6610, JEOL, Tokyo, Japan). Surface topography was recorded from secondary electrons, at 15 kV and 2000x magnification.

Statistical analysis

Color change (ΔE_{00}) and smoothness (Ra) data were analyzed statistical software Sigma Plot version 11.0 (Systat Software Inc., San Jose, USA). Analyses were carried out separately according to aging conditions (artificial saliva or red wine). Firstly, data had normality and homoscedasticity tested and were then submitted to repeated measures two way ANOVA. All pairwise multiple comparison procedures were conducted using Tukey's test. Correlation between color change and roughness was tested using Pearson's correlation test. Significance level was set at 5% for all analyses.

RESULTS

Groups aged in artificial saliva

Color change:

Color difference (ΔE_{00}) values, standard deviation, and differences found among groups after bleaching treatment (P1), after surface treatment (P2), and after aging in artificial saliva (P3) are described in Table 2. Interaction between experimental group (material + treatment) and study phase were not significant ($p=0.481$), and no significant differences were found among the different phases in any experimental condition. On the other hand, interaction among groups were significant ($p<0.001$). At P1, bleached groups of both composites presented greater color change than those non-bleached. At P2, repolishing did not have any effect neither in bleached nor in non-bleached resin composites. At P3, no significant differences among Z250 groups were noted. Significant difference was observed between bleached repolished and non-bleached repolished Z350 XT. All groups, except for those non-bleached repolished, had clinically perceptible color change (ΔE_{00}>0.8), but none had clinically unacceptable alteration (ΔE_{00}>1.8). No difference was perceived between microhybrid and nanofilled resin composite in all phases (p>0.05).

Smoothness:

Smoothness (Ra) means, standard deviation, and differences found among groups, immediately after specimen preparation (P0), bleaching treatment (P1), surface treatment (P2), and aging in artificial saliva (P3) are described in Table 3. Interaction between experimental group (material + treatment) and study phase were significant (p=0.010), as well as in groups interaction (p=0.013). Significant differences among phases were detected after surface treatment (P1 vs. P2) in almost all repolished groups. Bleaching (P1) did not alter smoothness for both microhybrid and nanofilled composites. After repolishing (P2), bleached Z350 XT did show a significant smoothness reduction (bleached repolished vs. bleached unrepolished).This difference was kept after aging in saliva (P3). Values of all phases and conditions were maintained above the thresholds used in this study (Ra<0.2 µm).

Correlation:

There was no significant correlation between color change and smoothness on groups aged in artificial saliva (P=0.616, r=0.0421).

Groups aged in red wine

Color change:

Color difference (ΔE_{00}) values, standard deviation, and differences found among groups after bleaching treatment (P1), after surface treatment (P2) and after aging in red wine (P3) are described in Table 4. Interaction between experimental group (material + treatment) and study phase were significant (p<0.001), as well as in groups interaction (p<0.001). All groups presented significant and clinically unacceptable color change (ΔE_{00}>1.8) after 30 days of immersion (P3). Previously to aging in wine (P1 and P2), no difference was detected among experimental conditions for both resin composites. At P3, bleached unrepolished groups showed greater color change than the others groups for both resin composites, whereas bleached repolished groups reached ΔE_{00} values similar to non-bleached ones. Differences between composites were observed at P3 in all groups, except for non-bleached unrepolished groups (Figure 2).

Smoothness:

Smoothness (Ra) means, standard deviation, and differences found among groups, immediately after specimen preparation (P0), bleaching treatment (P1), surface treatment (P2), and aging in red wine (P3) are described in Table 5. Interaction between experimental group (material + treatment) and study phase were significant ($p=0.019$), but groups interactions were not ($p=0.505$). Statistically significant differences among phases were pointed out after repolishing (P1 vs. P2) in almost all repolished groups. No significant differences were noted among experimental conditions and between the materials ($p>0.05$), when each phase was independently analyzed. Values of all phases and conditions were maintained above the thresholds used in this study (Ra<0.2 µm).

Correlation:

There was no significant correlation between color change and smoothness on groups aged in artificial saliva ($P=0.756$, $r=-0.0241$).

Morphological analysis

Figure 3 and Figure 4 respectively depicts microhybrid and nanofilled composite specimens at the baseline (a), after bleaching (b), and after bleaching and repolishing (c). It is possible to note polishing disc marks and inherent defects of manipulated materials, with no considerable difference among groups.

Figure 5 and Figure 6 respectively present microhybrid and nanofilled composite specimens aged in artificial saliva and red wine. Bleached unrepolished specimen (5b) seems to show more porosities after immersion in artificial saliva than bleached repolished (5a) and non-bleached (5c and 5d) specimens. When exposed to red wine (5e to 5h), images suggest some surface alteration, especially in BUW (5f), which presented more porosities and defects. When comparing Figure 5 to Figure 6, Z350 XT seems to show less perceptible topographic differences between aging in saliva and red wine than Z250. In addition, bleached unrepolished specimens (6b and 6f) presents more porosities than the other ones.

