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Effectiveness of hydrogen peroxide in removing bulk-fill composite pigmentations

Eficácia do peróxido de hidrogênio na remoção de pigmentações em compósito bulk fill

Eficacia del peróxido de hidrógeno en la remoción de pigmentaciones en composite bulk fill

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The study aimed to assess in vitro the effectiveness of the bleaching agent Whiteness HP Blue Calcium 35% (FGM) in removing pigments in bulk-fill resin composite. It was used an inductive approach in the laboratory, from August to October 2017. The sample comprised 30 specimens made from Filtek Bulk Fill (3M ESPE) resin, divided into 3 groups, containing distilled water (control) and the stain agents: coffee and wine. Initial assessment of color (baseline) was performed. Then, three sessions were done applying the bleaching gel. Data were subjected to statistical tests Friedma, Kruskal-Wallis, Mann-Whitney and Wilcoxon ($p<0.05$). There was significant differences in color in each stage analyzed ($p=0.00$, $p=0.00$, $p=0.00$, $p=0.001$, respectively).The groups immersed in coffee and wine changed their colors after bleaching (<0.001). It was concluded that the bleaching gel Whiteness HP Blue Calcium 35% was able to lighten the pigments from the stains agents.
Descriptors: Tooth bleaching; Hydrogen peroxide; Pigmentation.

O estudo teve como objetivo avaliar *in vitro* a eficácia do agente clareador Whiteness HP Blue Calcium 35% (FGM) na remoção de pigmentos em resina composta bulk fill. Utilizou-se uma abordagem indutiva em laboratório no período de agosto de 2017 a outubro de 2017**.** A amostra foi composta por 30 espécimos confeccionados a partir da resina Filtek Bulk Fill (3M ESPE), separados em 3 grupos, contendo água destilada (controle), e os agentes pigmentantes: café e vinho. Realizou-se avaliação inicial da cor (*baseline*). Em seguida, foram feitas três sessões de aplicação do gel clareador. Os dados foram submetidos aos testes estatísticos Friedma, Kruskal-Wallis, Mann-Whitney e Wilcoxon ($p<0,05$). Houve diferença significativa na cor em cada etapa analisada ($p=0,00$; $p=0,00$; $p=0,00$; $p=0,001$ respectivamente). Os grupos imersos no café e no vinho alteraram suas cores após o clareamento ($<0,001$). Concluiu-se que o gel clareador Whiteness HP Blue Calcium 35% foi capaz de clarear as manchas provenientes dos agentes pigmentantes.
Descritores: Clareamento dental; Peróxido de hidrogênio; Pigmentação.

El estudio tuvo como objetivo evaluar *in vitro* la eficacia del agente blanqueador Whiteness HP Blue Calcium 35% (FGM) en la remoción de pigmentos en resina compuesta bulk fill. Se utilizó un abordaje inductivo en laboratorio en el periodo de agosto de 2017 a octubre de 2017. La amuestra fue compuesta por 30 espécimen confeccionados a partir de la resina Filtek Bulk Fill (3M ESPE), separados en 3 grupos, conteniendo agua destilada (control), y los agentes pigmentarios: café y vino. Se realizó evaluación inicial del color (*baseline*). En seguida, fueron hechas tres secciones de aplicación del gel blanqueador. Los datos fueron sometidos a los tests estadísticos Friedma, Kruskal-Wallis, Mann-Whitney y Wilcoxon ($p<0,05$). Hubo diferencia significativa en el color en cada etapa analizada ($p=0,00$; $p=0,00$; $p=0,00$; $p=0,001$ respectivamente). Los grupos inmersos en el café y en el vino alteraron sus colores después del blanqueamiento ($<0,001$). Se concluyó que el gel blanqueador Whiteness HP Blue Calcium 35% fue capaz de blanquear las manchas provenientes de los agentes pigmentarios.
Descriptores: Blanqueamiento de dientes; Peróxido de hidrógeno; Pigmentación.

