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White Diet: Is It Necessary During Tooth Whitening?

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Clinical Relevance

Ingestion of coffee/tea during bleaching did not minimize the effect of tooth whitening. Subjects who drank large amounts of coffee/tea had a greater effect of bleaching because their teeth were initially darker. Ingestion of red wine/dark fruit did not limit the effect of tooth whitening.

SUMMARY

Patients are sometimes blamed for a reduced effect of bleaching when they do not adhere to a dentist's prescribed white diet. This study aimed to determine whether a white diet is necessary by evaluating the effects of coffee, tea, wine, and dark fruits on the potential tooth whitening during the bleaching process. Each of the effects of discoloration was categorized as "yes" or "no" based on a patient questionnaire. Data from five published studies were included in the analyses. Outcomes were based on the color change between baseline and the end of bleaching. The relationships between color changes were measured subjectively and objectively. A nonwhite diet was not significantly associated with less tooth whitening, and there was only a weak positive association between tooth whitening and diet for subjects who drank large amounts of coffee/tea.

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INTRODUCTION

Cosmetic dentistry has become a very important part of today's restorative dental practice. The esthetic appearance of patients' teeth is very important to them; as white teeth are believed to be associated with health and beauty. Cosmetic procedures have become more available because of improved standards of living. Although more patients are demanding esthetic treatments, it is the responsibility of dentists to offer treatments to help patients safely achieve their goals.[1]

Dentists often instruct patients to refrain from smoking and drinking coffee, tea, or red wine during the active bleaching procedures, as some manufacturers ask patients to stay on a white diet during that time. However, no current clinical studies have determined whether refraining from these substanc-

Table 1: *Inclusion and Exclusion Criteria*
Inclusion Criteria
• Patient has all six maxillary anterior teeth.
• None of the maxillary anterior teeth has more than one-sixth of the labial surfaces of the natural tooth covered with a restoration, and the location must not interfere with colorimeter placement.
• All six anterior teeth must be darker than B54 and lighter than B85 on the Trubyte Bioform Color Ordered Shade Guide.
• None of the maxillary anterior teeth is excessively rotated, such as mesiorotation or distorotation, which interferes with colorimeter placement
• Patient is willing to sign a consent form.
• Patient is at least 18 years old.
• Patient is able to return for periodic examinations.
Exclusion Criteria
• A history of any medical condition that may interfere with the study and other conditions left up to the judgment of the principal investigator.
• Patient used professionally applied or prescribed tooth whiteners, whether in-office or at-home, in the preceding five years.
• Gross pathology in the oral cavity (excluding caries).
• Gingival index score greater than 1.0.
• Intrinsic discolored teeth due to tetracycline staining.
• Pregnant or lactating women.

es during the process of tooth whitening is necessary.

Many people drink coffee, tea, and red wine and eat dark-colored fruit as a part of daily life. Some investigators have reported that coffee, tea, and wine can lead to tooth discoloration.[2-4] In an *in vitro* study, Attia and others[5] found that the stability of a dental whitening treatment could be compromised by the use of coffee during home bleaching procedures. Gerlach and Zhou[6] recognized that drinkers of coffee and tea may require a specialized post-treatment maintenance plan. However, it is not known if the patients' behavior influences the effectiveness and stability of dental whitening during bleaching or if the dentist should recommend restricting the consumption of coffee, tea, wine, or dark fruit during the tooth whitening process.

This study addresses those questions with a review of five *in vivo* studies where patients responded to a questionnaire regarding their ingestion of coffee, tea, red wine, and dark fruit during tooth whitening. The objective was to determine if a patient should restrict the consumption of coffee, tea, red wine, and dark fruit during tooth whitening. The reviewed studies were conducted at the same facility by the same faculty, and they have been previously reported in the scientific literature.

