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EFFICACY OF POLISHING IN REDUCING SURFACE ROUGHNESS OF DIFFERENT RESTORATIVE MATERIALS AFTER TOOTH WHITENING

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Abstract: In current relationships, a smile has the power to influence, both positively and negatively, individuals' interactions. In this sense, a person with a harmonious smile has a great chance of having advantages and success in the social sphere. The present study aimed to evaluate the effectiveness of intraoral polishing of some direct restorative materials in reducing surface roughness after tooth whitening. To carry out this study, the following direct restorative materials were tested: Filtek Z350 XT nanoparticle composite resin (3M-ESPE) and Vittra APS (FGM); and the conventional glass ionomer cements Maxxion R (FGM) and the light-cured Vitro Fill LC (DFL). These were subjected to the whitening procedure with 35% hydrogen peroxide (Whiteness HP Maxx, FGM), simulating the in-office whitening technique, and the use of polishing agents, simulating intra-oral polishing after whitening. After verifying the normality of data distribution, Analysis of Variance (2-factor ANOVA) was applied and subsequently the Kruskall-Wallis Test. According to the results found in this study, the polishing procedure was not effective in reducing the surface roughness of these materials after the bleaching carried out. Therefore, after using whitening gels, it is important to replace the restoration or carry out repairs.

Keywords: Surface roughness, dental polishing, composite resins, glass ionomer cement and tooth whitening.

INTRODUCTION

In current relationships, a smile has the power to influence, both positively and negatively, individuals' interactions. In this sense, a person with a harmonious smile has a great chance of having advantages and success in the social sphere[1]. On the other hand, patients who have tooth darkening are likely to have complications in their relationships, since whiter teeth are considered more beautiful and healthier. Among the attempts to improve smile aesthetics and reduce dental pigmentation, the alternative of tooth whitening can be presented, a treatment that is highly sought after, mainly due to the preservation of healthy tooth structure and proven effectiveness in the literature[2].

With a multifactorial origin, dental pigmentations can be classified into: intrinsic and extrinsic. As an example of intrinsic classification, this is a phenomenon that occurs due to the impregnation of large and complex molecules within the dental structure, which favors greater absorption of light, causing easily visible pigmentations[3]. Its removal, with the aim of whitening the tooth, can be carried out with some chemical substances, while to reduce extrinsic pigmentation, there is a need for simple prophylactic procedures4. In the whitening process, the stains will be degraded, promoting the structural change of atoms, and consequently molecular alteration, leading to tooth whitening [3].

There is a polarization of opinions found in the literature regarding the aforementioned procedure, demonstrating the lack of consensus regarding its side effects. While on the one hand, this method can be considered conservative, which does not cause major damage to the dental structure, on the other hand, the action of whitening gels on the surface roughness of dental tissues and restorative materials is observed, regardless of their concentration or technique used[5]. This way, future damage may occur to these structures, even if there is effectiveness in relation to their primary objective[6]. After stating this issue, the relevance of better investigating techniques that aim to reduce these possible damages can be seen.

The chain of possible damages arising from the tooth whitening technique has, as its starting point, the increase in surface roughness, which in turn leads to the accumulation of biofilm and bacterial adhesion, culminating in significant harm to the patient's oral health[7, 8]. Furthermore, it facilitates the occurrence of surface staining, changes in brightness and a reduction in the longevity of restorations[9].

Although massive studies point to the proof of all these consequences for tooth enamel[10,11,12] and other research demonstrates their impact on restorative materials,[8,13] one can see the relevance of better investigating techniques that aim to reduce these possible damages to restorative materials.

Studies indicate that intra-oral polishing after tooth whitening has been an efficient method for reducing these possible changes caused to tooth surfaces and restorative materials[14]. However, others state that the tooth whitening technique promotes irreversible damage, leading to an increase in the surface roughness of the enamel and restorative materials, and replacement of the restoration is often suggested, especially when there is aesthetic involvement[15]. Given this, this study aimed to evaluate the effectiveness of intra-oral polishing of some direct restorative materials (composite resins and glass ionomer cements) in reducing surface roughness after tooth whitening.