DISCUSSION

Repolishing lead to lower color change in bleached groups which had contact with staining agent. Results showed that Filtek Z250 and Z350 XT bleached unrepolished groups aged in red wine had ΔE_{00} values 14% and 19% greater than the bleached repolished, respectively. On the other hand, surface treatment caused no difference on color stability of bleached groups that were not immersed in red wine. SEM images also suggested that staining beverage had effect on resin composites surface (Figure 5). As red wine have low pH (3.55), it could have caused resinous matrix softening [26]. Repolishing also made surfaces smoother (P1 vs. P2), but Tukey's Test did not detect this effect in all groups, as well as it did not detected differences among all bleached repolished vs. bleached unrepolished groups (Table 3 and Table 5). Despite of polishing and repolishing procedures were carried out by a single calibrated operator, it is not so accurate than using an automatic device. Then, this difference among results was probably caused by an operator bias. However, roughness did not reached unacceptable thresholds (0.2 µm) in any study phase, which evidences that these differences may not have clinical relevance. Therefore, first tested hypothesis was partially accepted.

Barakah and Taher [27] evaluated the effect of polishing systems on composites' color stability and concluded that polishing improves color stability of resin composites. Güler et al [28] observed that polishing with discs and diamond paste, similar to those used in this study, decreased resin composites color change. In the same manner, our results showed that repolishing immediately after bleaching also improves composites color stability. Literature suggests that bleaching agents action may cause matrix softening, microhardness decrease, and smoothness increase of restorative materials [14,29,30]. Our smoothness analysis have not showed statistical difference on all experimental groups after bleaching procedures (BR vs. BU groups) and Pearson's Correlation Test did not detect significant correlation between color alteration and smoothness. Despite of that, repolishing may have eliminated defects, resulting in a smoother surface and, consequently, less likely to color change. SEM images (b) and (f) of Figure 5 and Figure 6 show more porosities on BUS and BUW groups, which may have contributed to greater ΔE_{00} values.

Bleaching treatment was not able to promote greater color change in all groups and smoothness increase in none group compared to non-bleached ones, which made second tested hypothesis to be partially accepted. At P1, ΔE_{00} values from bleached groups of both composites (exposed later to saliva or red wine) were similar and greater than non-bleached ones, but Tukey's Test pointed out statistical difference between them (bleached vs. non-bleached groups) only in specimens aged in artificial saliva. Nevertheless, no ΔE_{00} value at P1 reached 1.8, which means there was not a clinically unacceptable change.

Color change of not stained specimens have been explained by the pigments inherent of the composites and/or amine compounds oxidation, or by the incomplete polymerized resinous matrix break [31]. Previous studies showed ΔE_{ab} values of resin composites immediately after hydrogen peroxide bleaching ranging from 0.56 to 3.71 [9, 27, 28]. It seems that results can vary according to resin composite type and used protocol of bleaching gel. Moreover, the chosen formula to calculate color alteration can also lead to variation in results; while CIELAB is mostly employed, this study chose to use CIEDE2000, since it is more sophisticated than the antecessors [32] and utilizes hue and chrome concepts, reinforcing the importance of conceptual developments of Munsell [33].

Previous studies that used different bleaching agents in different concentrations also have not reported significant smoothness alterations in resin composites [34,35], whereas other studies observed significant changes [36,37], which seems to evidence the material dependent effect of bleaching on restorative materials smoothness.

Cengiz et al [38] evaluated quantitatively (Ra scale) and qualitatively (SEM analysis) the effect of 10% hydrogen peroxide in five resin composites commercial brands. They detected significant smoothness alteration on bleached groups compared to control ones, in both analyzes. The present study used higher concentration of hydrogen peroxide and significant alterations caused by the bleaching (P1) were not observed. SEM images (Figures 3 and 4) have not showed any noticeable difference as well. However, composites and the bleaching gels used in cited studies were not the same (type and/or commercial brands) as in this research, which may lead to different results. Varanda et al [30] also evaluated the influence of bleaching agents, including 35% hydrogen peroxide, on smoothness and surface morphology (Atomic Force Microscope) of nanofilled (the same of the present study) and microhybrid resin composites. In the former, authors have not found significant alteration in neither analysis, while the latter presented little smoothness alteration, which could be eliminated by repolishing as suggested by the researchers.

Third tested hypothesis was accepted, since both composites showed differences among experimental conditions in color alteration and smoothness at P3. All nanofilled composite groups that have been submitted to any treatment (bleaching and/or repolishing) reached greater ΔE_{00} values than microhybrid one when exposed to red wine (P3). In addition, no smoothness differences were observed between the materials in any phase or immersion media, corroborating with Kaizer et al [39] who, in a systematic review, have not found enough scientific evidences to show differences in smoothness and gloss between microhybrid and nanofilled resin composites.

