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Clinical Effects of Exposure to Coffee During At-home Vital Bleaching

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Clinical Relevance

Coffee consumption during bleaching did not affect the effectiveness of dental bleaching.

SUMMARY

The purpose of the present study was to evaluate whether exposure to coffee during bleaching treatment with 16% carbamide peroxide (CP) affects the degree of whitening and tooth sensitivity. Forty patients with central incisors darker than A2 were selected. Participants who did not drink coffee were assigned to the control group (CG), while participants who drink coffee at least twice a day were assigned to the experimental group (EG). For CG, foods with dyes were restricted. For EG there was no restriction on food and patients were asked to make coffee rinses for 30 seconds, four times daily. For both groups 16% CP was used for a period of three hours daily for three weeks. Shade evaluation was assessed visually by Vita classical shade guide and by the Easyshade spectrophotometer at baseline, during bleaching (first, second, and third weeks), and post-bleaching (one week and one month). Patients recorded their sensitivity perceptions by means of the numerical rating scale and 0-10 visual analog scales. Variation in shade guide units and the two colors (ΔE) were evaluated by two-way analysis of variance and Tukey tests (α=0.05). Absolute risk of tooth sensitivity and intensity of tooth sensitivity was evaluated by Fisher exact and Mann-Whitney tests (α=0.05). Effective bleaching was observed for both groups after three weeks, without statistical difference. No difference in terms of risk of tooth sensitivity and intensity of tooth sensitivity was detected between groups. Approximately 57% of the participants experienced tooth sensitivity, which was recorded mainly as "mild." Exposure to coffee during bleaching treatment does not seem to affect the degree of bleaching and tooth sensitivity.

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INTRODUCTION

Dental bleaching is one of the most sought-after clinical procedures at present, because tooth color is considered the most important factor with regard to dental esthetics.[1] It is a safe, conservative, and

effective procedure,[2,3] generally performed with gels containing hydrogen peroxide or carbamide peroxide (CP) in different concentrations.[4,5] Treatment is performed in-office with or without light activation, at home with the use of trays, or by means of a combination of these two modalities.[4,6,7]

In spite of the effectiveness of the tooth whitening technique, this procedure may cause changes, such as an increase in the permeability of dental tissues[8] and demineralization[9] of the tooth enamel surface[10,11]. Therefore, while bleaching treatment is being performed, it is common for professionals to ask their patients to avoid the ingestion of foods and drinks rich in coloring agents, such as coffee, red sauces, red wine, chocolate, tea, beetroot, and acai. Among these coloring agents, coffee is outstanding, as it is a coloring beverage frequently consumed in Western countries.[12]

It has been demonstrated that coffee is capable of causing tooth staining[13] because it has a dark color and an acid pH.[14,15] This would cause an increase in permeability and penetration into the tooth structure during bleaching and may cause interference in terms of the final results of bleaching.[3,16,17] Laboratory studies[13,18] have indicated that teeth submitted to dental bleaching and those exposed to coloring agents in the diet indeed have greater potential for staining. This leads to lower longevity/stability of the whitening effect[19] and induces clinicians to impose dietary restrictions during dental bleaching procedures.

Nevertheless, this is a controversial topic, since other *in vitro* studies[16,20,21] have concluded that the ingestion of colored foods during dental bleaching and over the course of time does not interfere with the results obtained with dental bleaching. Although there are studies[22,23,24] that have attempted to correlate the effectiveness and longevity of dental bleaching with the frequency of ingesting foods rich in coloring matter, a literature search revealed no clinical studies that correlated the effectiveness and longevity of dental bleaching with the consumption of colored foods and beverages during dental bleaching. Therefore, the aim of this clinical study was to evaluate whether the effectiveness of bleaching is diminished by exposure to coffee during home bleaching treatment with 16% CP and whether this treatment affects tooth sensitivity.

