Salivary pH changes during 10% carbamide peroxide bleaching

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The purpose of this study was to evaluate the effect on salivary pH of a 10% carbamide peroxide solution when used with a custom-fitted guard for bleaching teeth. Baseline pH values were established for unstimulated saliva and on saliva produced while wearing an empty guard. After insertion of a guard half filled with Proxigel, salivary pH measurements were made at 5-minute intervals until the values returned to baseline levels. Mean salivary pH values were 6.81 ± 0.11 for unstimulated samples and 6.91 ± 0.18 after insertion of the empty guard. After insertion of the filled guard, there was a statistically insignificant decrease in salivary pH during the first 5 minutes, followed by an increase above baseline at 10 minutes, to a mean peak value of 7.32 ± 0.27 at 15 minutes. The difference between the baseline values and the mean peak value at 15 minutes was statistically significant. The results of the study indicated that the pH of saliva increased significantly during the first 15 minutes of nightguard vital bleaching and did not significantly drop below baseline in the first 2 hours after insertion with a moderately low-pH solution. (Quintessence Int *1994;25:547–550.*)

Introduction

Nightguard vital bleaching (NGVB), or dentist-prescribed—home-applied bleaching, has received much attention as an effective and simple method for lightening intrinsically stained or discolored teeth. Since Haywood and Heymann[1] first reported this technique in 1989, several articles have documented the effectiveness of the NGVB technique.[2] Studies have been conducted on the effects of the NGVB agents on restorative materials,[3,4,8–12] on the potential etching of enamel and dentin,[9,10,13,14] on enamel surface texture,[9,13,15] and on enamel subsurface hardness.[12,16] The effects of the active NGVB ingredient on caries, plaque reduction, and wound healing have also been extensively studied.[17–28] The results of these studies, along with the current emphasis on esthetic dentistry and the patient's desire for whiter teeth, have contributed to an increased use and acceptance of the NGVB technique.[29]

In spite of this increased acceptance and use of the NGVB technique, questions remain concerning its effects on plaque and salivary pH. The original and still predominant agent used for NGVB is a 10% carbamide peroxide solution.[1] Historically, 10% carbamide peroxide (also known as *urea peroxide, hydrogen peroxide carbamide,* or *perhydrol-urea*[30]) has been used intraorally for treatment of minor oral inflammation and denture irritations. Other beneficial effects of use of urea or hydrogen peroxide include reductions in plaque and gingivitis scores.[21,24,27,31–35] Different concentrations of urea and urea peroxide have been reported to reduce caries formation in selected populations.[24,31–33] It was concluded from these studies that the pH of saliva and plaque increases and the microbial count of the saliva is altered, resulting in decreased carious activity. In the NGVB technique, the carbamide solution is used at a different concentration and exposure time than those solutions reported to reduce caries and increase salivary pH.

Enamel demineralization occurs at pH 5.2 to 5.8.[36–38] One of the early major concerns about acidic bleaching

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Table 1 Salivary pH during the first 20 minutes of nightguard vital bleaching

Environment	pH	
	Mean	SD
Unstimulated saliva	6.81	0.11
Empty guard	6.88	0.23
Guard with Proxigel		
5 min	6.67	0.39
10 min	7.14	0.31
15 min	7.32*	0.27
20 min	7.24*	0.26

* Statistically significant difference.

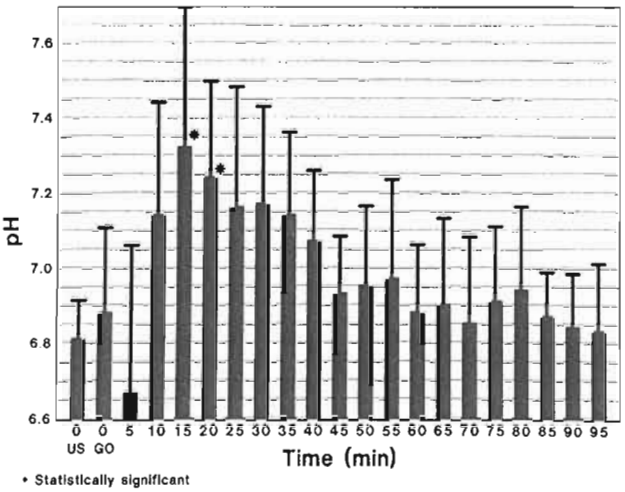

Fig 1 Salivary pH over time. *(US)* Unstimulated saliva; *(GO)* empty guard.

solutions (pH 4.8 to 5.2) was that the moderately low-pH solution may increase the patient's caries rate by enhancing tooth demineralization. Laboratory studies have shown that certain NGVB bleaching agents do not etch or cause softening of the enamel;[10,12,16,19] however, no clinical studies concerning the in vivo effects of the NGVB agents have been reported.

The objective of this study was to evaluate in vivo the effects of a 10% carbamide peroxide solution (Proxigel, Reed and Carnrick), pH 5.3, on salivary pH when the bleaching agent is used in a custom-fitted mouthguard.

