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Use of a Whitening Dentifrice for Control of Chlorhexidine Stain

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Abstract

A major drawback to clinicians prescribing and patients using chlorhexidine rinse is the development of extrinsic staining. In order to assess the effectiveness of a whitening dentifrice in controlling chlorhexidine stain, fifty-seven subjects rinsed with chlorhexidine twice daily while brushing twice daily with either fluoridated whitening or a fluoridated regular dentifrice. Stain was assessed at 1, 2, and 3 month intervals using a stain index with two components; one with parameters for color intensity and one for tooth percentage covered with stain. Facial surfaces accumulated less stain than lingual surfaces. For many, although not all surfaces, and at many, although not all time periods, the group utilizing the whitening dentifrice exhibited less staining.

It is advantageous to recommend a whitening dentifrice that has demonstrated stain suppression when prescribing a chlorhexidine rinse. Improved patient satisfaction leading to increased compliance with the antimicrobial regimen is a desired outcome.

Keywords: Chlorhexidine, dentifrice, whitening, stain, mouthrinse

Introduction

Historically, chlorhexidine has been considered a safe and effective antimicrobial agent to control plaque and gingivitis.[1,2,3,4,5,6,7] These properties have stood the test of time with chlorhexidine still regarded as the most effective chemical anti-plaque agent. According to Addy, "Chlorhexidine has not been superceded as a chemical anti-plaque agent, although other compounds have been shown to be useful."[8] Similarly, Jones has stated that, "After 20 years of use by the dental profession, chlorhexidine is recognized as the gold standard against which other anti-plaque and gingivitis agents are measured."[9]

However, the side effect of extrinsic staining which results from chlorhexidine use remains the single most confounding limitation to its long-term use and has been the topic of considerable discourse and study.[8,9,10,11,12,13,14,15,16,17,18,19,20,21]

Explanations of the staining mechanism have been postulated.[9,22,23,24,25,26,27,28,29] It has been suggested that the staining results from compounds which are products of a series of rearrangement reactions between sugars and amino acids. This reaction is termed the maillard or non-enzymatic browning reaction, also seen in the browning of foods high in carbohydrates and sugars, such as apples and potatoes.[29] The stain mechanism has also been described as a result of a local precipitation reaction between tooth-bound chlorhexidine and chromogens found within foodstuffs and beverages.[9]

To counteract the staining drawback of chlorhexidine rinses, several studies have examined different delivery systems and stain control approaches for their effects on chlorhexidine stain. These have included chewing gums,[10,15] sprays and gels,[11] a less concentrated formulation,[12,13,16] a morning vs. evening rinse time,[17] incorporation of chlorhexidine into a dentifrice,[18,19] use of a sonic toothbrush,[30] oxidizing mouthwash,[14,31] toothpicks,[34] tartar control dentifrice,[20] and a whitening toothpaste.[21,35,36,37]

To date, most studies utilizing whitening dentifrices have examined subsequent stain removal after the occurrence of chlorhexidine induced stain. This study examines the control of initial stain deposition rather than removal of pre-existing chlorhexidine stain.

Methods and Materials

Subjects were screened and accepted based upon meeting the following criteria: 18-65 years of age, visible extrinsic staining indicative of staining propensity, no advanced periodontal disease, no anterior porcelain or composite restorations, and dentition primarily comprised of natural teeth. Fifty-nine adults began the study. All subjects received a full-mouth scaling and a polish performed by experienced dental hygienists. All visible calculus and extrinsic stains were removed and any areas of intrinsic staining were documented.

Sulcular brushing instructions were provided and subjects were asked to brush in the morning and evening. Half of the subjects were given a manual toothbrush (Crest® Complete, Procter & Gamble, Cincinnati, OH), and the other half were given another brush being piloted. Half of the subjects were given a whitening dentifrice (Crest® Extra Whitening, Procter and Gamble, Cincinnati, OH) while the other half received regular dentifrice (Crest® Cavity Protection, Procter & Gamble, Cincinnati, OH). Products were issued in non-branded tubes with investigational labels, blinding both subjects and examiner to treatment groups. Brush and dentifrice groupings were determined by random assignment.