MATERIALS AND METHODS

In this study, the following direct restorative materials were tested: composite resin, nanoparticles Filtek Z350 XT (3M-ESPE) and Vittra APS (FGM); and the conventional glass ionomer cements Maxxion R (FGM) and the light-cured Vitro Fill LC (DFL). These were subjected to the whitening procedure with 35% hydrogen peroxide (Whiteness HP Maxx, FGM), simulating the in-office whitening technique, and the use of polishing agents, simulating intra-oral polishing after whitening.

To prepare the samples, a rectangular metal matrix measuring 10.0 cm long, 3.0 cm wide and 2.0 mm thick was used, with 5 perforations measuring 5.0 mm in internal diameter by 2.0 mm. thickness, which determined their measurements. During the manufacture of the specimens made of composite resin and glass ionomer cement, in the perforations of this matrix, the internal surfaces were properly isolated with solid petroleum jelly, to avoid adhesion of the material during its manufacture.

Thus, the material was manipulated, according to the manufacturer's instructions, and inserted with the aid of a titanium spatula (composite resins) and using a centrix syringe (glass ionomer cements), in the form of a single increment in the metallic matrix and the samples were photopolymerized following the time recommended by the manufacturer, against a polyester strip pressed by a glass plate, with the aid of a VALO photopolymerizer (Ultradent, Brazil), with a light intensity of 1000 mW/cm2, measured through a radiometer (Demetron/Kerr, Danbury, CT, USA). This way, 30 specimens of each restorative material were manufactured, which were then stored in a plastic collection container containing artificial saliva, to avoid dehydration after preparation.

DIVISION OF GROUPS

The specimens were divided into 12 groups, each containing 10 samples, which received different treatments, as shown in Table 01.

CARRYING OUT THE WHITENING PROCEDURE

Then, all groups, except the control groups, underwent bleaching procedures using 35% hydrogen peroxide (Whiteness HP Maxx, FGM, Brazil). For this, the specimens were fixed to a glass plate using double-sided tape. Then, the product was manipulated and applied 3 times for 15 minutes, according to the manufacturer's recommendations. After this procedure, the samples were washed, dried and stored again in artificial saliva, which was replaced with a new solution after the procedure. This step was repeated for 3 days, with an interval of 72 hours.

POLISHING

After completion of whitening, samples from groups G3, G6, G9 and G12 were polished with aluminum oxide discs (OptiDisc, Kerr), felt disc (Diamond, FGM) and diamond paste (Diamond Excel, FGM). All polishers were adapted to a low-speed, contra-angle handpiece (Kavo do Brasil Ind. Com. LTDA), using light, intermittent back-and-forth movements for 30 seconds for each step, performed by a single operator. previously calibrated. Each disk was used for just 5 samples and then discarded.

ASSESSMENT OF AVERAGE SURFACE ROUGHNESS

After the bleaching and polishing procedures were completed, each specimen was fixed with double-sided tape to a glass plate and read using a Surftest SJ-301 roughness meter (Mitutoyo, Tokyo, Japan), to determine the average surface roughness. The reading considered was the arithmetic mean (Ra) between the peaks and valleys covered by the active tip of the device, with a measuring path of 4.0 mm. Three readings were taken on the surface of each specimen: one in the horizontal direction, another perpendicular to the first and one in the oblique direction.

STATISTICAL DATA ANALYSIS

The average values obtained were noted, tabulated and subjected to statistical analysis. After verifying the normality of data distribution, Analysis of Variance (2-way ANOVA) was applied and subsequently the Kruskall-Wallis Test. The significance level considered was less than or equal to 5%.

RESULTS

Table 02 presents the values of the average surface roughness (Ra) of the tested groups, each of which was composed of 10 samples (n=10), made with different types of composite resin, one nanoparticle (G1, G2 and G3) and another based on zirconia silicate (G4, G5 and G6), and glass ionomer cements, one conventional (G7, G8 and G9) and the other resinous (G10, G11 and G12).