Method and materials

Four adult subjects (one man and three women) participated in the study. An irreversible hydrocolloid impression (Jeltrate, Caulk/Dentsply) was made of the maxillary arch of each subjet. Stone casts of the maxillary arch were generated and a bleaching guard was fabricated (0.02-inch, No. 31720 coping material, Buffalo Dental) in accordance with the original technique described by Haywood and Heymann.[2]

Twelve individual clinical sessions were conducted in which salivary pH was measured. Measurements were performed between 1:30 and 5:00 pm. The four subjects were examined an average of three times (range of two to four) and were instructed not to eat, drink, or smoke for at least 2 hours before the session. On arrival, each subject rested 5 minutes before saliva collection. Whole resting saliva was collected in a disposable beaker and the pH was measured with a Beckman 71 pH meter (Beckman Instruments). The saliva collection and pH measurement techniques were similiar to those that have been previously documented.[39]

Two baseline reference points were established: resting and unfilled guard. Resting or unstimulated salivary pH was determined by the average readings of two to four saliva samples taken at 5-minute intervals. A second baseline was established as an average of two to four saliva samples taken at 5-minute intervals while the subject was wearing the unfilled guard.

The guard was then removed, rinsed, and dried. The anterior portion (canine to canine) was half filled with 10% carbamide peroxide and inserted onto the maxillary arch. Excess peroxide was expectorated. Salivary pH readings were recorded every 5 minutes until the pH returned to either of the two baseline levels.

Results

Mean salivary pH values are presented in Table 1. Salivary pH values remained above baseline for 100 ± 19 minutes (Fig 1). Analysis of variance revealed no statistically signicant difference between the two baseline reference points (unstimulated saliva and the unfilled guard). Nor was there a statistically significant decrease in pH between 0 and 5 minutes. The difference between the baseline values and the mean peak value at 15 minutes was statistically significant ($P < .01$), was the difference between the baseline values and the pH value at 20 minutes ($P < .05$).

Discussion

Carbamide peroxide solutions can vary in their acidity, causing concern for dentists who use this technique to lighten teeth. Demineralization of tooth structure occurs at a critical pH of 5.5 for enamel or 6.0 for dentin.[36–38] Practitioners would not want to enhance the esthetic appearance of their patient's smile at the risk of demineralizing enamel. The results of this study should help dispel these concerns. This study indicated that an acidic 10% carbamide peroxide solution significantly raised the salivary pH at some points and, more importantly, did not significantly reduce the salivary pH below the normal baseline at any time.

This rise in pH may be attributed to the chemical reactions of carbamide peroxide and its by-products. Ten percent carbamide peroxide solutions are extremely unstable intraorally, and immediately disassociate into 3% hydrogen peroxide and 7% urea.[17] Hydrogen peroxide further degrades into oxygen and water, while the urea degrades into ammonia and carbon dioxide.[35] Stephan[35] and Brown[40] concluded that degradation of urea into ammonia and carbon dioxide is a major neutralizer of acid in saliva. These reactions are catalyzed by the enzymes peroxidase and catalase, which are found in most body fluids, tissues, and some bacteria (especially gram-positive bacteria).[40,41]

The change in pH that was observed may not be entirely due to the degradation of the urea found in carbamide peroxide. Several other factors may have contributed to the rise. First, the release of urea from the salivary glands, especially the parotids, tends to elevate the pH. When stimulated, urea is one of the components secreted by the parotid glands and is subject to the same chemical reactions described above. Second, all subjects experienced an increase in salivary flow (stimulated salivary flow), which tends to increase salivary pH. Although the salivary flow was not measured per se, the increase was revealed by the increased volume of saliva in the collection beaker. A third mechanism that might explain the positive change in salivary pH would be the buffering systems of saliva. Contained in saliva are solutions of weak acids and their salts. These buffering solutions or systems possess the capacity to resist changes in pH whenever acids or bases are added to saliva. The most important buffering system of human saliva is the carbonic acid – bicarbonate system.[42–44] In saliva the bicarbonate concentration is determined primarily by the secretion rate of saliva,[45–47] thus creating an interrelationship among pH, buffer capacity, and secretion rate.[44–47]

The temporary increase in salivary pH observed in this study was most likely a result of all of the above-mentioned mechanisms, working together. Dentists should feel confident that the acidic carbamide peroxide extruded from the bleaching guard will be quickly neutralized and should not demineralize tooth structure outside the guard. A question that remains unanswered is the effect of carbamide peroxide on tooth structure and plaque inside the guard. Such a study is presently being conducted by the authors.

Summary

The results of this study, in which a moderately low-pH bleaching solution was used, indicated that the pH of saliva in the mouth, after an insignificant decrease in the first 5 minutes, increased to a statistically significant amount above baseline after 15 minutes of treatment. At no time did the pH of saliva outside the nightguard fall significantly below baseline. Whether the pH varies in the same manner for the bleaching solution and saliva contained within the nightguard is the subject of subsequent research.

Acknowledgments

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