MATERIALS AND METHODS

This clinical investigation was approved (Protocol No. 17854/10) by the local ethics committee. Forty subjects who were willing to sign the consent form before the study began were enrolled according to the inclusion and exclusion criteria. All subjects received dental screening and dental prophylaxis two weeks before the bleaching protocol began.

Inclusion and Exclusion Criteria

Patients included in this clinical trial were at least 18 years old and had good general and oral health. Each subject had at least one central incisor with shade A2 or darker, assessed by comparison with a value-oriented shade guide (Vita Lumin, Vita Zahnfabrik, Bad Säckingen, Germany) and spectrophotometer (Easyshade, Vita Zahnfabrik). Patients were excluded from the study if they had undergone previous tooth-whitening procedures, had anterior teeth with restorations on the labial surfaces, had veneers or full crowns, were pregnant or lactating women, were smokers, had gingival recession on anterior teeth, had spontaneous tooth pain, had endodontically treated anterior teeth, had fluorosis or severe internal tooth discoloration, had teeth with noncarious cervical lesions, were under orthodontic treatment, or had bruxism habits.

Experimental Groups

Patients who met the inclusion criteria were asked about their daily coffee consumption. Those who did not drink black coffee were placed in the control group and instructed to not consume colored foods and drinks (coffee, tomato sauce, ketchup, mustard, beets, carrots, chocolate, black tea, acai, or artificial and naturally dye-colored drinks [such as Coca-Cola® and orange and grape Fanta], green tea, jelly, snacks, soy sauce, candies and chewing gum with dyes, grapes, berries, and red wine) one week before treatment began and during the entire period of bleaching therapy.

The participants who reported that they drank black coffee at least twice a day every day were placed in the experimental group. No dietary restrictions were placed on participants in the experimental group. Apart from their daily coffee intake (two to three cups daily), these patients were instructed to make mouth rinses with instant black coffee for 30 seconds (Nescafé® Tradição, Nestlé, Araras, São Paulo, Brazil), four times a day. For this procedure, participants received 8 mg of coffee to be dissolved in 50 mL of warm water (equivalent to one teaspoonful of instant coffee powder in a small coffee cup full of water), in accordance with the instructions for making instant black coffee. They were instructed to perform the first rinse immediately

after removing the bleaching tray. During the day, three more rinses had to be performed, with an interval of four hours between rinses. Participants were instructed to wait at least 15 minutes after coffee rinses before rinsing the mouth with clean water, brushing their teeth, or eating.

The aim of this procedure was to increase the exposure of bleached teeth to black coffee. As a measure of adherence to the experimental protocol, participants were given a diary in which they were asked to take note of the number of coffee rinses performed daily. They were emphatically instructed about the importance of the procedure and the importance of reporting any time they forgot or were unable to perform the coffee rinses.

Bleaching Procedure

Alginate impressions were made of each subject's maxillary and mandibular arch, and these were filled with dental stone. To produce study models, no block-out material was applied to the labial surfaces of teeth.[25-27] A 0.9-mm soft vinyl material, provided by the manufacturer, was used to fabricate the custom-fitted tray that would hold the whitening gel. The excess material from the labial and lingual surfaces was trimmed to 1 mm from the gingival junction.

The tray and 16% CP gel (Whiteness Perfect, FGM Dental Products, Joinville, Brazil) were delivered to each subject, with verbal instructions for use. All subjects were instructed to wear the tray containing the bleaching agent for at least three hours a day for a period of three weeks. After the daily three-hour period they were instructed to remove the tray, wash it with water, and brush their teeth as usual. At this time, participants in the experimental group were instructed to perform the first daily coffee rinse.

With regard to oral hygiene, all participants were instructed to brush their teeth regularly and were asked to not use whitening toothpaste and mouthwash containing peroxides.