METHODS AND MATERIALS

This study is based on five published *in vivo* studies[7-11] in peer reviewed publications that include a total of 185 subjects. The studies were approved by the Institutional Review Board at Indiana University Purdue University Indianapolis. The studies used different products and methods and came to different conclusions regarding color change. In each study, the manufacturers' instructions for handling and use were followed for each product. Four of the five studies were half-mouth design studies; the remaining study used parallel groups. All studies, except one, had the same inclusion and exclusion factors (Table 1), which required the lightest color tooth in the maxillary arch to be at least a B65 shade on the Trubyte Bioform Color Ordered Shade Guide (Dentsply International, York, PA, USA), which equates to an A-3 on the Vita Classical Shade Guide (Vita Zahnfabrik, Bad Sackingen, Germany). One study evaluating over-the-counter tooth whitening products did not exclude smokers from participating;[7] however, because of the small number of subjects, smoking was not evaluated in this study. All five studies asked questions regarding the number of cups of coffee or tea and the number of glasses of red wine each participant drank. Four of the studies asked about the number of servings of dark-colored fruits (blueberries, blackberries) consumed during the study.

In all of the studies, color was evaluated both subjectively and objectively. In four studies, a faculty member who is experienced in color matching used the Trubyte Bioform Color Ordered Shade Guide to evaluate color. The fifth study used a Vita Classical Shade Guide; the results of that study were mapped to the Trubyte shade guide for comparison purposes in the current study. The color evaluation was performed in an area that was shielded from direct sunlight and lit using color-corrected overhead lighting. The objective evaluation of color in all of the studies was accomplished using a colorimeter (Chroma Meter CR 321, Minolta, Osaka, Japan) that was calibrated to a color standard.

The colorimeter measured the color of the teeth based on the CIE L*a*b* color space system. This system, defined by the International Commission on Illumination in 1978, is referred to as CIELAB.[12] L* represents the value (lightness or darkness), a* is the measurement along the red-green axis, and b* is the measurement along the yellow-blue axis. A

Table 2: *Mean (Standard Deviation) and Range Responses to Dietary Questions*

Study (Ref. No.)	N	Cups Coffee/Tea per Day	Red Wine/Dark Fruit per Week	White Diet (%)
All	185	1.5 (1.8), 0-10	0.9 (1.6), 0-8	30 (16)
1 (7)	75	0.5 (0.6), 0-3	0.8 (1.6), 0-8	14 (19)
2 (8)	32	2.9 (2.3), 0-10	1.3 (1.9), 0-7	2 (6)
3 (9)	36	2.0 (2.1), 0-8	0.9 (1.7), 0-7	6 (17)
4 (10)	19	1.2 (1.0), 0-3	1.1 (2.1), 0-7	3 (16)
5 (11)	23	2.0 (1.7), 0-5	0.2 (0.4), 0-1	5 (22)

positive L* indicates a lighter color tooth. A negative a* indicates a decrease in the intensity of red, and a negative b* indicates a decrease in the intensity of yellow. Total color differences, or distances between two colors (ΔE), were calculated at the end of each study using the following formula: $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.[12] This formula is only valid for increased lightness of tooth color if the L* value increases and a* and b* are in the red and yellow colors, respectively, and decrease in number.

No restrictions on dietary habits were imposed during the course of the studies. Each subject was evaluated based on the diet questions, and a subject was classified as following a white diet if he or she did not drink any coffee, tea, or wine or consume any dark fruits. Analysis of the white diet was performed using mixed-model analysis of variance, with study and product included as covariates and a random subject effect included to account for the half-mouth design used in most of the studies. Interactions with baseline color were also examined to determine if the effect of the white diet varied by baseline tooth color. The Spearman rank correlations for color change were also examined, and the number of cups of coffee/tea and the number of wine/fruit servings were used to evaluate a dose effect. Because the timing of postbleaching visits varied too much to make strong conclusions from that data, analyses in the present study were restricted to the color change between baseline and the end of bleaching. Also, by focusing only on the bleaching period, a strict analysis of the effects of diet on bleaching itself was performed and not an evaluation of additional staining caused by diet after bleaching.

RESULTS

Sixteen percent of the subjects followed a white diet during the study period (Table 2). The baseline color and color-change results from each study are summarized in Table 3. The baseline color and color change results for the white and nonwhite groups are summarized in Table 4.

The number of cups of coffee and tea consumed per day was significantly and positively associated with ΔE (r=0.32, p<0.0001; Figure 1) and negatively associated with ΔShade (r=–0.30, p<0.0001; Figure 2). A positive correlation in ΔE and a negative correlation in ΔShade Guide signify that the number of cups of coffee and tea consumed per day were positively associated with more tooth whitening (greater consumption equals greater bleaching).

