Effect of 10% Carbamide Peroxide Dental Bleaching on Microhardness of Filled and Unfilled Sealant Materials

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ABSTRACT

Purpose: The purpose of this study was to quantitatively evaluate the effect of 10% carbamide peroxide on the microhardness of pit and fissure sealant materials.

Methods: Fluroshield, Vitroseal Alfa, and one unfilled (Clinpro) sealants were placed in Teflon matrices (4 mm in diameter by 2 mm in height) and polymerized for 40 seconds. A total of 20 specimens were prepared for each material, in which half were assigned as the control group (stored in artificial saliva and no bleaching treatment). For the remaining half, Clarigel Gold bleaching agent (10% carbamide peroxide) was placed over the specimen surface for 4 hours/day during 4 weeks. When specimens were not under bleaching treatment, they were kept in artificial saliva. Afterwards, specimens were subjected to Knoop microhardness testing using a 25-g load for 5 seconds. Five measurements were made on the sealants' surfaces and then calculated in Knoop hardness values. The data were statistically analyzed by two-way analysis of variance and Tukey's tests with a 5% confidence level.

Results: The results of this in vitro study showed that the application of a carbamide peroxide-based bleaching material significantly affected the microhardness values of filled sealant materials. The bleaching agent did not affect the microhardness of the unfilled sealant.

CLINICAL SIGNIFICANCE

The results of this in vitro study suggest that the bleaching agents altered the surface hardness of filled sealant restorative materials. This could possibly lead to increased wear and surface roughness.

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INTRODUCTION

The application of occlusal sealants can be considered a substantial advance in dental caries prevention. The principal benefit of preventing dental caries and covering enamel defects is the long-term maintenance of the natural dentition.[1–4] Also, the development of more conservative esthetic treatments has been proposed, such as the use of at-home bleaching

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technique treatment, reported by Haywood and Heymann.[5] The home bleaching treatment is indicated for vital teeth that present undesirable chromatic alterations especially the yellowish colors that can occur at all ages.

Although there is widespread use of bleaching agents, there is no agreement as to the effect of bleaching agents on restorative materials.[6] The mechanism of action of bleaching agents on tooth structures apparently is due to the oxidation of dentin molecules, causing changes in color.[7,8] This oxidation reaction would be able to alter the structural integrity of restorative materials.[9] However, not all the side effects related to the use of these agents have been clarified. Some of these issues are related to the effect of bleaching agents on restorative materials,[9] associated with the restorative bonding procedure performed after bleaching,[10,11] or due to alterations in the already present restoration properties.[12–14]

Conflicting results are reported regarding the impact of low-concentration (10–16%) carbamide peroxide gels on the surface microhardness of restorative composite materials. In some investigations, softening of composite resins was associated with the application of bleaching gels.[15,16] Other investigations revealed no significant hardness changes[17,18] or increased surface hardness[12,19] due to the application of home bleaching gels. These results may show that the effect of carbamide peroxide gels is dependent on the composite material. In the current literature, there is no data concerning the performance of pits and fissure sealants after dental bleaching treatment with carbamide peroxide. The sealants present at the occlusal surfaces are exposed to constant masticatory stresses. Therefore, it is important to investigate the effects of dental bleaching agents on the microhardness of sealant restorative materials.

The purpose of this in vitro study was to evaluate the effects of 10% carbamide peroxide gel on the microhardness of filled and unfilled pit and fissure sealants. The null hypothesis tested was that there is no difference in the surface hardness of the sealants after the use of 10% carbamide peroxide, regardless of the presence of filler particles in the sealant.

MATERIALS AND METHODS

The sealant materials and bleaching agents employed in this study are described in Table 1. Sixty

TABLE 1. SEALANTS AND BLEACHING AGENT EMPLOYED IN THIS STUDY.