Shade Evaluation

The shade evaluation was performed with the use of subjective and objective evaluation methods. For the subjective evaluation, the 16 tabs of the shade guide (Vita Classic, Vita Zahnfabrik) were arranged from highest (B1) to the lowest (C4) value. Although this scale is not linear in the truest sense, for the purpose of analysis, the changes were treated as though they represented a continuous and approximately linear ranking.[4] Two calibrated evaluators (M.R. and S.K.) with agreement of at least 85% determined by weighted kappa statistics recorded the shade of each subject's teeth at baseline, during treatment (after the first, second, and third weeks of undergoing bleaching treatment), and one week and one month after the end of the bleaching protocol.

The area of interest for measurement of tooth color matching was the middle third of the facial surface of the anterior central incisors, according to the American Dental Association guidelines. Shade changes were calculated from the beginning of the active phase through to the individual recall times by calculating the change in the number of shade guide units (ΔSGU), which occurred toward the lighter end of the value-oriented list of shade tabs. In the event of disagreements between the examiners during shade evaluation, a consensus was reached.

An objective shade evaluation was also performed with a digital spectrophotometer (Vita Easyshade, Vita Zahnfabrik) right after the subjective shade evaluation. Before the spectrophotometer measurement, an impression of the maxillary arch was taken with dense silicone paste (Coltoflax e Perfil Cub, Vigodent, Rio de Janeiro, Brazil). The impression was extended to the maxillary canine and served as a standard color measurement guide for the spectrophotometer. For each dental component to be evaluated, a window was created on the labial surface of the molded silicone guide using a metal device with a radius of 6 mm and well-formed borders.

The shade was determined using the parameters of the Easyshade device on which the following values were indicated: L*, a*, and b*, where L* represents the value from 0 (black) to 100 (white) and a* and b* represent the shade, where a* is the measurement along the red-green axis and b* is the measurement along the yellow-blue axis. The color comparison before and after treatment is given by the differences between the two colors (ΔE), which is calculated using the formula[28] $\Delta E = [(\Delta L^*)2 + (\Delta a^*)2 + (\Delta b^*)2]^{1/2}$. The classical Vita shade detected by the spectrophotometer was also recorded.

Tooth Sensitivity Evaluation

Subjects were asked to keep a daily record of whether they experienced sensitivity, using a five-point verbal numerical rating scale (NRS)[29,30] and a visual analog scale (VAS).[4,31,32] For the NRS scale, participants were instructed to choose one of the following scores to represent the intensity of the

tooth sensitivity they felt every day: 0 = none, 1 = mild, 2 = moderate, 3 = considerable, and 4 = severe. For the VAS scale, the participants were instructed to place a line perpendicular to the 10-mm–long line with zero at one end indicating "no sensitivity" and at the 10-mm end indicating "unbearable sensitivity."

To compare the intensity of tooth sensitivity between the groups, the median of the intensity of tooth sensitivity experienced by each patient was calculated throughout the period of bleaching therapy. The overall percentage of patients with tooth sensitivity and the total number of days on which patients experienced tooth sensitivity were also evaluated.

Statistical Analysis

A pilot study was conducted and it was shown that use of the bleaching protocol described in this study would lead to a ΔE value of 4.0 ± 1.0 after three weeks of bleaching. In order to have an 80% chance of detecting significance at the level of 5%, considering an increase in the primary outcome measure from "4" in the control group to "5" in the experimental group, a minimum of 16 participants would be required in each group. In order to accomplish this, considering follow-up losses, 20 participants were selected for each study group.

Data from the 40 patients were used in this study, according to the intention-to-treat analysis.[33] The ΔSGU data obtained from subjective and objective evaluation and the ΔE data were submitted to a two-way repeated-measures analysis of variance (ANOVA) (groups vs assessment time), with the assessment time being the repeated factor (α=0.05). After this, a *post hoc* analysis (Tukey test, α=0.05) was used for pairwise comparisons. Comparison of the absolute risk of sensitivity was made using the Fisher exact test (α=0.05) and comparison of the intensity of tooth sensitivity between groups was made using the Mann-Whitney test (α=0.05) for both pain scales.

