EFFECT OF WHITENING DENTIFRICES CONTAINING HYDROGEN PEROXIDE OR CARBAMIDE PEROXIDE, IN BOND ADHESION TO DENTAL ENAMEL

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ABSTRACT:

This study evaluated the effect of whitening dentifrices on the microshear bond strength (μCM) to the dental enamel at different times elapsed after the completion of the whitening protocol. Thirty samples from 15 third molars were divided into six groups: G1 and G4 (Crest baking soda & peroxide), G2 and G5 (Optic White), and G3 and G6 (Colgate Total 12). Samples were submitted to mechanical brushing test in 3 daily brushing sessions of 3 minutes each, for 15 days. Teeth were restored immediately (G1, G2 and G3) and 15 days (G4, G5 and G6) after bleaching, and then submitted to the μCM test. Data were analyzed by ANOVA and Tukey tests ($p < 0.05$). G1 and G4 presented lower μCM values, however, restorations performed immediately or 15 days after the brushing period presented similar μCM values ($p < 0.05$), regardless of dentifrice. It could be concluded that the use of these dentifrices did not compromise the bond strength in both evaluation times.

KEYWORDS:

Dental enamel. Tooth whitening. Dentifrice. Bond. Carbamide peroxide. Hydrogen peroxide. Microshear.

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INTRODUCTION

Dental whitening has been widely used and can be considered one of the most important dental cosmetic treatments[1], in case of non-invasive treatments[2].

Due to the benefits of home bleaching, numerous over-the-counter (OTC) products were made available to the population as low-cost alternative when compared to professional treatment. However, because they are products that have, in some presentations, carbamide or hydrogen peroxide, if used without professional supervision they can cause damage to hard and soft tissues[2].

The use of bleaching agents reduces bond strength values due to the residual oxygen present in the dental substrate[1,2], but a systematic review (personal communication) about this effect after the use of bleaching dentifrices concluded that methodological differences among studies have limited the confirmation of this association, recommending further research in order to elucidate this effect with greater strength of evidence. It has been also recognized that these effects are reversible, taking a period of 7-14 days to perform the adhesive restorative procedures to ensure effective restorative material/substrate bonding, and consequently greater longevity of the treatment performed[3-5].

Thus, due to the indiscriminate use of bleaching dentifrices and the possible consequences in clinical practice, it is relevant to evaluate its effect on adhesive restorative procedures, encouraging this study.

MATERIAL AND METHODS

After approval by the Research Ethics Committee, under CAAE registration 55894916.0.0000.5626, 15 healthy third molars were selected, due to clinical indications, for the preparation of 30 specimens randomly distributed in 6 groups (n = 5), as described in Table 1.

Sample preparation — After extraction, teeth were cleaned with pumice paste and water, stored in 0.5% chloramine T solution and frozen until the time of use. With the use of a double-sided diamond disc, a cut was made to separate the crown from the root. Then, crowns were divided, in the mesiodistal direction, under refrigeration, to obtain 2 samples per tooth. Samples were embedded in a PVC tube in acrylic resin. To obtain a flat surface in the dental enamel, the surface was polished with #600, 1000 and 1200 granulation silicon carbide sandpapers under constant irrigation. Stereoscopic microscope was used to analyze the presence of caries lesions or cracks.

Brushing test — Samples were submitted to mechanical brushing test in an MSEt machine (Elquip, São Carlos, Brazil). Johnson & Johnson 30' toothbrushes with extra-soft bristle were arranged in rows with 36 tufts measuring 170 mm in diameter and 10 mm in length. Considering 3 daily brushing sessions, cycles were performed, simulating 5 seconds of brushing, that is, 15 seconds per daily session, for 15 days. The test was performed with constant axial load at 200g, linear movements on the longitudinal surface of samples and speed of 150 cycles per minute. A dentifrice and distilled water solution (1:1), respectively, at the ratio of 4.6 mL (6g) x 6 mL was released at each cycle. These solutions were prepared and stored in coded bottles, so the operator would not know which solution was being used. At the end of each daily test, samples were washed in distilled water and stored at 37°C in artificial saliva.

At the end of 15 days of brushing, half of samples (Table 1) were stored in distilled water for another 15 days. During this time, samples were washed in distilled water once a day. The other half of samples were submitted to the restorative procedure.

Restorative procedure — for the preparation of specimens, the materials and the technique described in Table 2 were used. A single calibrated operator prepared the specimens, unaware of which group was being restored, since they were coded. Restorative procedures occurred 30 minutes after brushing. Adhesive materials were used according to manufacturer's instructions. After adhesive application, two cylinders (1mm high X 0.7mm diameter) were placed on the surface and the composite resin inserted and polymerized for 40s. Specimens were stored in distilled water, and after 24 hours, cylinders were removed. Before the micro-shearing mechanical test occurred, specimens were analyzed under stereoscopic microscope to observe the presence of microcracks, voids or absence of material.