Material	Brand Name	Composition	Manufacturer (Batch Number)
Pit and fissure sealant	Fluroshield	Urethane modified Bis-GMA dimethacrylate, barium aluminoborosilicate glass, polymerizable dimethacrylate, Bis-GMA, sodium fluoride, dipentaerythritol pentaacrylate phosphate, and silica amorphous (50% by weight)	Dentsply Caulk (62501)
Pit and fissure sealant	Clinpro	Bis-GMA/TEGDMA resin composition, unfilled, releases fluoride	3M ESPE (2B 2004—01)
Pit and fissure sealant	Vitroseal Alfa	Bis-GMA, ionomer glass, TEGDMA, aerosil, silanized, polymethacrylated, polymethacrylic acid, and stabilizer, silica (7% by weight)	DFL (0207548)
Bleaching gel agent	Clarigel Gold	Sodium benzoate, polypropyleneoxide, EDTA, carbopol, triethanolamine, carbamide peroxide, sodium fluoride, distilled water, mint flavor	Dentsply Caulk (1057)

Bis-GMA = bisphenol glycidul methacrylate; TEGDMA = triethyleneglycol dimethacrylate; EDTA = ethylenediaminstetraacetic acid.

specimens were prepared and assigned to six groups ($N = 10$). Specimens were divided according to the materials tested ($N = 20$): Fluroshield (Dentsply Caulk, Petrópolis, RJ, Brazil), Clinpro (3M ESPE Dental Products, St. Paul, MN, USA), and Vitroseal Alfa (DFL Industry and Commerce Ltd., Rio de Janeiro, RJ, Brazil). For each material, 10 specimens were assigned to a control group and kept in artificial saliva until tested. The remaining 10 were subjected to 10% carbamide peroxide (Clarigel Gold [Dentsply Caulk]) bleaching treatment.

For the specimen preparation, cylindrical Teflon matrices with dimensions of 4 mm in diameter by 2 mm in height were placed over a glass slide and fixed with wax. After material placement in the matrices, a polyester strip (3M ESPE Dental Products) and glass slide were placed over the matrix/material. Then, a weight of 100 g was applied over the glass plate for 30 seconds. The specimens were polymerized for 40 seconds using an Optilux 501 (Sybron Kerr, Danbury, CT, USA) light unit with 600 mW/cm^2 light intensity. After polymerization, specimens remained in the Teflon matrix and were stored in an appropriate container to simulate oral conditions (Figure 1), allowing for the saliva (Aphoticário Pharmacy of Manipulation, Araçatuba, Brazil) (Table 2)[20] and bleaching agent to be in contact only with the upper surface of the specimen. The specimens remained immersed in artificial saliva and the apparatus/specimen remained in 100% relative humidity at 37°C for 24 hours.

The experimental groups were subjected to 10% carbamide peroxide bleaching treatment using Clarigel Gold gel. The specimens received 1 cm^3 of gel plus one drop of artificial saliva to cover the bleach entirely. The apparatus allowed bleaching agent/artificial saliva to be in contact with the specimen upper surface for 4 hours at 37°C (Figure 1). Afterwards, specimens were thoroughly rinsed with tap water, dried with absorbent paper, and immersed in artificial saliva for 20 hours. The procedure was repeated daily for 4 weeks. Control and treated groups (except for 4 hours daily) were kept in artificial saliva for 4 weeks and artificial saliva was changed daily. During the 4-week experiment, the

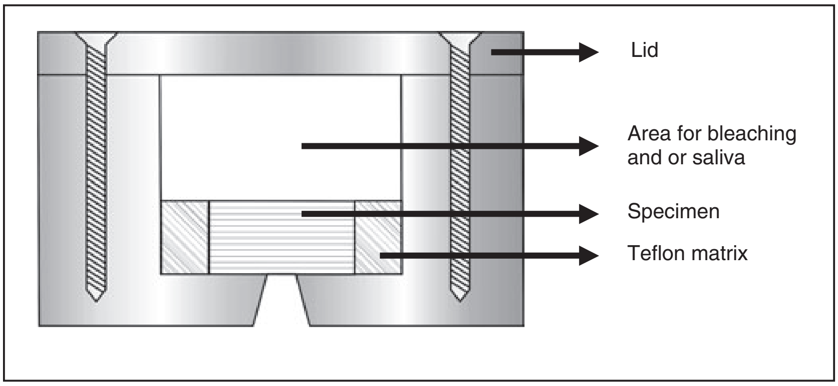

Figure 1. Apparatus used for sample storage.