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INTRODUCTION

Nowadays, due to the standardization of a new beauty concept, the search for aesthetic dental treatments increasingly reaches higher levels. Patients wish aligned whiter teeth with ideal contours[1,2].

The color and shape of the tooth are important factors for patients who want to improve the aesthetics of their smile[2]. Composite resins are widely used in dentistry, being one of the most popular aesthetic materials, due to their coloring similar to tooth structure and its ability to bind itself to the dentin and enamel[3].

However, color stability throughout the functional life of the restorations is of great importance to the longevity of the treatment[4]. Fail in aesthetics, especially change in color, is one of the most common reasons for restoration replacements[5]. Salivary enzymes, pH changes, organic solvents, ionic composition of the food, drink and saliva may influence the surface quality of the composite resins[3].

It was found that intrinsic and extrinsic factors contribute to color changes in restorative materials[5]. Intrinsic factors that influence this color change involve chemical changes of the materials due to the oxidation of the monomers or catalysts, exposure to different sources of energy and immersion in water for a long period of time. The extrinsic factors include staining by adsorption or absorption of dyes, from exogenous sources, present in food or beverages, such as coffee, tea and soft drinks[6,7].

A study analyzed[8] the effect of bleaching agents, the change in color of the composite resin when immersed in several food with dyes, and found that the material susceptibility to color change, of extrinsic nature, is proportional to the water absorption capacity of the material, which in turn is determined by the nature and composition of the material.

The structure of a composite resin and the characteristics of the particles have a direct impact on the surface smoothness and sensitivity to extrinsic stain. In addition to the composite material, finishing and polishing are procedures which can also influence the surface quality and are linked, therefore, to early discoloration of the resin[5,8].

Color changes in the composite resins may also be related to the structure of the organic matrix. Resins having triethyleneglycol dimethacrylate (TEGDMA) in its composition, which is a high flexibility monomer and diluent, have high levels of discoloration due to its hydrophilic character[9]. Conversely, the Bis-EMA, hydrophobe monomer, can also present evident discoloration in contact with solutions[1].

A new class of composite resins has been introduced in the market, which are the Bulk-Fill composite. They are indicated to perform unique increments of 4-5 mm, with better marginal adaptation in the walls of the cavity[10]. The manufacturers claim that there is a complete photopolymerization, reducing the incorporation of air bubbles and contamination among the increments.

These advantages are possible because they are composed of special monomers that allow the modulation of the polymerization reaction. Thus, the composite are more translucent, allowing greater transmission of light[11,12]. Moreover, this material has a lower accumulation of stresses and cusp deflection[12].

In addition to the composite resin, another aesthetic treatment option that has been extensively developed in recent years was the tooth bleaching. Studies have shown that hydrogen peroxide is able to modify the color of the resin microhybrid, nanofilled and microparticulated composites[13,14]. The incorporation of pigments through extrinsic factors may be influencing the clinical success and aesthetic dentistry, because the color of dental structure and restorative material may be different.

The vast majority of researches published on the subject agree that the change of color restorations after bleaching occurs due to a cleaning of the surface of the resin, provided by the bleaching agent[1,13]. On the other hand, it was not observed in the literature any systematic review on the subject, being very important for the scientific community and dentists a work that had as a goal to evaluate the bleaching potential of hydrogen peroxide in bulk fill composites.

Due to the constant introduction of new dental restorative and composite bleaching, independent researches should be done in order to verify the effectiveness of these materials. Thus, this study aimed to evaluate in vitro the effectiveness of the bleaching agent Whiteness HP Blue Calcium 35% (FGM) in removing pigments in bulk-fill composite resin.

METHOD

It is a study of inductive approach, with comparative statistical procedure and direct-technical documentation in the laboratory. Samples were prepared with Filtek Bulk Fill (3M ESPE / St. Paul, MN, USA) A3 color, in a total 30 specimens from a tube mold (measuring 4 mm height and 4 mm diameter).