Resin composite color changes have been related to the hydrophobic and hydrophilic nature of resinous matrix compounds [40], which determines the material liquid sorption degree. Water sorption causes expansion and plasticizes the resinous compound, hydrolyzing silane and causing micro cracks on the interface of filler particles and resinous matrix. In this way, fluids and pigments infiltration occurs and cause discoloration [41]. Higher level of water sorption have been attributed to composites containing low concentration of TEGDMA and Bis-GMA monomers in its composition [42]. Z250 has reduced TEGDMA concentration, which seems to favor its color stability. Moreover, particles size (microhybrid vs. nanofilled) also influence fluid sorption. Nanoclusters of composite Z350 XT present micro porosities, which facilitate fluid sorption and pigment retention [43,44]. The quantum effect is a phenomenon that makes the nanoparticles susceptible to different surface interactions, as adsorption of other substances to which they are exposed [45,46]. The smaller the particle, the more pronounced is the quantum effect on them [45,46], which probably is another factor that lead to the greater color change of nanofilled composite.

Staining procedures of our study consisted of immersion in red wine for 15 min a day, which is clinically plausible, since a person can easily keep their restorations in contact with staining beverages per 15 min in one day. However, people usually brush their teeth at least once a day, and this procedure was not evaluated in this research. This fact contributed to the ΔE_{00} values to be well above the unacceptability threshold. In spite of an *in vitro* study limitations, our results indicated that when clinicians choose to maintain a resin composite restoration after bleaching treatment, the simple act of repolishing it immediately after the last bleaching gel application can minimize color change susceptibility, in cases when patient's diet is rich in pigments.

CONCLUSION

Repolishing immediately after bleaching improves color stability of resin composites when exposed to staining agents. This procedure also may improve its smoothness. Bleaching procedure by itself has promoted neither clinically unacceptable color nor smoothness change. Both microhybrid and nanofilled resin composites had color and smoothness affected by bleaching and surface treatments after aging.

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TABLES

Table 1: Material, manufacturer, type, color and composition of composite resins, bleaching gels and aging solutions used*

Material (Manufacturer)	Type/color	Composition*
Filtek Z250 (3M ESPE, St. Paul, MN, USA)	Microhybrid A2 Enamel	Matrix bases on bis-GMA, bis-EMA, TEGDMA, UDMA; 60% silica/zirconia (0.6 µm) particles
Filtek Z350 XT (3M ESPE, St. Paul, MN, USA)	Nanoparticle A2E	Matrix based on bis-GMA, bis-EMA, UDMA,TEGDMA; 63.3% silica/zirconia clusters; silica particles (20 nm); zirconia (4-11 nm) and silica/zirconia clusters (0.6 -10 µm)
Total Blanc Office H35 (Nova DFL, Rio de Janeiro, RJ, Brasil)	--	35% hydrogen peroxide, thickener, plant extracts, amide, sequestering agent, glycol, dye and water
Artificial saliva (Dermapelle Farmácias de Manipulação, Santa Maria, RS, Brasil)	--	Sodium chloride, potassium chloride, calcium chloride, magnesium chloride, potassium phosphate, methylparaben, carboxilometilcelulose, sodium fluoride, xylitol C and deionized water
Salton Classic Cabernet Sauvignon (Vinícola Salton, Bento Gonçalves, RS, Brasil)	--	Dry red wine. Fermented of cabernet sauvignon grapes. Alcohol content of 13.0%.

** Manufacturer’s information*

Table 2: Means (standard deviation) of ΔE_{00} values of groups aged in artificial saliva

		P1 (After bleaching)		P2 (After repolishing)		P3 (After aging)	
		ΔE_{00}	**Clinically visible change**	**ΔE_{00}**	**Clinically visible change**	**ΔE_{00}**	**Clinically visible change**
Filtek Z250	BR	1.51 (0.25)$^{A.a}$	Yes	1.25 (0.51)$^{A.a.b}$	Yes	1.24 (0.45)$^{A.a}$	Yes
	BU	1.44 (0.46)$^{A.a}$	Yes	1.44 (0.46)$^{A.a}$	Yes	1.38 (0.52)$^{A.a}$	Yes
	NR	0.72 (0.48)$^{A.b}$	No	0.76 (0.30)$^{A.b}$	No	0.77 (0.28)$^{A.a}$	No
	NU	0.80 (0.20)$^{A.b}$	Yes	0.80 (0.20)$^{A.b}$	Yes	1.00 (0.75)$^{A.a}$	Yes
Filtek Z350 XT	BR	1.22 (0.31)$^{A.1}$	Yes	1.15 (0.50)$^{A.1.2}$	Yes	1.18 (0.25)$^{A.1}$	Yes
	BU	1.31 (0.24)$^{A.1}$	Yes	1.31 (0.24)$^{A.1}$	Yes	1.12 (0.12)$^{A.1.2}$	Yes
	NR	0.45 (0.28)$^{A.2}$	No	0.49 (0.32)$^{A.3}$	No	0.51 (0.07)$^{A.2}$	No
	NU	0.53 (0.37)$^{A.2}$	No	0.53 (0.37)$^{A.2.3}$	No	0.80 (0.21)$^{A.1.2}$	Yes

Distinct uppercase letters in the same line indicate phases differences, distinct lowercase letters in the same column indicate differences on bleaching procedures for Z250 and numbers indicate differences on bleaching procedures for Z350 XT (Tukey's Test, $p<0.05$).