At baseline, all subjects received a month's supply of 0.12% chlorhexidine mouthrinse (Peridex®, Zila Pharmaceuticals, Phoenix, AZ). Instructions were to rinse with 1/2 ounce of chlorhexidine immediately after brushing. This was to occur in the morning after breakfast and in the evening just prior to bed. This brushing and rinsing sequence was provided to simulate instruction that would be given to most dental patients being prescribed chlorhexidine to treat gingivitis. Any other oral hygiene practices already being utilized could be continued. In order to encourage compliance, calendars were given and subjects asked to document each of their twice-daily brush and rinse sequences. These were collected at the end of each month.

Subjects returned at 1, 2 and 3 months after baseline. At each of these visits additional dentifrice and mouthrinse were provided, intraoral photographs were taken and stain accumulation was assessed. Stain was evaluated in two parameters: intensity of color and percentage of tooth surface covered with stain. All natural teeth in the dentition were included. Intensity was recorded for the distofacial, middle facial, mesiofacial, distolingual, middle lingual, and mesiolingual surfaces. A five-point color intensity scale, modeled after Lang and Raber39 was used with the following descriptors:

- 0 - no staining
- 1 - light stain
- 2 - medium stain
- 3 - dark stain
- 4 - extreme dark stain

The second parameter, percentage of the buccal and lingual surfaces covered by stain, by Raber and others,40 was estimated to the nearest 10 percent.

All stain evaluations were conducted by one blinded clinician, who was an experienced clinical research examiner calibrated in the stain indices utilized.

After the 3-month evaluation, the teeth of all subjects were re-scaled and polished to remove any accumulated extrinsic stains in order to return to a stain-free baseline. Subjects received monetary compensation in addition to the two debridements.

Results

When reporting the percentage of the tooth stained and the intensity of the stain color between the fluoridated whitening dentifrice and fluoridated regular dentifrice groups, a two-sample t-test was used. T-tests were performed at each time interval for various tooth surfaces. When the outcome variable was clearly non-normally distributed, the Wilcoxon's Rank Sum test was used. A level of significance was set at p=0.05 for all mean comparisons.

All but two subjects who began the study completed the entire 3 months for a total of 57 participants. One participant developed intense extrinsic staining and by the second month declined to continue. He was provided a prophylaxis and departed the study. Another subject moved unexpectedly and was exited.

All data for the two test toothbrushes were combined because there were no evident differences. Therefore, the only two reported cohorts are the fluoridated whitening dentifrice group and the fluoridated dentifrice group.

Table 1: Percentage & Intensity of Stain by Surface

	Percentage (%)			Intensity		
Facial Surfaces	**Month 1**	**Month 2**	**Month 3**	**Month 1**	**Month 2**	**Month 3**
Whitening	**10.1**	**10.4**	**12.0**	**.80**	**1.0**	**1.30**
Regular	**11.5**	**12.3**	**13.7**	**.95**	**1.25**	**1.54**
Lingual Surfaces	**Month 1**	**Month 2**	**Month 3**	**Month 1**	**Month 2**	**Month 3**
Whitening	**15.3**	**14.7**	**16.1**	**1.26**	**1.43**	**1.74**
Regular	**17.5**	**17.5**	**20.1**	**1.50**	**1.67**	**2.01**

Another consistent trend was that there was less stain on the facial surfaces than the lingual surfaces. This is demonstrated in Table 1. (Note that intensity values for all facial surfaces and for all lingual surfaces were averaged.) This finding persisted at each time interval, for both dentifrice types for both intensity of color and percentage of stain. Additionally, the whitening dentifrice had lower percentage and intensity stain scores than the regular at each time interval when scores for a variety of surfaces were averaged and compared as shown in Tables 2 and 3. (Note: In all Tables, if data from two surfaces are combined, it has been averaged. Only statistically significant findings are provided in Tables.)