With the aid of a double spatula for resin, the insertion in an unique increment was performed, as indicated by the manufacturer, superimposed on a polyester strip and a glass plate to obtain a flat surface without bubbles. Then, the specimens were light-cured with the apparatus Emitter C (SCHUSTER, Santa Maria, RS, Brazil), whose light intensity was measured above 800 mw/cm^2, as the reading of the Radiometer RD - 7 (ECEL) and the polymerization time was 20 seconds, as recommended by the manufacturer of the composite, positioning it in the center of the specimen.

After photopolymerization, with the aid of a scalpel blade, the matrix and the excesses of the composite were removed, and with permanent marking pen, the opposite side to the reading of the digital spectrophotometer was marked. Table 1 shows the description of the composite used.

Table 1. Description of the Filtek Bulk Fill composite.

Composite	Filtek Bulk Fill
Manufacturer	3M ESPE, St. Paul, MN, USA
Color	A3
Organic Matrix	Urethane dimethacrylate aromatic, UDMA, DDMA and EDMAB.
Charge particles	Silica, zirconia and itbério trifluoride.
Particle size	4-100 nm
% load (weight/volume)	Weight: 76.56% Volume: 58.4%
Photopolymerization time according to the manufacturer	≥800 mW / cm^2 for 20 sec
Batch	1522200095

Source: Technical Profile of the Product Filtek Bulk Fill (3M ESPE).

The body-specimens were stored in containers, divided into three groups of ten samples. The group G1 (control) remained immersed in distilled water at a temperature of 37° C for 24 hours. The G2 (n=10), G3 (n=10) groups remained immersed in soluble coffee and wine for 72 hours, respectively, with exchange of substances being taken every 24 hours. At the end of 72 hours, a new assessment of the color with the digital spectrophotometer was performed.

Subsequently, three application sessions of the bleaching gel Whiteness HP Blue Calcium 35% (FGM, Joinville, Brazil) were carried out, with a 1-week interval among them. The bleaching was applied on the surface of the sample, for 40 minutes, without the need for photopolymerizable light, using the microbrush each 10 minutes to increase the contact area of the bleaching agent and prevent bubble formation. The color was measured in each corresponding week.

After the bleaching, a new measurement of color was made, using the same parameters. The samples were stored in distilled water at a temperature of 37° C for a week. At the end of that period, another bleaching session was held in all the samples, following the pattern set by the manufacturer. Another evaluation of the color was done and the samples were put back to distilled water for a week. In turn, the last bleaching session was made, as well as the last assessment of the color of the specimens.

Color Measurement and immersion in substances

After the post-restoration storage, it was made the initial assessment of the color (baseline) of all samples with the aid of the digital spectrophotometer device Vita Easyshade (Vita Zahnfabrik, Bad Säckingen, Germany).

For each sample, three measurements were made, later obtaining an average of these values. The parameters of the color space system CIEL*a*b were used, which is given by three coordinates: L*, a*, and b*. The L* coordinate indicates brightness, a* is a measure of the hue in the red-green axis and b* is the measure of hue in the yellow-blue axis. The formula used to calculate the color difference (ΔE) was $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$. The reading was performed on a white card stock, always in the same place, time and lighting.

Data were tabulated and subjected to Kruskal-Wallis and Friedman ($p<0.05$) statistical tests. In order to check which groups differed in fact, the achievement of Mann Whitney and Wilcoxon tests were necessary, with appropriate penalties.

RESULTS

After the application of statistical tests, it was found that there was a statistically significant difference among the groups at each time evaluated (table 1). It is noteworthy that the variables used are significant for the event to occur. These differences two by two are represented in the columns by capital letters. When color changes over time were compared in each immersion, it was found that only the composite immersed in distilled water remained stable. The others were also evaluated in two by two and are represented in lines by lowercase letters.

Table 1. Mean and standard deviation of the color change (ΔE) over time. João Pessoa/PB, 2018.