BR: Bleached repolished, BU: Bleached unrepolished, NR: Non-bleached repolished, NU: Non-bleached unrepolished

Table 3: Means (standard deviation) of Ra values of groups aged in artificial saliva

		P0 **(Baseline)**	**P1** **(After bleaching)**	**P2** **(After repolishing)**	**P3** **(After aging)**
Filtek Z250	BR	0.15 (0.06)$^{A.a}$	0.16 (0.10)$^{A.B.a}$	0.11 (0.03)$^{B.a}$	0.12 (0.04)$^{A.B,.b}$
	BU	0.14 (0.02)$^{A.a}$	0.17 (0.07)$^{A.a}$	0.17 (0.07)$^{A.a}$	0.19 (0.03)$^{A.a}$
	NR	0.15 (0.05)$^{A.a}$	0.14 (0.06)$^{A.a}$	0.12 (0.06)$^{B.a}$	0.10 (0.03)$^{B.b}$
	NU	0.13 (0.03)$^{A.a}$	0.15 (0.03)$^{A.a}$	0.15 (0.03)$^{A.a}$	0.13 (0.02)$^{A.a.b}$
Filtek Z350 XT	BR	0.13 (0.03)$^{A.1}$	0.13 (0.03)$^{A.1}$	0.08 (0.02)$^{B.2}$	0.08 (0.02)$^{B.2}$
	BU	0.15 (0.03)$^{A.1}$	0.16 (0.03)$^{A.1}$	0.16 (0.03)$^{A.1}$	0.15 (0.04)$^{A.1}$
	NR	0.15 (0.02)$^{A.B.1}$	0.16 (0.06)$^{A.1}$	0.10 (0.03)$^{B.1}$	0.12 (0.03)$^{B.1.2}$
	NU	0.16 (0.04)$^{A.1}$	0.15 (0.04)$^{A.1}$	0.15 (0.04)$^{A.1}$	0.16 (0.03)$^{A.1}$

Distinct uppercase letters in the same line indicate phases differences, distinct lowercase letters in the same column indicate differences on bleaching procedures for Z250 and numbers indicate differences on bleaching procedures for Z350 XT (Tukey's Test, $p<0.05$).

BR: Bleached repolished, BU: Bleached unrepolished, NR: Non-bleached repolished, NU: Non-bleached unrepolished

Table 4: Means (standard deviation) of ΔE_{00} values of groups aged in red wine

		P1 (After bleaching)		P2 (After repolishing)		P3 (After aging)	
		ΔE_{00}	**Clinically visible change**	**ΔE_{00}**	**Clinically visible change**	**ΔE_{00}**	**Clinically visible change**
Filtek Z250	BR	1.46 (0.28)$^{B.a}$	Yes	1.27 (0.43)$^{B.a}$	Yes	8.12 (1.18)$^{A.b}$	Yes
	BU	1.39 (0.53)$^{B.a}$	Yes	1.39 (0.53)$^{B.a}$	Yes	9.26 (1.47)$^{A.a}$	Yes
	NR	0.90 (0.56)$^{B.a}$	Yes	0.81 (0.48)$^{B.a}$	Yes	7.30 (1.32)$^{A.b}$	Yes
	NU	0.86 (0.30)$^{B.a}$	Yes	0.86 (0.30)$^{B.a}$	Yes	8.07 (0.71)$^{A.b}$	Yes
Filtek Z350 XT	BR	1.25 (0.34)$^{B.1}$	Yes	1.04 (0.27)$^{B.1}$	Yes	9.87 (1.62)$^{A.2}$	Yes
	BU	1.15 (0.23)$^{B.1}$	Yes	1.15 (0.23)$^{B.1}$	Yes	11.81 (1.51)$^{A.1}$	Yes
	NR	0.61 (0.21)$^{B.1}$	No	0.61 (0.13)$^{B.1}$	No	9.61 (0.88)$^{A.2.3}$	Yes
	NU	0.62 (0.18)$^{B.1}$	No	0.62 (0.18)$^{B.1}$	No	8.55 (0.60)$^{A.3}$	Yes

Distinct uppercase letters in the same line indicate phases differences, distinct lowercase letters in the same column indicate differences on bleaching procedures for Z250 and numbers indicate differences on bleaching procedures for Z350 XT (Tukey's Test, $p<0.05$).

BR: Bleached repolished, BU: Bleached unrepolished, NR: Non-bleached repolished, NU: Non-bleached unrepolished