Percentage of Teeth Stained

The whitening dentifrice resulted in a significantly smaller percentage of the tooth stained than did the regular dentifrice when facial and lingual surfaces were combined both at month 1 ($p=.032$) and at month 2 ($p=.020$) (Table 2). There was also significantly less stain for the whitening dentifrice group at 2 months when just the facial surfaces were considered ($p=.025$). This finding also held consistent for the lingual surfaces at month 3 where subjects using the whitening dentifrice had significantly less stain than did those using the regular dentifrice ($p=.018$). For surfaces not listed in Table 2, there were no significant differences between dentifrices.

Table 2: Percentage of Tooth Stained

	Month 1	Month 2		Month 3
Surface	**Facial & Lingual %**	**Facial & Lingual %**	**Facial %**	**Facial %**
Whitening	**12.6**	**14.1**	**10.4**	**16.1**
Regular	**14.9**	**16.9**	**12.3**	**20.1**
P Value	**.032**	**.020**	**.025**	**.018**

Table 3: Intensity of Stain Color

	Month 1	Month 2		Month 3		
Surface	Midfacial & Midlingual	Midfacial	Midfacial & Midlingual	Midfacial	Midlingual	Midfacial & Midlingual
Whitening	.49	.20	.53	.34	1.12	.73
Regular	.72	.49	.85	.61	1.61	1.11
P Value	.04	.004	.008	.03	.005	.002

Intensity of Stain Color

After one month of brushing and rinsing, use of the whitening dentifrice resulted in significantly less intense stain than the regular dentifrice when the mid-facial and mid-lingual surfaces were averaged together (p=.04) (Table 3). By month 2, this difference was even more significant (p=.008). By month 3, the difference in stain intensity for the two dentifrices at these surfaces was still strongly significant (p=.002). Similarly, the whitening dentifrice resulted in significantly less intense stain color for the mid-facial surfaces at month 2 (p=.004) and 3 (p=.03) and also for the mid-lingual surfaces at month 3 (p=.005). For surfaces not listed in Table 3, differences between the dentifrices were not statistically significant.

Discussion

An efficacious product, such as chlorhexidine, loses its efficacy if the patient is resistant to its use due to staining issues. Any approach to controlling chlorhexidine stain has merit only if it encourages practitioners to recommend it and fosters compliance among those using it.

Assessing stain is always a difficult matter. Issues of coverage and color intensity should be considered. A variety of indices have been used in different stain investigations.[10,11,15,16,17,18,19,20,21,27,30,33,34] Other studies have assessed stain with a plainer and microcomputer,[38] and photometrically with a colorimeter.[31,32] In reality, clinical significance is what matters most since it is the parameter used by patients in deciding whether to maintain a regimen known to cause stain development.

Another important consideration in approaches for controlling chlorhexidine stain is the simplicity of the technique. Adding yet another product or procedure to the oral hygiene regimen of a gingivitis or periodontitis patient is unlikely to be instituted. These individuals often have not demonstrated commitment in the past to thorough oral hygiene practices. To add an additional step beyond the addition of chlorhexidine rinse seems unlikely to be adopted as a habit.

View of a patient in the regular dentifrice group at baseline.

Same patient at the 3 month evaluation.

The advantage of employing a dentifrice to control stain is that it feeds into a current practice and requires no additional steps. For patient compliance there is also the advantage of preventing/controlling the stain that is forming, rather than focusing on removal once it has accumulated. This is likely to foster continued compliance. Many of the investigations previously cited have evaluated stain removal following stain induction.