IMMERSION MEDIA	After immersion in substances	1st bleaching session	2nd bleaching session	3rd bleaching session	p
Distilled water	1.21 (0.70) Aa	1.44 (0.78) Aa	1.25 (0.58) Aa	1.44 (0.47) Aa	0.49
Coffee	8.14 (1.12) Ba	4.35 (0.86) P	4.05 (0.57) P	2.66 (0.32) Bc	<0.001
Wine	9.78 (0.81) Ca	4.63 (0.87) P	2.29 (0.64) CC	2.35 (1.04) Bc	<0.001
P	0.00	0.00	0.00	0.001	

* Different upper case letters represent different statistically significant difference in the column.
* Different upper case letters represent different statistically significant difference in the line.

DISCUSSION

Recently, a new composite was designed to reduce the time of incremental restoration technique, which favors the working time and patient comfort. Being new to the market, it is necessary that further studies are made on it in relation to the color stability, since the aesthetics today is one of the main factors for the patient well-being and satisfaction.

The study evaluated the ability of substances (soluble coffee and red wine) causing staining in Bulk-Fill resins. Moreover, it was possible to establish which drink had the greatest power of pigmentation and also whether the hydrogen peroxide at 35% was effective in removing such stains caused by common drinks in the diet.

It was proven that the composite resin is capable of absorbing water and also other liquids[2]. That justifies the color changing in restoration and also reduction of mechanical properties through degradation of the polymeric matrix, for fluid absorption takes place directly through absorption in the resin matrix[8].

The organic matrix of the resin, the particle size, the depth of polymerization and staining agents are factors related to color stability of a composite resin[1-12,15]. Photoactivation should be well performed, so that the composite obtain optimal mechanical properties. A poor polymerization can produce undesirable effects, due to the formation of colorimetric degradation products through the residual monomers, which facilitate the penetration of solvents and colorants in the polymer matrix, water absorption and solubility of the unreacted monomers, that make the material more vulnerable to stains[15].

In this study, it was found that the two liquids used were capable of dye the resin Filtek Bulk Fill, being the red wine the substance with highest power of pigmentation. A study shows that the color change on the resin is explained by its organic composition[16]. Those having TEGDMA, high flexibility and diluent monomer, have high levels of discoloration due to its hydrophilic character. Thus, the greater the amount of TEGDMA monomers, higher are the levels of discoloration[1-16]. Furthermore, it is suggested that the presence of silane together with the filler particles negatively influence the color stability, as silane is a material that has a high level of water absorption[16].

The influence of coffee in color changes of three kinds of Bulk Fill composites (Filtek Bulk Fill- 3M, X-Trafil- Voco, and SonicFill Bulk Fill- Kerr) that were immersed for 1 month in the substance was previously evaluated[17]. The result found was a significant change in color of the three composites, which increased proportionally to the time that the samples were immersed in the coffee. This study above mentioned corroborates the results found in this study, where coffee was able to color the Bulk Fill resins. A research[18] suggests that staining by coffee is because the adsorption and absorption of the yellow dye present in the substance, which occurs due to the compatibility of the resin matrix of the composite with coffee dyes.

The results showed that both drinks were able to cause pigmentation. Red wine is the substance capable of causing pigmentation with greater intensity, with ΔE=9.78 after immersion of the samples in the substance, while coffee had a ΔE=8.14. This can be explained by the presence of alcohol in the composition of red wine, which tends to degrade the resin surface properties, causing roughness in the material, which provides greater surface area for the adsorption of pigments present in the substances that cause greater coloring[19].

Although the results obtained in the study present color changes in the specimens, Filtek Bulk Fill resin has lower potential for pigmentation when compared to Filtek Z350, as proven[18]. According to the literature, the presence of monomer AUDMA and UDMA, and the absence of Bis-GMA and TEGMA. According to some authors, the UDMA is a monomer that is more resistant to staining, compared to monomers Bis-GMA and TEGDMA, present in Filtek Z350[18].