Table 5: Means (standard deviation) of Ra values of groups aged in red wine

		P0 **(Baseline)**	**P1** **(After bleaching)**	**P2** **(After repolishing)**	**P3** **(After aging)**
Filtek Z250	BR	0.14 (0.03)$^{A.B.a}$	0.16 (0.04)$^{A.a}$	0.09 (0.01)$^{B.a}$	0.10 (0.05)$^{B.a}$
	BU	0.15 (0.03)$^{A.a}$	0.15 (0.07)$^{A.a}$	0.15 (0.07)$^{A.a}$	0.17 (0.07)$^{A.a}$
	NR	0.13 (0.03)$^{A.B.a}$	0.14 (0.04)$^{A.a}$	0.10 (0.02)$^{B.a}$	0.09 (0.01)$^{B.a}$
	NU	0.15 (0.01)$^{A.a}$	0.14 (0.08)$^{A.a}$	0.15 (0.09)$^{A.a}$	0.14 (0.07)$^{A.a}$
Filtek Z350 XT	BR	0.14 (0.02)$^{A.1}$	0.14 (0.04)$^{A.1}$	0.11 (0.04)$^{A.1}$	0.11 (0.04)$^{A.1}$
	BU	0.15 (0.03)$^{A.1}$	0.14 (0.04)$^{A.1}$	0.14 (0.04)$^{A.1}$	0.15 (0.05)$^{A.1}$
	NR	0.16 (0.03)$^{A.1}$	0.16 (0.08)$^{A.1}$	0.10 (0.04)$^{B.1}$	0.10 (0.02)$^{B.1}$
	NU	0.14 (0.03)$^{A.1}$	0.16 (0.05)$^{A.1}$	0.16 (0.05)$^{A.1}$	0.15 (0.04)$^{A.1}$

Distinct uppercase letters in the same line indicate phases differences, distinct lowercase letters in the same column indicate differences on bleaching procedures for Z250 and numbers indicate differences on bleaching procedures for Z350 XT (Tukey's Test, $p<0.05$).

BR: Bleached repolished, BU: Bleached unrepolished, NR: Non-bleached repolished, NU: Non-bleached unrepolished

FIGURES

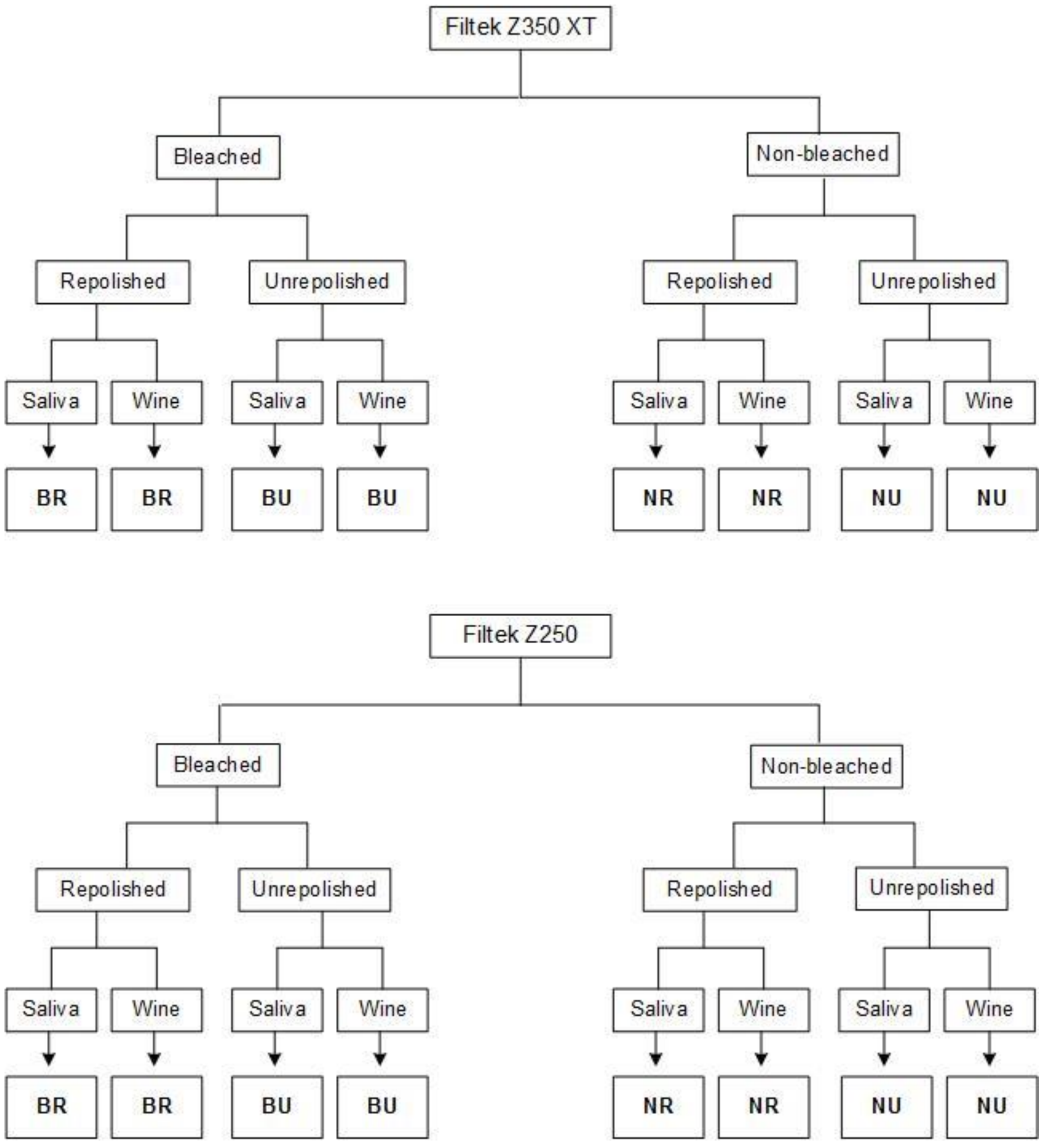

Figure 1: Experimental design of groups

BR: Bleached repolished, BU: Bleached unrepolished, NR: Non-bleached repolished, NU: Non-bleached unrepolished