Table 1:

Distribution of groups and composition / batch of dentifrices

WHITENING DENTIFRICE	RESTORATIVE PROCEDURES	
	IMMEDIATE	15 DAYS
Crest baking soda & peroxide (active ingredient: sodium fluoride 0.243%, other ingredients: glycerol, water-hydrated silica, propylene glycol, sodium bicarbonate, tetrasodium pyrophosphate, sorbitol, PEG 12, sodium hydroxide, sodium lauryl sulfate, saccharin, poloxamer 407, xanthan gum , cellulose gum, calcium peroxide, titanium oxide / LOT 619132EXPMA18)	G1	G4
Optic White (propylene glycol, calcium pyrophosphate, glycerol, PEG/ PPG-116/66, PEG-12, PVP, silica, tetrasodium pyrophosphate, sodium lauryl sulfate / hydrogen peroxide, di sodium pyrophosphate, sodium saccharin, sucralose, BHT / 1217L66158)	G2	G5
Colgate Total 12 (active ingredients: sodium fluoride (1450 ppm fluorine), triclosan 0.3%; other ingredients: water, glycerin, sorbitol, hydrated silica, sodium lauryl sulphate, pvm / ma copolymer, aroma, carrageen, sodium saccharin, sodium hydroxide, white dye ci 77891. composition / batch 6308BR122B)	G3	G6

Table 2:

Materials used in the experiment and method used.

MATERIAL	COMPOSITION	COMPANY/BATCH
[a]37% phosphoric acid	water, 37% phosphoric acid	FMG Produtos Odontológicos - Joinville - SC/121214
[b]Ambar adhesive system	Active Ingredients: Methacrylic monomers, photoinitiators, co-initiators, stabilizer Inactive Ingredients: Inert load (silica nanoparticles) and carrier (ethanol)	FMG Produtos Odontológicos - Joinville - SC/040815
[c]Opallis flow resin composite	Microhibryd composite (monomeric matrix BisGMA, BisEMA, UDMA and TEGDMA, silanized silicate, aluminum silica dioxide nanoparticles, camphorquinone as photoinitiator, accelerators, stabilizers, and pigments	FMG Produtos Odontológicos - Joinville - SC/160114

[a]acid etching of the enamel for 15s, followed by abundant rinsing and excessive drying (opaque white appearance), [b]application of the first drop, with friction, for 10s; followed by new application for another 10s; drying for 10s, and photoactivation for 10s; [c]resin insertion in an increment and photoactivation for 20s.

Micro-shear mechanical test (μCM) — the mechanical test was performed by a single operator unaware of which group was being evaluated. It was used was a universal test machine (EMIC, Equipamentos e Sistemas de Ensaio LTDA., São José dos Pinhais/PR, Brazil), using orthodontic wire with diameter of 0.2 mm at speed of 0.5 mm/min and load cell of 50 N. The values obtained in Kgf were converted into MPa for further statistical analysis.

Analysis of the fracture sites — the types of fracture produced by the micro-shearing test were classified by the stereo microscope analysis, with magnification of 25X. Failures were classified as adhesive, cohesive in dentin, cohesive in composite or mixed.

Results analysis — results were statistically analyzed using one-way ANOVA followed by Tukey's post-hoc multiple comparison tests, with significance level of 5% ($p<0.05$). The results of the fracture pattern analysis were presented in a descriptive way, by frequency distribution.

RESULTS

The mean μCM values and the standard deviation of groups are presented in Table 3. Restorations performed immediately after the brushing test presented higher bond strength values in the group that used the bleaching dentifrice (Optic), while in those performed 15 days later, control group (fluoridated dentifrice) presented better bond strength values. Groups 1 and 4 (Crest) presented the lowest bond strength values in both evaluation times. Although the descriptive analysis presented different means, ANOVA two-way analysis revealed that these differences were not statistically significant, regardless of product and/or evaluation time. All failures were classified as adhesive regardless of group analyzed.

Table 3:

Micro-shear bond strength values and standard deviation of the samples restored after brushing with whitening dentifrices (Baking Soda & Peroxide and Optic White) and conventional (Colgate Total 12) at the times evaluated.