The correlations indicate that subjects who drank more coffee/tea had greater color change. These associations are statistically significant but not large enough to be clinically relevant. Color change, as measured by the colorimeter parameters and shade guide, was not significantly different between subjects who followed a white diet and those who did not ($p \geq 0.65$). Given the significance of the number of cups of coffee/tea, this result indicates that a subject's diet needs to be fairly severe to affect the color change.

A significant interaction was found between the white diet and baseline L* when ΔL* was the outcome (Figure 3) and a significant interaction between white diet and baseline a* when Δa* was the outcome (Figure 4). No significant interaction was found between white diet and baseline b* when Δb* was the outcome (Figure 5). Subjects on a white diet who had low baseline L*, or darker teeth, had less change in L*, and those who had high baseline L*, or lighter teeth, had more change in L* compared with subjects not on a white diet. However, subjects on a white diet who had low baseline a*, or less red, had more change in a* and those who had high

Table 3: *Mean (Standard Deviation) Color and Color Change for Each Study*

Study (Ref. No.)	L*	a*	b*	Shade	ΔL*	Δa*	Δb*	ΔE	ΔShade
1 (7)	66.2 (2.9)	0.4 (0.6)	14.2 (3.3)	19.3 (2.7)	2.4 (1.2)	–0.8 (0.4)	–2.5 (1.3)	3.7 (1.5)	–7.9 (3.6)
2 (8)	49.1 (2.8)	–0.5 (0.7)	4.2 (3.0)	20.5 (2.5)	6.5 (3.0)	–1.1 (0.5)	–4.1 (1.9)	8.8 (2.8)	–15.6 (3.8)
3 (9)	47.7 (2.4)	–0.5 (0.5)	3.1 (2.2)	18.2 (2.9)	5.9 (2.6)	–0.9 (0.6)	–3.8 (1.5)	7.2 (2.8)	–10.8 (4.4)
4 (10)	45.3 (2.7)	–0.5 (0.7)	4.4 (2.7)	18.0 (2.9)	7.3 (4.0)	–1.0 (0.6)	–4.3 (2.3)	8.8 (4.3)	–13.3 (4.4)
5 (11)	46.8 (3.7)	–0.6 (0.5)	4.2 (2.4)	17.8 (4.0)	7.7 (3.8)	–1.5 (0.6)	–5.4 (1.8)	10.1 (3.3)	–15.9 (4.0)

Table 4: *Mean (Standard Error) Color and Color Change by Diet*

	L*	a*	b*	Shade	ΔL*	Δa*	Δb*	ΔE	ΔShade
White diet	51.1 (0.5)	–0.3 (0.1)	5.7 (0.5)	18.9 (0.6)	6.1 (0.4)	–1.1 (0.1)	–4.2 (0.2)	7.7 (0.4)	–13.0 (0.7)
Nonwhite Diet	51.0 (0.3)	–0.3 (0.1)	6.0 (0.3)	18.7 (0.3)	6.0 (0.2)	–1.1 (0.1)	–4.3 (0.1)	7.7 (0.2)	–12.7 (0.3)
p-Value	0.93	0.91	0.54	0.74	0.85	0.99	0.70	0.99	0.65

baseline a*, or more red, had less change in a* compared with subjects not on a white diet.

We repeated the analyses using more lenient definitions of white diet that included subjects who had up to one, up to two, or up to three servings of coffee/tea/fruit in the white diet group. The conclusions using these other white diet definitions did not differ from the results presented earlier using the pure white diet definition.

DISCUSSION

The effectiveness of bleaching has been related to peroxide concentration and time of contact with the dental tissues.[13] Because nonwhite diets have colorants that cause extrinsic stain, it is a worthwhile exercise to determine whether a nonwhite diet may influence the effectiveness of bleaching.

Determining color changes is challenging. Most shade tabs do not have even color spacing. When using the CIELAB system, the accepted standard for noticeable color change under close examination is a ΔE of 1.0.[14] A ΔE of 2.0 is detectable[15] by visual observation, and a ΔE of 3.3 is unacceptable[16] from an esthetic standpoint.