RESULTS

A total of 163 participants in the age range of 18 to 40 years were evaluated to select 40 participants that met the inclusion criteria (Figure 1). The mean age (years) of the participants in this study was similar between the groups (control: 22.5 ± 4.8 years; experimental: 23.7 ± 5.8 years). Fifty percent of the participants were women, 11 being in the control group and nine in the experimental group.

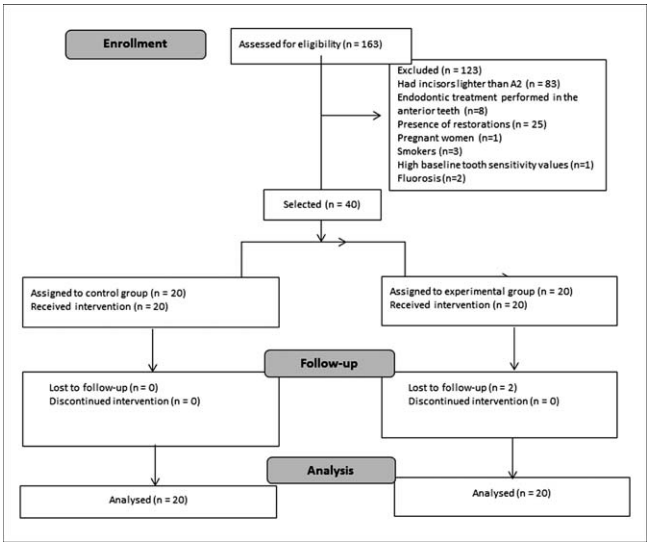

Figure 1. *Flow diagram of the clinical trial, including detailed information on the excluded participants.*

The mean baseline color in the shade guide units was 5.6 ± 1.5 for the control group and 6.3 ± 2.0 for the experimental group.

All participants attended the recall visits during the bleaching protocol. Two participants from the experimental group did not attend the one-week and one-month postbleaching visit. For these participants, the data obtained in the earlier recall visit were attributed, for statistical purposes, according to the recommendation of the intent-to-treat analysis.[33]

Each participant in the experimental group performed a total of 84 coffee rinses, with the exception of five patients who did not perform the rinsing once, two who did not perform it three times, and two who did not adhere to the protocol four times throughout the study.

Shade Evaluation

The two-way ANOVA for the subjective and objective evaluation of ΔSGU values showed that the cross-product interaction between groups vs assessment time (p=0.962 and 0.964, respectively) and the main factor group (p=0.109 and 0.339, respectively) was not statistically significant. Only the main factor assessment time (p<0.001 and p=0.045, respectively) was significant (ie, bleaching efficacy). A higher degree of bleaching was obtained after the third week of treatment, and this was statistically similar to the shade measured at one week and one month postbleaching (Table 1).

Two-way ANOVA for the ΔE values showed that the cross-product interaction group vs assessment

Table 1: *Means and Standard Deviations Between Assessment Points for the Two Treatments in Shade Guide Units (ΔSGU) Assessed by Means of Subjective and Objective Evaluation*[a]

Assessment Time Intervals	Subjective Evaluation		Objective Evaluation	
	Control	Experimental	Control	Experimental
Baseline vs 1 wk	3.0 ± 0.9 A	3.3 ± 1.6 A	3.4 ± 1.9 a	3.9 ± 1.9 a
Baseline vs 2 wk	3.4 ± 1.3 A,B	4.0 ± 1.7 A,B	3.7 ± 2.1 a,b	4.3 ± 1.9 a,b
Baseline vs 3 wk	4.4 ± 1.4 B	4.7 ± 1.6 B	4.3 ± 2.2 b	4.4 ± 2.1 b
Baseline vs 1 wk postbleaching	4.4 ± 1.5 B	4.5 ± 1.5 B	4.2 ± 2.1 b	4.4 ± 2.1 b
Baseline vs 1 mo follow-up	4.4 ± 1.1 B	4.3 ± 1.7 B	4.2 ± 2.1 b	4.3 ± 2.1 b

[a] *Two-way analysis of variance (ANOVA) and Tukey test for each measurement (α=0.05). Means identified with the same uppercase and lowercase letters indicate statistically similar values for the subjective and objective evaluations, respectively.*

time was not significant (p=0.934), but the main factors were (p=0.019 and p<0.001, respectively). A higher degree of bleaching was observed for the control group. With regard to assessment time, a higher degree of bleaching was obtained after the third week of treatment, and this was statistically similar to the shade measured at one week and one month postbleaching (Table 2).