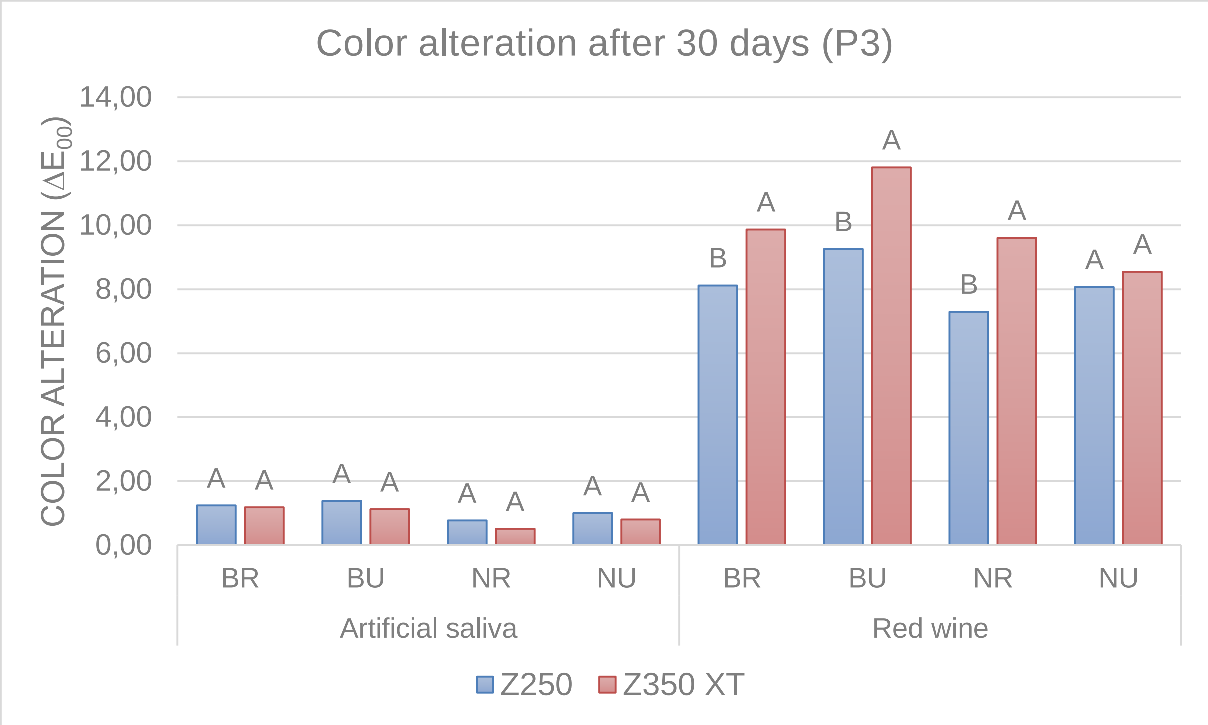

Figure 2: Groups of microhybrid and nanofilled composite resins after 30 days of aging (P3).

Distinct letters in the same experimental condition (surface treatment + aging solution) indicate difference between composite resins (Tukey's Test, $p<0.05$).

BR: Bleached repolished, BU: Bleached unrepolished, NR: Non-bleached repolished, NU: Non-bleached unrepolished.

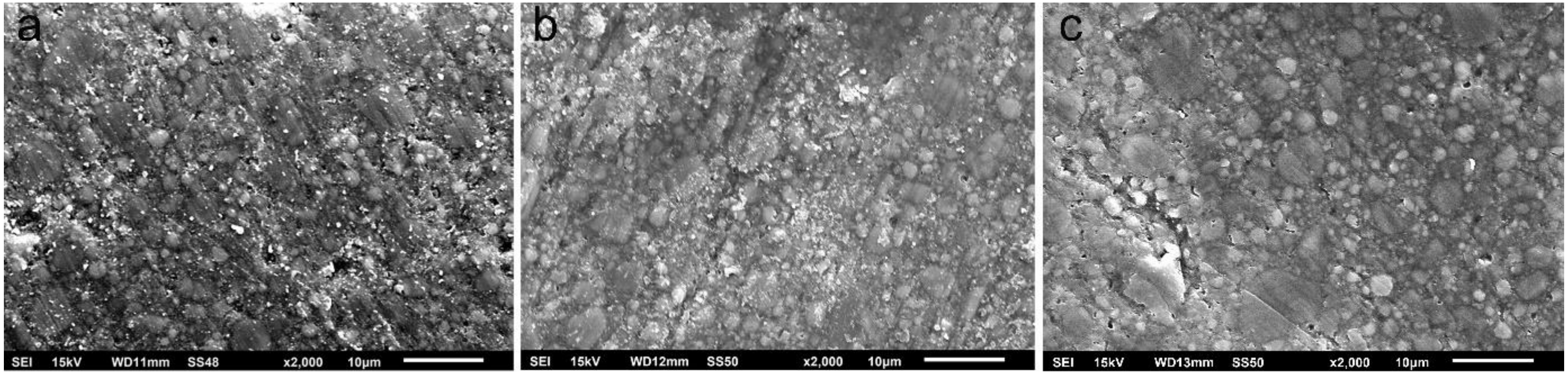

Figure 3: SEM images of composite resin Filtek Z250 a) initial,, b) after bleaching c) after bleaching and repolishing