DENTIFRICE	BOND STRENGTH [MEDIA ± DP]	
	IMMEDIATE	15 DAYS
Crest Baking Soda & Peroxide	18.38 ± 4.73 ^{Aa}	18.22 ± 5.96
Optic White	21.31 ± 4.76 ^{Aa}	21.20 ± 7.73 ^{Bb}
Colgate Total 12	18.86 ± 3.58	21.81 ± 5.91 ^{Aa}

Different upper case letters in each row and different lowercase letters in each column indicate statistically significant differences between the same material and the same time period respectively ($p<0.05$; Tukey HSD test).

DISCUSSION

Due to the indiscriminate use of whitening dentifrices and the possible consequences in clinical practice, it is of utmost importance to observe whether such products had the capacity to compromise the effectiveness of the adhesive restorative procedure, since the other professional bleaching products are recognized as negatively affecting this procedure.[3-15]

After analyzing the results of this study, it was verified that the whitening dentifrices did not decrease the immediate bond strength values, when compared to the use of a conventional dentifrice. Such findings are conflicting with literature for disagreeing with the results of Cura, Fuentes, and Ceballos[7] and Briso et al;[3] however, they corroborate those of Da Silva, Flório and Basting.[16]

Regarding studies that observed negative influence on the use of whitening dentifrices, it is believed that this fact is due to the methodology used. In this study, it was prioritized to mimic, to the maximum, the daily routine. Thus, when comparisons to the study by Briso et al[3] are made, it is verified that the authors used a period of 21 days, with immersion in 2:1 dentifrice solution for 15 minutes/day. According to the authors, this high proportion may have led to an increase in oxygen concentration, causing alterations in the organic and inorganic matrix and consequent decrease of bond strength values. In addition, the exposure time to the bleaching solution was higher, 21 days, which may have potentiated the negative result. Finally, it is believed that immersion for 15 consecutive minutes does not mimic clinical reality. The continuous exposure of the substrate to the product may have produced deleterious effects higher than the daily routine, i.e., 3 brushings throughout the day, presenting interval between brushings in saliva solution, which is able to rebalance the mineral constituents of the substrate.

In this study, the choice for the 15-day experimental period was due to the proposal of one of the manufacturers to guarantee whitening effect on the dental substrate after this period.

Regarding the study of Cura, Fuentes and Ceballos[7], in addition to the 30-day trial, twice the time of this study, the use of bleaching dentifrices was followed by the use of mouthwash and/or gel, whose pH was between 5 and 2.5, respectively. It is believed that this overexposure has generated such negative results.

Issues related to the methodologies used emphasize the importance of researches with dental materials to mimic, even under controlled laboratory conditions, the daily routine so that

the performance of restorative materials is as close as possible to clinical practice. Also regarding methodology, it is important that its design, execution and description contemplate criteria that reduce the risk of bias and thus increase the strength of evidence of the results found. Thus, all the design and writing of the methodology of this study followed criteria proposed by Sarkis-Onofre et al.[17] and Altmann et al.[18] for studies with dental materials.

Da Silva, Flório and Basting[16] evaluated only one dentifrice containing carbamide peroxide for 21 days in solution at ratio of 1:3 (by weight), by immersion of 15 minutes. It was observed that despite a longer exposure period to bleaching agents, the proportion was lower, suggesting that the challenge was milder when compared to the other studies under discussion. However, because the mechanical shear test was not used, it did not allow numerical data to be compared to those of the present study, being limited to the comparison of the outcomes, which showed similarity in results, with higher adhesion values for the whitening toothpaste, when compared to conventional treatment.

Thus, in view of the above, it is believed that despite the presence of hydrogen or carbamide peroxide, their low concentration is not enough to release oxygen to the point of being residual and impacting adhesion. However, when in contact with the dental surface, it is capable of producing changes in the organic and/or inorganic components favoring the union of adhesive restorative materials, as reported by Da Silva, Flório and Basting[16]. Specifically in this case, as the Optic White dentifrice contained hydrogen peroxide instead of carbamide peroxide, present in the Crest Baking Soda & Peroxide dentifrice, this could explain the greater surface change, and consequently the change in the bond values observed, since it is known that hydrogen peroxide releases more oxygen than carbamide peroxide[19].

The occurrence of adhesive failures, in their entirety, demonstrated that the mechanical test was correctly performed, confirming the findings of Briso et al,[3] who observed higher prevalence of this pattern, and Cura, Fuentes and Ceballos[7].

Thus, considering the methodology applied that mimicked the daily brushing practice, and the results found, it could be observed that dentists

who plan to perform adhesive restorative treatment should not be concerned about the possibility of patients using bleaching toothpaste in a short period of time, as there is no negative impact on bond strength.

CONCLUSION

Considering the obtained data, it could be concluded that dentifrices containing hydrogen and carbamide peroxide, when used for a short period of time, do not compromise the bond strength values. However, further studies should be carried out in order to understand the performance of these dentifrices at different evaluation times.

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