Tooth Sensitivity

No statistical difference between groups was observed in terms of absolute risk of tooth sensitivity (Fisher exact test, p=1.0). The values for absolute risk of tooth sensitivity of the control and experimental groups were 55% (95% confidence interval [CI] 34.2%-74.2%) and 60% (95% CI 38.7%-78.2%), respectively. The intensity of tooth sensitivity was also similar between groups (p=0.529 for NRS and p=0.258 for VAS scales, respectively; Table 3). Approximately 57% of the participants presented with mild tooth sensitivity.

Table 2: *Means and Standard Deviations Between Assessment Points for the Two Treatments in ΔE for the Two Groups*[a]

Assessment Time Interval	Groups	
	Control	Experimental
Baseline vs 1 wk	6.8 ± 2.5 Aa	6.5 ± 3.2 Ab
Baseline vs 2 wk	8.8 ± 2.6 Aa	7.7 ± 3.3 Ab
Baseline vs 3 wk	10.8 ± 3.0 Ba	9.8 ± 2.7 Bb
Baseline vs 1 wk postbleaching	11.0 ± 3.1 Ba	9.5 ± 2.8 Bb
Baseline vs 1 mo follow-up	10.6 ± 2.3 Ba	9.8 ± 2.6 Bb

[a] *Two-way analysis of variance (ANOVA) and Tukey test (α=0.05). Means identified with the same uppercase letters indicate similar values within column. Means identified with the same lowercase letters indicate statistically similar averages within rows.*

DISCUSSION

In the present study, each patient performed mouth rinses with coffee four times a day for 30 seconds for a period of three weeks. In previous laboratory studies, the time of exposure to coffee varied greatly.[19,21] For example, Attia and others[19] immersed the specimens for 15 minutes a day for 28 days, whereas Cardoso and others[21] performed five daily exposures lasting one minute each for 15 days. The time of bleached tooth exposure to coffee in this study was determined by taking into consideration

Table 3: *Medians and First and Third Interquartiles of the Tooth Sensitivity Scores and Pain Scales for the Two Groups*

Group	Five-point Numerical Verbal Rating Scale*	Visual Analog Scale**
Control	1 (0; 1)	0.1 (0; 0.3)
Experimental	1 (0; 1)	0.4 (0; 0.7)

** Mann-Whitney test, p = 0.529; ** Mann-Whitney test, p = 0.258.*

the time it took to swallow the coffee.[34] Considering that this probably did not take longer than two to five seconds, four daily mouth rinses performed for 30 seconds each would represent excessive consumption of the beverage.

Researchers are constantly concerned about the possibility that alterations in tooth enamel caused by bleaching agents[10,11] may negatively interfere with the effectiveness of treatment. Indeed, laboratory studies have related that bleaching agents promote alterations in the tooth enamel surface due to the slightly acidic nature[35] and demineralizing potential of bleaching products,[9] and this could favor greater retention of coloring agents in the enamel. However, the results of the present study oppose the widespread idea among clinicians that foods and beverages with coloring agents, such as coffee, may pigment the teeth if used while dental bleaching is being performed.[15] When the ΔSGU values obtained by the subjective and objective methods were compared, a similar degree of bleaching was observed in the two study groups after three weeks of bleaching. These results are in agreement with those of previous laboratory studies[21,36] that investigated the effect of coffee on home and in-office dental bleaching, in which no significant difference in the effectiveness of bleaching was observed when coffee was tested as a coloring beverage during dental bleaching.