TABLE 2. COMPOSITION OF THE ARTIFICIAL SALIVA, MODIFIED FROM BO KRASSE,[20] USED IN THE PRESENT STUDY (PH 7.0).

Components	Concentration (in 1 L solution)
Carboxymetilcelulose	4 g
Sorbitol	60 g
Potassium chloride	1 g
Sodium chloride	1 g
Sodium fluoride	2 mg
Magnesium chloride	50 mg
Calcium chloride	150 mg
Potassium phosphate	400 mg
Nipagin	2 mg
Distilled water	Add sufficient water to produce 1,000 m

specimens were kept in the apparatus at 37°C.

Seventy-two hours after the last treatment, all specimens had their Knoop microhardness analyzed by means of a microhardness tester, HMU–2000 Shimadzu (Shimadzu do Brasil Comércio Ltda., São Paulo, SP, Brazil). Prior to testing, specimens were cleaned using a detergent solution in an ultrasound Ultrason 1440 D (Odontobrás ind Comércio Med. Odont. Ltda, Rio Preto, SP, Brazil) for 10 minutes and placed perpendicularly to the tip using an acrylic apparatus. Because specimens were prepared using polyester strips, no polishing prior to testing was necessary.

Knoop microhardness testing was performed in five different places using a 25-g load for 5 seconds. For each specimen, the indentations were measured using 10× magnification. The values were calculated in Knoop hardness number (KHN), following the equation:

$$\mathrm{KHN} = \frac{F}{Cd^2}$$

where F is the load (N), C is the constant with the value of 0.07028, and d is the measure of indentation.

Five measurements were performed on each specimen. A mean value of the five measurements was used to define the hardness values for each specimen. The mean values of the groups were subjected to the statistical analysis using two-way analysis of variance (ANOVA) and Tukey's tests with a 5% confidence level.

RESULTS

The results for each group, evaluated by the ANOVA and Tukey's test ($p < 0.05$) (Table 3), showed that there is no interaction between the factors sealant and bleaching. The sealant materials Fluroshield and Vitroseal Alfa presented a statistically significant decrease in microhardness after the bleaching treatment compared with their respective control groups. For the sealant material Clinpro, no significant difference in microhardness values was observed after the bleaching treatment as compared with the control group. Vitroseal Alfa sealant presented statistically higher hardness values when compared with Fluroshield after the bleaching treatment (Table 3). Clinpro sealant presented the lowest values of hardness, regardless of the surface treatment (Table 3).

DISCUSSION

The at-home bleaching agents are usually composed of carbamide peroxide in different concentrations.[21,5] When in contact with saliva and enzymes, the bleaching agents 10 to 16% is degraded to 3 to 5% hydrogen peroxide and 7 to 10% urea. The hydrogen peroxide is the active agent that dissociates into water and oxygen, while the urea is degraded into carbon dioxide and ammonia. Some aspects of the chemical process might accelerate the hydrolytic degradation of composites, as described by Soderholm and colleagues.[22]

In the present study, specimens were kept in artificial saliva while not under the bleaching treatment in order to closely simulate clinical conditions. It has been reported that components present in saliva act as accelerators of carbamide peroxide degradation and therefore increase the adverse effect of the material and also the release of oxygen.[12] For that reason, drops of saliva were added to the bleaching agent immediately after

TABLE 3. MEANS AND STANDARD DEVIATIONS OF THE KNOOP MICROHARDNESS OF THE GROUPS TESTED.