The ΔE values between 1 and 3 are visibly noticeable and ΔE values above 3.3 are considered clinically unacceptable[18-20].

A survey found that drinks with low pH can directly affect the integrity of the resin surface, also contributing to greater susceptibility to pigmentation[21]. In the case of this research, coffee and red wine are low pH substances, which may have contributed further to the darkening of the samples.

Recently, color stability in nanohybrid composites was evaluated by immersing them for 24 hours in solutions of water, coffee, tea, cola soft drink and red wine.

The study found as one of the main results that coffee was the one that most caused darkening (ΔE=4.37-7.41), followed by wine (ΔE=3.97-7.01). The difference between the results presented here can be explained by the type of resin that was used in that study (Brilliant NG and Filtek Z350 XT)[22]. Moreover, there was no use of hydrogen peroxide 35%, and thus, it is suggested that the peroxide has increased bleaching power over coffee compared to the wine. Further studies are recommended, in order to respond to these changes when comparing the different types of resin.

In Table 1 it is possible to check the response of the specimens subjected to the bleaching agent hydrogen peroxide at 35% obtained. It was possible to demonstrate a statistically significant color change for group 2 and 3 (coffee and wine, respectively). This result suggests the effectiveness of the bleaching agent in the composites that had suffered pigmentation. According to a previous study[22] the organic matrix of the composite resin tends to suffer chemical changes induced by the acid component of the bleaching agent.

Hydrogen peroxide is an oxidizing agent of high performance and intensity, highly unstable, has the ability to degrade the polymeric matrix resin. When there is direct interaction of the bleaching agent with the surface of the restorative material, the peroxide degrades into radicals free of oxygen and unstable water, which combine with each other and, when there is a reduction or oxidation of these radicals, the pigmented molecules break[1-23].

One hypothesis for the great efficiency of the bleaching agent used in this research is the concentration of it, as it has large amount of active ingredient which diffuses faster. A previous study[24] used Hydrogen peroxide and Carbamide peroxide, proving more effectiveness in stain removal with hydrogen peroxide at 40% when compared to other carbamide-based bleaching agents and in lower concentration. These have a lower amount of hydrogen peroxide in their composition, only one third decomposes into hydrogen peroxide and the others in urea.

One emphasizes that the color change can be related to the type of resin used. Some studies describe that the resin Filtek Z250 XT and Filtek Z350 XT shows no statistically favorable response to color change after application of 35% hydrogen peroxide and 16% carbamide peroxide[18-24].

The bleaching agent is capable of removing the superficial stains found in the resin pigmented by drinks; however, stains penetrated into the resin matrix of the composite cannot be removed using the bleaching agent[25]. This study is in line with the findings in this research, since no test group had the color equal to the group of distilled water, which remained stable.

Based on this study and all the others analyzed, it was found that hydrogen peroxide was effective at removing pigmentation in Bulk Fill composite resin, but, there was not complete bleaching.

CONCLUSION

From this study it was concluded that the drinks used in this study were able to cause staining on Filtek Bulk Fill (3M ESPE) resin. Among them, the red wine obtained greater power of pigmentation when compared to the soluble coffee.

Hydrogen peroxide 35% (Whiteness HP Blue Calcium 35%/FGM) was able to remove surface stains of the specimens. One emphasizes the need to carry out further studies comparing the ability of hydrogen peroxide 35% (Whiteness HP Blue Calcium 35%/FGM) in removing pigments in different types of resin.

It is pointed as a limitation that the study was carried out at laboratory level and, to obtain conclusive results, it is necessary controlled and randomized clinical trials.

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CONTRIBUTIONS

Ingrid Fabiane Costa de Sousa Cavalcante and **Laís Guedes Alcoforado de Carvalho** contributed to the data collection and writing of this study. **Robinsom Viegas Montenegro, Sonia Saeger Meireles** and **Rosângela Marques** participated in the research supervision and writing. **Ana Karina Maciel de Andrade** participated with the guidance of the research.

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