Saliva most likely plays a fundamental role in reversing the structural alterations produced by dental bleaching agents. During the use of the bleaching tray, human saliva may act to replace minerals lost by the tooth structure during bleaching[17,37] and may also neutralize the low pH of coffee,[17] which justifies the favorable results obtained even in the presence of coffee. Indeed, in a literature review Attin and others[38] observed that in studies that found a reduction in enamel microhardness, human saliva and fluoridation were not used during dental bleaching. In a comparison between *in vitro* and *in situ* results, Justino and others[39] confirmed the remineralizing effect of human saliva, since the most pronounced alterations, such as depressions in the tooth surface and reduction in microhardness values, were observed in the *in vitro* group. In addition, the bleaching gel used in this study contained sodium fluoride and potassium, which also act as remineralizing agents.

Another important aspect to point out is that the substances that are thought to cause extrinsic staining, such as coffee, are compounds constituted of macromolecular chains and, thus, are hardly capable of permeating through human enamel, which allows only the passage of low-molecular-weight molecules.[40] Tooth enamel functions as a semipermeable membrane that only allows the passage of ions and small molecules,[40] therefore the bleaching process does not occur in the mineralized enamel structure, but possibly as a result of oxidation of the organic tissues of human dentin.[41] Moreover, it is known that extrinsic stains are associated with the adsorption of pigments on the tooth enamel surface as well as with biofilm[42] and can be efficiently removed by means of professional dental prophylaxis.

During the return visits scheduled in this clinical study, it was observed that the effectiveness of dental bleaching was maintained over the course of time. There was no statistically significant difference between the ΔSGU values (Vita subjective and objective) and ΔE values obtained on the conclusion of treatment and those obtained in the postbleaching time intervals evaluated (one week and one month). These results are in disagreement with the results obtained by Attia and others,[19] who observed that the bleaching effect was less stable when human and bovine teeth were exposed to coffee during home bleaching. The fact that the patients maintained oral health in a satisfactory manner, a procedure that was not performed in the study of Attia and others,[19] may have prevented the incorporation of extrinsic stains on the tooth surfaces.

Another adverse effect commonly observed during bleaching is dental sensitivity.[4,7,29,30] No statistically significant difference was found between the two groups evaluated with regard to the dental sensitivity reported by the patients (control group, 55%; experimental group, 60%). The absolute risk of sensitivity presented in this study corroborates the values of other researchers.[29,43] In this study, the majority of the patients who presented with sensitivity defined it as "slight" when it was evaluated by means of the NRS and VAS scales, which is in agreement with the results shown in other studies.[16,29,43]

The low intensity of dental sensitivity in this study may be associated with the fact that the bleaching agent contained potassium nitrate as a desensitizing agent. Potassium nitrate penetrates the enamel and dentin and travels to the pulp, creating a desensitizing effect on the nerve by affecting the transmission of nerve impulses.[44] In addition, the bleaching gel was used for only three hours a day. Cardoso and others[45] verified that the prevalence and intensity of dental sensitivity increased considerably when the

CP-based bleaching gel was used for eight hours a day in comparison with only one hour a day.

Some of the limitations of this study should be mentioned. Unfortunately, the participants were not randomized to the study groups because this procedure was not ethically justified. In spite of this, the findings of this nonrandomized clinical trial are stronger than those obtained in a laboratory setting. In addition, dietary restrictions were only utilized in the control group. If differences were detected among groups we would not be able to discriminate between the effect of coffee exposure and those of the other staining foods from the patient's diet. The patients included in this study presented excellent oral hygiene, had no restoration in the anterior teeth, and had no gingival recessions, which could facilitate the penetration and deposition of coloring matter from the coffee. Therefore, the results of this study cannot be extrapolated to populations with deficient oral hygiene and those presenting with one of the exclusion criteria of this research.

CONCLUSION

Within the limitations of this study, it can be concluded that exposure to coffee during at-home dental bleaching with 16% CP did not affect tooth sensitivity or the effectiveness of dental bleaching.

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Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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