According to these findings, for all restorative materials tested, significant statistical differences ($p<0.05$) were observed between their control groups and the respective experimental groups treated with 35% hydrogen peroxide, that is, the bleaching agent. significantly increased the surface roughness of all materials used. However, when comparing the bleached groups of each material with the groups subjected to bleaching and polishing, no statistically significant differences were observed ($p>0.05$), which in turn demonstrates that polishing was not effective in reducing roughness. surface of these materials after bleaching.

When comparing the control groups of each restorative material with each other, no differences were found in the average surface roughness values between the different composite resins tested (G1 and G4), however between these and the different types of glass ionomer cements used (conventional and resinous) statistically significant differences were found, as well as these ionomers among themselves (G7 and G10).

Comparing the bleached groups, the composite resins showed similar behavior (G2 and G5), however with significant statistical differences between the glass ionomer cements, and between them (G8 and G12). Therefore, glass ionomer cements were the most negatively affected by the bleaching agent, especially conventional cement (G8), presenting the highest surface roughness values among all materials. The same result was found when comparing the groups subjected to bleaching and polishing, thus this procedure provided lower values of surface roughness in composite resins in relation to GICs, and resin cement in relation to conventional cement.

Furthermore, the coefficient of variation was observed, which in all groups was lower than 30%, demonstrating the homogeneity between the samples from each group.

DISCUSSION

Taking into consideration, that the increase in surface roughness of restorative materials, caused after tooth whitening, can cause damage to intra-oral health, such as increased surface staining capacity, change in gloss, accumulation of bacterial plaque, caries lesions, decreased microhardness, among other[8.9]studies aimed at finding techniques capable of reducing these possible damages, are of extreme clinical relevance. In the literature, some studies demonstrate that intra-oral polishing is capable of reducing the surface roughness of the restorative materials used[14]. However, other results show that this procedure is not capable of minimizing this roughness, which makes this subject quite controversial in the literature[15].

Regarding the increase in surface roughness of restorative materials, in the present study, significant differences were found between the average surface roughness values in relation to the control groups and those treated with 35% hydrogen peroxide.

This result agrees with the studies presented by Vieira et al.6 and Tavares et al.[18], who evaluated different composite resins exposed to bleaching agents in different concentrations, and found a significant increase in the surface roughness of these materials, regardless of the concentration of the product used. Contradicting the study of Savic-Stankovicet al.[19], which states that when performing the whitening technique on a nanohybrid and another micro hybrid composite, no change in surface roughness was observed, nor any change in the brightness of the restorations.

Observing the data obtained in the present work, in the case of the control group (G1, G4, G7 and G10), those who were not exposed to whitening gels, it can be seen that no differences were found in the average surface roughness values between the different composite resins tested (G1 and G4), this may be due to the fact that they are resins that have similar composition, presenting a small size of inorganic particles and a small presence of organic matrix, promoting greater smoothness for these materials. However, between the different types of glass ionomer cements used (G7 and G10), conventional and resinous, statistically significant differences were found. This can be explained due to the addition of resinous components in the formulation of resin cements, which gives this material greater surface smoothness compared to conventional materials[16].

When evaluating the effect of polishing on the surface of restorative materials exposed to the bleaching agent, the results obtained in our study state that no statistically significant differences were found ($p>0.05$) between the bleached groups (G2, G5, G8 and G11) and the groups subjected to bleaching and subsequent polishing (G3, G6, G9 and G12), pointing out that polishing after bleaching was not effective in reducing the increase in surface roughness of these materials, in accordance with studies of Dziedzicet al.[20] and Mendes et al.[15], who evaluated the roughness of restorative materials after the bleaching technique, reaching the conclusion that this polishing procedure is ineffective in returning materials exposed to bleaching gels to their original surface roughness.