In this study, the finding that facial surfaces had less intensity and coverage of stain than the lingual surfaces at each time interval was interesting. This occurred with both dentifrices, but especially with the whitening dentifrice. Other studies have had similar findings. Bollmer and others found that brushing with an anti-calculus toothpaste produced a significant reduction in cosmetically relevant facial-anterior stain although not in whole mouth stain when compared to use of a regular dentifrice. Likewise, Emling found significantly less stain on facial than lingual anterior surfaces when comparing a whitening to a regular dentifrice.[21] The clinical significance of these findings cannot be overlooked. It is probably stain on the facial surfaces that patients are most concerned with aesthetically. It may be that subjects in this and other studies brushed more effectively in areas where they could actually see stain. Clinical observation suggests that in a general population more stain is evident on the lingual than facial surfaces probably due to anatomical considerations or brushing efficacy.

View of a patient in the whitening dentifrice group at 1 month.

Same patient at the 3 month evaluation. Note very little change i slight cervical stain.

In looking at the intensity of staining that occurred at the end of 3-months, it was possible to demonstrate significant differences among dentifrices only at mid-facial and mid-lingual surfaces, or at their combined average. The reasons for this are worth examining. Although flossing or other interproximal practices were not documented in this study, it is assumed that subjects were no more committed to such behaviors than the general population. This lack of interproximal care presumably allowed stain to accumulate interproximally irrespective of the dentifrice utilized. Although the design of the Crest® Complete toothbrush is intended to reach interproximally, even this was not enough to overcome lack of interproximal care relative to stain accumulation. This could help explain why significant differences were seen only on mid-facial and mid-lingual, but not mesio-or disto-facial or mesio-or disto-lingual surfaces.

In looking at the combined scores for the mid-facial and mid-lingual surfaces, at three months the average intensity score was 1.11 for the regular dentifrice group and .[73] for the whitening dentifrice group. This means that the stain of the whitener group was less than 'light stain.' In contrast, the stain for the regular dentifrice group was more than 'light stain.' This clinical difference alone would seem to be apparent and important for the consumer.

The findings for percentage of the teeth that were stained are more difficult to interpret than the intensity findings. At both months 1 and 2, the whitening dentifrice group had significantly less of the tooth covered than the regular dentifrice group. It is interesting to consider the clinical relevance of the statistical significance. At month 1, the clinical appearance of 12.6% of the tooth covered may not vary much from the appearance of 14.9% of the tooth covered. Similarly at 2 months one must ask whether 14.1% of coverage would be different enough from 16.9% to please a consumer. However, it is important to remember that the intensity of color will have an impact on appearance of stain. The differences between 12.6% and 14.9% as well as between 14.1% and 16.9% may be more clinically relevant when the color intensity is less intense at the sites with less coverage as was seen in this study.

The reason for the small reduction in the percentage of the tooth covered may be understood with a look at brushing practices. It is common knowledge that people are usually not able to accomplish effective and complete coverage of the teeth when brushing. Since whitener dentifrices work by physical rather than chemical action, the brush and product must make contact with the stain to have an effect. By month 3, the lingual was the only surface to show a statistically significant difference in percentage of the tooth stained for the whitening dentifrice group compared to the regular dentifrice group (Table 2). The reason for this is unclear.

Even though at months 1 and 2 less of the tooth was stained for the whitening dentifrice group than the regular group, this was not a consistent result by month 3. This finding may suggest that for those using chlorhexidine rinse, a two-month re-appointment for stain removal is more judicious than waiting 3 months. This blurring between treatment groups as stain accumulation proceeds was also found in the study by Bollmer and others comparing stain accumulation with an anti-tartar and regular dentifice.[20]

Conclusion

It is advantageous to offer a simple solution to the staining problem when chlorhexidine is recommended for patients. It is ideal to recommend a recognizable product which is easily attainable over-the-counter and does not require an addition to the current oral hygiene regimen. Recommending a whitening dentifrice that has demonstrated stain suppression at the time of commencing chlorhexidine mouthrinse use makes good sense in our never-ending quest to increase patient compliance with the recommended regimen for attaining and maintaining oral health.

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