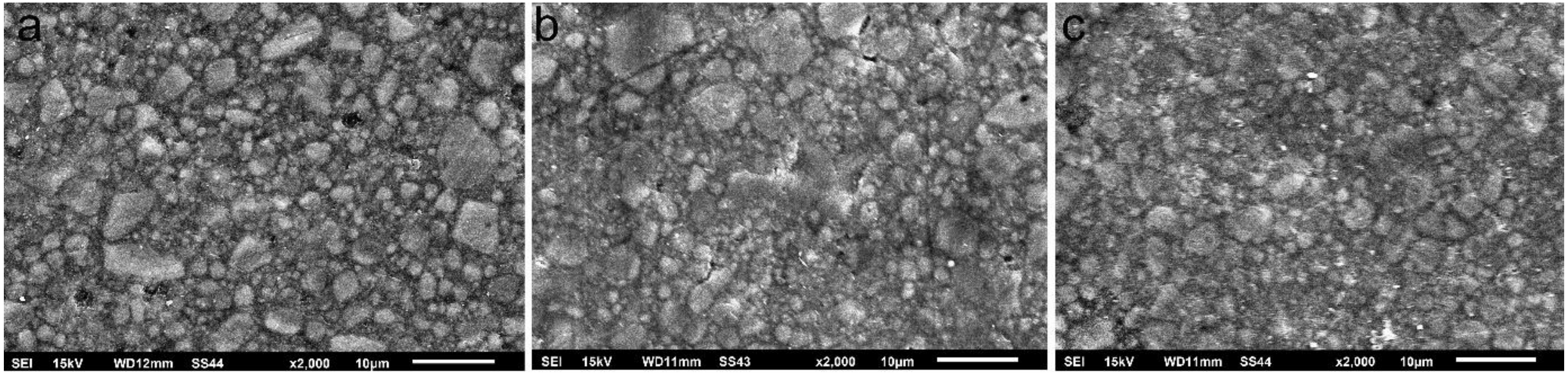

Figure 4: SEM images of composite resin Filtek Z350 XT a) initial, b) after bleaching, c) after bleaching and repolishing

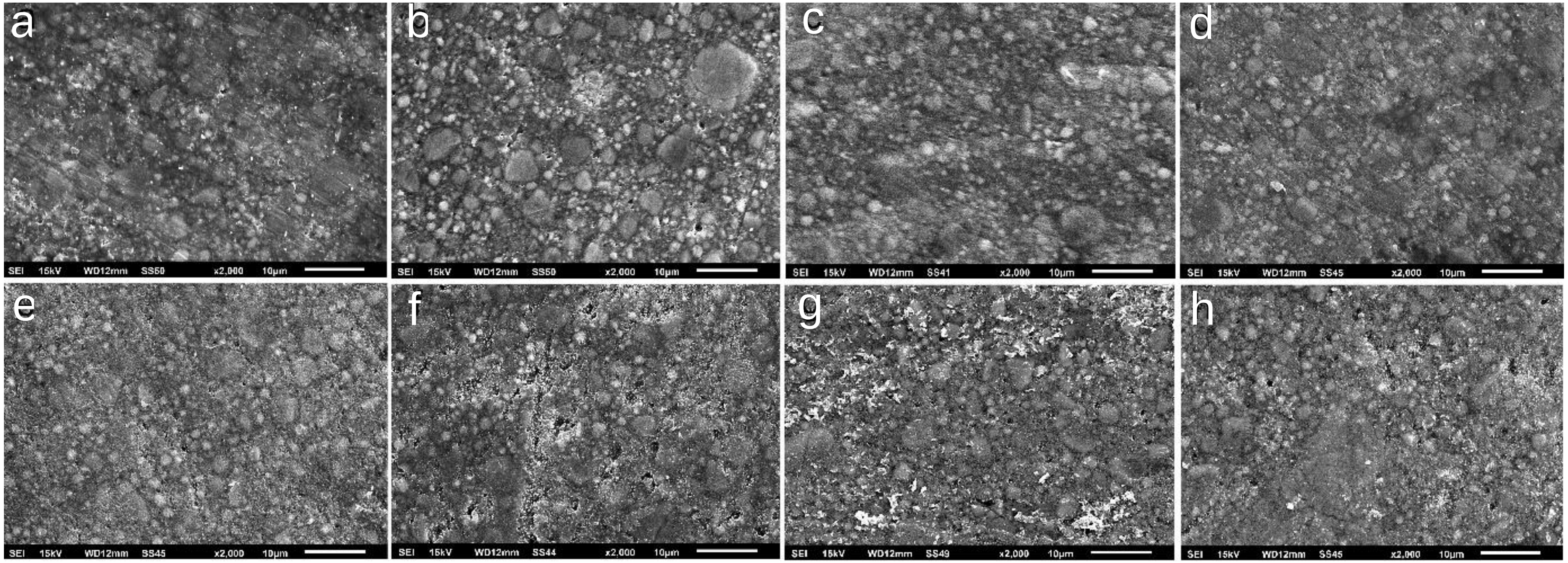

Figure 5: SEM images of composite resin Filtek Z250 aged in artificial saliva a) Bleached repolised (BRS), b) bleached unrepolished (BUS), c) non-bleached and repolished (NRS), d) non-bleached unrepolished (NUS), and aged in red wine e) Bleached repolised (BRW), f) bleached unrepolished (BUW), g) non-bleached repolished (NRW), h) non-bleached unrepolished (NUW)