The findings of this study demonstrated that those subjects who drank a greater amount of coffee/tea had teeth that were initially darker and therefore had a greater amount of color change during bleaching compared with those whose teeth were initially lighter because they did not drink coffee/tea. Attia and others[5] found no affect of coffee on tooth bleaching during the bleaching process; however, the stability of dental whitening treatment was compromised by the use of coffee after bleaching. Bleached teeth were found to be more susceptible to staining with coffee after bleaching. Attia and others[5] concluded that tooth contact with brown staining agents should be avoided during the whitening procedure. Alternatively, Attin and others[3] found that extrinsic staining does not significantly affect postbleaching staining when studying tea-staining on previously bleached enamel. Liporoni and others[17] found that coffee had little effect on color change after bleaching, but wine staining susceptibility was increased after bleaching. Berger and others[18] also found that staining susceptibility increased when wine was applied to enamel surfaces after bleaching. Bazzi and others[19] reported that enamel stained with coffee was more susceptible to restaining than was enamel stained with cigarette smoke.

A recent study by Cortes and others[20] reported that bleaching is effective in preventing staining

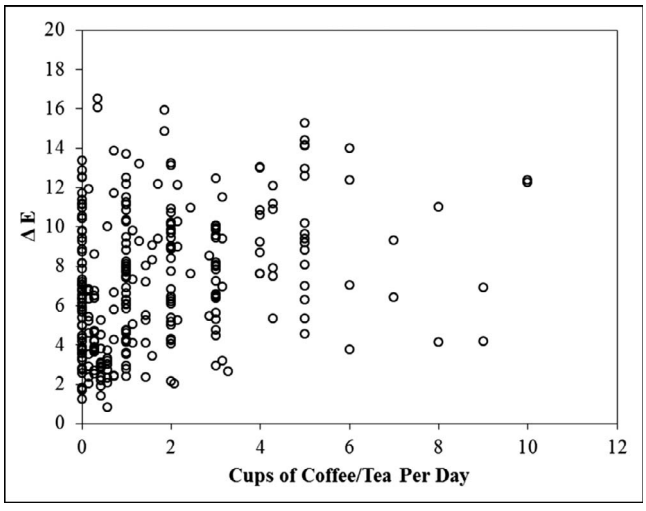

Figure 1. *Association of Number of Cups of Coffee/Tea With Total Color Difference (ΔE).*

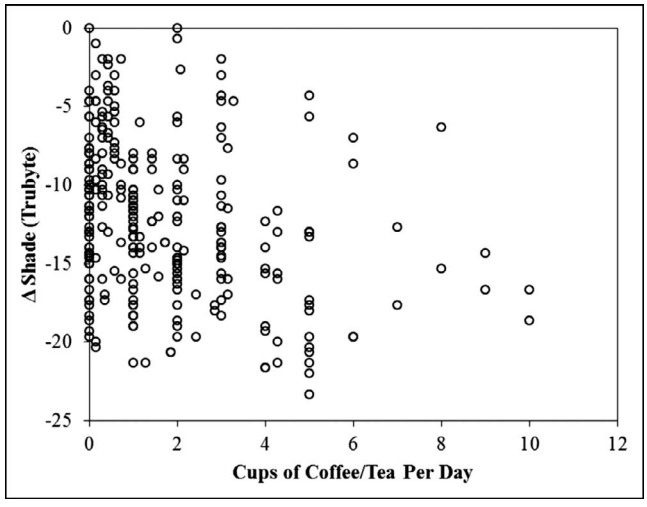

Figure 2. *Association of Number of Cups of Coffee/Tea With Change in Shade.*

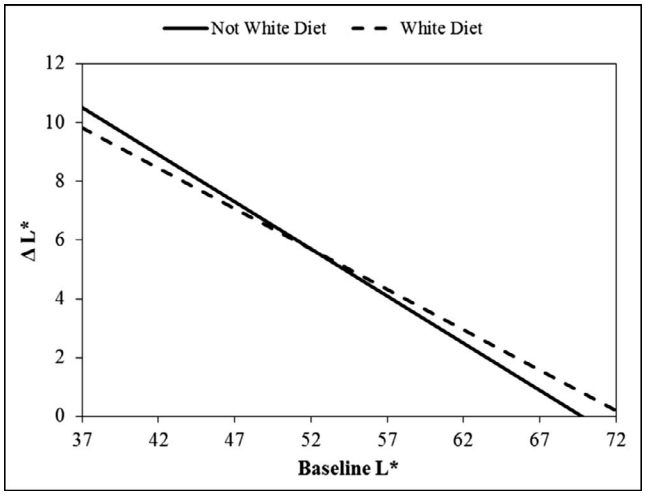

Figure 3. *Associations of Baseline L* With Change in L* Between White Diet and Not White Diet.*