Contrasting the results of this study of Bittencourt et al.[14] which evaluated the influence of finishing and polishing techniques on the surface roughness of two composite resins subjected to the bleaching procedure, finding that such procedures were effective in reducing the surface roughness caused by the bleaching treatment.

Given the different findings in the literature, Mendes et al.[15], argues that, when a whitening procedure is carried out, where the patient has resin in the anterior region, it is recommended to completely exchange the restoration or repair it, but this repair must not be done only superficially, as the degree of depth of the damage caused exposure to whitening gels is not yet adequately specified. Bittencourt et al.[14], believe that after bleaching, it is extremely important to analyze the appearance of the restoration, such as changes in color, integrity of the margin and surface roughness, in order to suggest the need for replacement or maintenance of the restoration.

We also have the findings found in the study of Calixto et al.[7] who analyzed the surface roughness of composite resins, observing that when the polishing technique is performed before the bleaching treatment, it is possible to notice considerable effectiveness in reducing problems caused by the increased surface roughness of these restorative materials, even after exposure to bleaching gels.

Despite these findings, it is worth highlighting that there are limitations in the results of this study, as it is an in vitro study, not providing natural physiological conditions of the oral cavity. Furthermore, due to existing controversies and insufficient data in the literature related to the effect of polishing after bleaching on the surface of restorative materials, it highlights the importance of carrying out this study and it is suggested that further research be carried out, with the aim of finding effective methods for solving these problems.

CONCLUSION

Considering the results of the present study, all materials exposed to whitening gels showed an increase in their surface roughness, with composite resins showing lower values of surface roughness in relation to the glass ionomer cements tested, and resin cement in relation to conventional. Furthermore, the polishing procedure was not effective in reducing the surface roughness of these materials after bleaching. Therefore, after using whitening gels on the surfaces of restorative materials, total replacement or repair of the restorations is suggested.

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TABLES

GROUP	RESTORATIVE MATERIAL	PROCEDURE
G1 (Control)	Filtek Z350 XT	No whitening treatments.
G2	Filtek Z350 XT	Whitening with 35% Hydrogen Peroxide.
G3	Filtek Z350 XT	Whitening with 35% Hydrogen Peroxide and polishing (aluminum oxide discs, felt disc and diamond paste).
G4 (Control)	Vittra AP.S.	No whitening treatments.
G5	Vittra APS	Whitening with 35% Hydrogen Peroxide.
G6	Vittra APS	Whitening with 35% Hydrogen Peroxide and polishing (aluminum oxide discs, felt disc and diamond paste).
G7 (Control)	Maxxion R	No whitening treatments.
G8	Maxxion R	Whitening with 35% Hydrogen Peroxide.
G9	Maxxion R	Whitening with 35% Hydrogen Peroxide and polishing (aluminum oxide discs, felt disc and diamond paste).
G10 (Control)	Vittro Fill LC	No whitening treatments.
G11	Vittro Fill LC	Whitening with 35% Hydrogen Peroxide.
G12	Vittro Fill LC	Whitening with 35% Hydrogen Peroxide and polishing (aluminum oxide discs, felt disc and diamond paste).

Table 01: Division of groups

GROUP	AVERAGE (Frog)	STANDARD DEVIATION (dp)	COEFFICIENT OF VARIATION
G1	0.117	0.026	22.45%
G2	0.336	0.051	15.12%
G3	0.305	0.071	23.30%
G4	0.209	0.046	21.80%
G5	0.387	0.055	14.16%
G6	0.317	0.041	12.88%
G7	0.761	0.068	8.94%
G8	1,034	0.087	8.45%
G9	1,024	0.035	3.42%
G10	0.365	0.061	16.65%
G11	0.593	0.097	16.33%
G12	0.520	0.060	11.47%

Table 2: Average surface roughness (Ra) of the experimental specimens, in µm, presented as mean, standard deviation (SD) and coefficient of variation, Feira de Santana, 2023.
*for each experimental group n=10