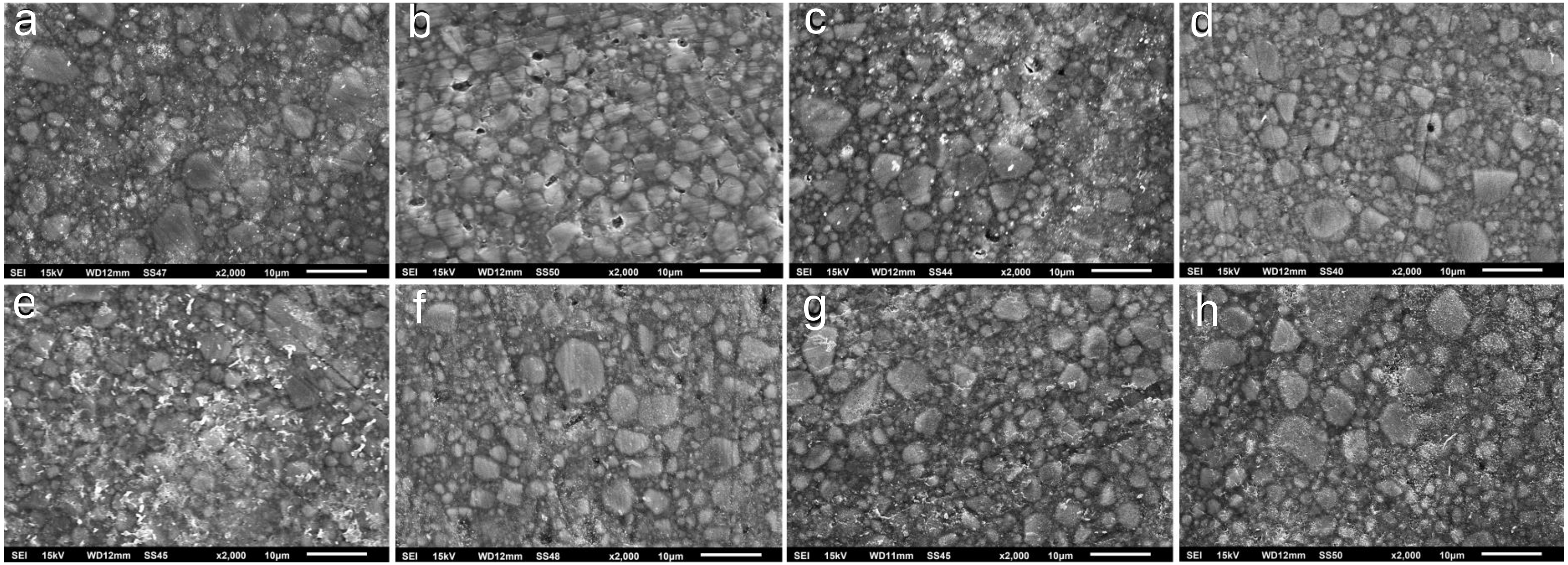

Figure 6: SEM images of composite resin Filtek Z350 XT aged in artificial saliva a) Bleached repolised (BRS), b) bleached unrepolished (BUS), c) non-bleached and repolished (NRS), d) non-bleached unrepolished (NUS), and aged in red wine e) Bleached repolised (BRW). f) bleached unrepolished (BUW) g) non-bleached repolished (NRW), h) non-bleached unrepolished (NUW)

3 CONSIDERAÇÕES FINAIS

O repolimento imediatamente após o clareamento aumentou a estabilidade de cor de resinas compostas utilizadas quando houve contato com agentes corantes. O clareamento não promoveu alterações de cor clinicamente inaceitáveis, nem alterações de rugosidade. Tanto a resina composta microhíbrida como a nanoparticulada tiveram sua cor e rugosidade afetada pelos tratamentos submetidos (clareamento e repolimento) após o período de imersão. A resina nanoparticulada mostrou maior alteração de cor quando submetida a algum procedimento anterior ao contato com agentes pigmentantes, do contrário, apresenta-se com alteração de cor semelhante à microhíbrida.

Portanto, apesar as limitações de um estudo *in vitro*, nossos resultados apontam que quando se opta por manter uma restauração anterior em resina composta após tratamento clareador, o simples ato de repoli-la logo após a última aplicação do gel pode minimizar problemas de maior susceptibilidade à alteração de cor, caso a dieta do paciente seja rica em corantes.

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ANEXO A – Normas para publicação no periódico *Journal of Dentistry*

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