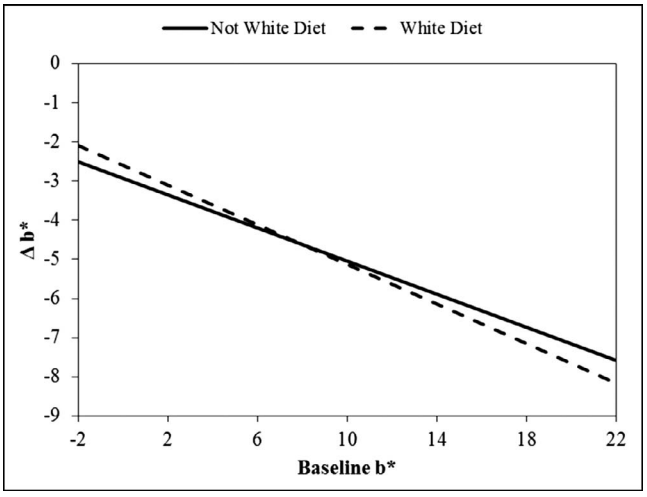

Figure 5. *Associations of Baseline b* With Change in b* Between White Diet and Nonwhite Diet.*

but that both coffee and wine caused enamel color changes after bleaching, though wine caused greater staining than coffee. Ley and others[4] recommend that applying topical fluorides to bleached enamel before exposure to a potentially staining and erosive beverage could be beneficial for maintaining tooth color by preventing extrinsic discoloration.

This present study evaluated the effect of coffee, tea, wine, and dark fruits on tooth bleaching during the process of tooth whitening. Previous research has evaluated the staining capacity of different agents *in vitro*. This is the first *in vivo* study that addresses the concern of adhering to a white diet during bleaching.

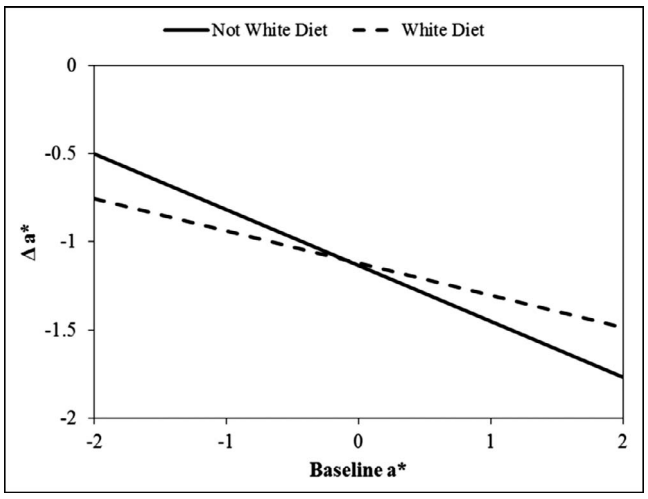

Figure 4. *Associations of Baseline a* With Change in a* Between White Diet and Nonwhite Diet.*

An evaluation of the five *in vivo* studies indicates that nonadherence to a white diet before bleaching results in a greater color change after bleaching treatment. Additionally, those same studies also indicated that the consumption of beverages/foods that are not included in a white diet does not negatively affect the bleaching process. As a result, strict adherence to a white diet during dental bleaching is not necessary during the bleaching process. However, care should be taken after bleaching, as extrinsic staining to bleached enamel will occur from the consumption of such agents as coffee/tea/wine/dark fruits.

CONCLUSIONS

The degree of tooth whitening increased as the number of cups of coffee/tea consumed during tooth whitening increased, although the change was not clinically relevant. Subjects that consumed red wine/dark fruit had no difference in ΔL* compared with the subjects that did not. Adhering to a white diet during the process of tooth whitening did not improve the esthetic outcome.

Conflict of Interest

The authors 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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