Materials	Control (N = 10)	Bleach (N = 10)
Fluroshield	23.98 ± 2.12 Aa	17.42 ± 3.62 Bb
Vitroseal Alfa	21.74 ± 1.33 Ab	19.60 ± 1.35 Ba
Clinpro	11.76 ± 0.93 Ac	11.68 ± 1.22 Ac

$\alpha = 0.05$.
Same letter indicates no significant difference between groups. Uppercase letters indicate differences in each row, while lowercase letters indicate differences in each column.

its placement over the sealant materials.

The statistical analysis of the groups studied showed a statistically significant decrease in the microhardness of the two filled sealant materials, Fluroshield and Vitroseal Alfa, after the bleaching treatment with Clarigel Gold. On the other hand, the microhardness of Clinpro, an unfilled sealant material, was not significantly affected after the bleaching treatment. These data suggest that the filler-based sealant materials were more susceptible to the bleaching treatment.

The effect of bleaching agents on the resinous matrix and filler particles of resinous materials had not yet been well documented. In contrast to the present study, the majority of the studies evaluating the effect of bleaching agents used only filler-based restorative materials.[6]

It is important to note that the control group specimens remained in artificial saliva with no placebo gel throughout the experiment. This condition could have affected the hardness results because surface alterations of restorative materials may possibly occur due to a complex interaction among the multicomponent of bleaching products.[15] The presence of fluoride and ethylenecliamine tetraacstic acid (EDTA) in the composition on the bleaching material used in the present study would be able to dissolve the Si-O-Si glass network,[19] and consequently reduce the hardness values of filler-based materials.[23]

Wattanapayaungkul and colleagues[24] reported that hydrogen peroxide and their free radicals of high energy can have an adverse effect over the filler particles/resinous matrix interface. In addition, they reported that the negative influence of the oxidizing agents on the resin matrix led to water uptake of the restorative materials with complete or partial debonding of fillers causing reduced surface integrity and loss of hardness of the materials. Türker and colleagues[19] observed a 4.44% decrease in the amount of SiO_2 for feldspathic porcelain surfaces and 4.03% for microfilled composite resin after bleaching treatment. This observation suggested a higher effect susceptibility against the bleaching treatment over the inorganic components when carbamide peroxide agent was used.[19] Therefore, according to the results of the present study, the bleaching material might remove SiO_2 from the inorganic components of sealant materials and/or from the union agent between the filler particles and organic resinous matrix, which can result in reduced surface hardness of the materials that present filler particles in its composition.[23] On the other hand, the maintenance of the microhardness values of the unfilled sealant material (Clinpro) after bleaching has been observed and can also be related to the composition of the material, which is exclusively composed of resinous matrix.

Longer exposure to the acidity of the bleaching agents could possibly increase the loss of filler particles from the sealant surfaces.[19] The reduction in the hardness values of Vitroseal Alfa could also be related to the deleterious effect of the bleaching gel on the ionomeric component present in this material (Table 1).[19,25,26]

It is important to note that when comparing the microhardness values among the sealants studied, the values of the Fluroshield and Vitroseal Alfa sealant materials after the bleaching treatment were considerably higher than the values of the Clinpro control group (without bleaching). It is important to note that Clinpro is approved by the American Dental Association, just as the other sealant materials. According to this information, we can assume that it is difficult to establish the clinical relevance of the hardness alterations incurred after bleaching for the two filler-based sealant materials and other restorative composites. It may be possible to avoid this situation by restricting bleach placement to the facial surface of teeth only. Longitudinal clinical studies and clinical follow-up should be carried out in order to evaluate the long-term performance of these sealant materials after exposure to bleaching agents and therefore support the finding of the present in vitro study.

CONCLUSION

According to the in vitro findings of the present study, it can be concluded that the application of a 10% carbamide peroxide-based bleaching agent decreased the microhardness of filler-based sealant materials. In addition, an unfilled sealant showed no significant microhardness alterations after a 10% carbamide peroxide treatment.

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