

# Tooth Whitening in Children

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**Abstract:** Although there are several case reports of vital tooth bleaching in children, there is limited clinical trial evidence of the safety or efficacy of this practice. Accordingly, a new clinical trial was conducted to evaluate the effects of 2 different bleaching systems, a 6.5% hydrogen peroxide strip system and a 10% carbamide peroxide tray system, in a population of pre-teens and teens. A total of 106 volunteers, aged 11 to 18 years, took part in this 8-week study. Patients were randomized by a ratio of 2:1 to the strip or tray groups, with each group treating the maxillary arch first and then the mandibular arch for 4 consecutive weeks each. Individuals assigned to the strip group used the system twice daily for 30 minutes (a total of 56 contact hours over the 8-week study). Those assigned to the tray group used that system overnight (approximately 448 contact hours). Digital images were obtained at baseline and after every 2-week treatment period. Average tooth color was determined in  $L^*$ ,  $a^*$ ,  $b^*$  color space, where  $L^*$  indicated lightness,  $a^*$  indicated red-green, and  $b^*$  indicated yellow-blue. Both systems significantly whitened teeth ( $P < 0.0001$ ). While there were no significant differences between groups with respect to the primary whitening response ( $\Delta b^*$ ) on the maxillary teeth, 4 weeks of overnight treatment with the 10% carbamide peroxide tray (approximately 224 contact hours) yielded statistically significant whitening ( $P < 0.05$ ) on the mandibular teeth compared with the 6.5% hydrogen peroxide strip used for 28 hours. Both tooth-whitening systems had similar sensitivity/irritation reported after instructed use. This research demonstrates that tooth whitening in teens may be safely accomplished using either the short-contact-time hydrogen peroxide bleaching strips or the overnight carbamide peroxide tray systems tested in this study.

## Learning Objectives

After reading this article, the reader should be able to:

- discuss the two tooth-whitening systems tested in this trial.
- explain the concept of digital imaging for evaluating tooth color and tooth-color changes.
- compare the effectiveness of both tooth-whitening systems.
- describe the sensitivity expected to be associated with both tooth-whitening systems.

The popularity of vital tooth whitening has increased with the advent of patient-applied kits. The use of peroxide is now widely recognized as a safe and effective method for tooth whitening.<sup>1</sup> Concentrations of up to 35% peroxide are used alone or in conjunction with various agents for tooth bleaching.<sup>2</sup> These whitening agents can be delivered professionally in the dental office, used independently at home by the patient, or a combination of both can be used.

Bleaching treatment is generally effective, as noted in previous clinical trials.<sup>3-14</sup> Nightguard overnight vital bleaching with 10% carbamide peroxide gel appears to be the most common patient-applied/dentist-supervised bleaching technique. Higher peroxide concentrations also have been shown to be effective in tooth whitening; however, these are professionally supervised to a greater extent.<sup>2,15-17</sup> Tooth sensitivity and gingival irritation associated with these higher peroxide concentrations are reported to be minor and transient.<sup>18,19</sup>

Most reports involve adult populations. While the literature indicates that bleaching is used in children,<sup>20-24</sup> little controlled research has been conducted and/or reported in this population. This new study was conducted to compare the objective efficacy and tolerability of tooth whitening in children and ado-

lescents using a marketed tray-based tooth-whitening system and an easy-to-use disposable polyethylene strip system.<sup>25-27</sup>

**C**olor change was greater in the maxillary teeth than in the mandibular teeth, irrespective of the treatment regimen.

## Materials and Methods

This controlled, randomized, 8-week clinical trial compared 2 different bleaching systems and regimens: a 6.5% hydrogen peroxide strip system (Crest® Professional Whitestrips<sup>a</sup>) used for 30 minutes twice daily; and a 10% carbamide peroxide tray system (Opalescence<sup>®b</sup>) used overnight. The volunteer study population was limited to children and adolescents who wished to whiten their teeth. To be eligible, subjects had to have all permanent anterior teeth erupted and with a Vita<sup>c</sup> shade score of A2 or darker. Some subjects were excluded because of previous vital bleaching, apparent caries, periodontal disease, orthodontic appliances, anterior restorations, or a history of dentin hypersensitivity.

To minimize the possible effects of examiner bias, the study population was treated in two separate cohorts by two independent investigators. The study protocol was explained to the patient and parent, and then informed consent and child assent were obtained in a manner reviewed and accepted

<sup>a</sup>The Procter & Gamble Co, Cincinnati, OH 45202; 800-492-7378

<sup>b</sup>Ultradent Products, Inc, South Jordan, UT 84095; 800-552-5512

<sup>c</sup>Vita Zahnfabrik, Germany; distributed in US by Vident<sup>™</sup>, Brea, CA 92621; 800-828-3839



**Figure 1A**—Baseline photograph of anterior teeth to be treated with the experimental polyethylene strip-delivery system.

by the Institutional Review Board of the University of Texas Health Science Center at San Antonio.

Digital images of the anterior teeth were collected using a high-resolution digital camera (Fuji HC1000 CCD<sup>d</sup>) and a standardized method.<sup>27</sup> The unit was connected to a computer that recorded and analyzed the images. Before daily use and approximately every hour thereafter, the system was calibrated to ensure proper operation. In addition, intraoral clinical photographs were taken at baseline (Figures 1A and 2A) and posttreatment.

Alginate impressions of the maxillary and mandibular dental arches were made, and soft, full-arch, scalloped bleaching trays with reservoirs were fabricated for all participants using materials supplied by the manufacturer of the tray system.

**T**he popularity of vital tooth whitening has increased with the advent of patient-applied kits.

At baseline, subjects were assigned to treatment groups (balancing for pretreatment tooth color and age), and given detailed written and verbal instructions on test product application. The first product use was supervised. Subjects residing in the same household were assigned to the same experimental group. Both groups were provided a 2-week supply of bleaching product (8 syringes of bleaching gel or 28 bleaching strips).

Subjects in the 10% carbamide peroxide gel group were asked to dispense approximate-

<sup>d</sup>Fuji Photo Film USA, Inc, Edison, NJ 08818; 800-800-3854



**Figure 2A**—Baseline photograph of anterior teeth to be treated with the tray-delivery system.



**Figure 1B**—Four-week photograph of anterior teeth treated with the experimental polyethylene strip-delivery system. Note the difference between the maxillary teeth that received whitening treatment compared with the mandibular teeth that did not receive whitening treatment.



**Figure 2B**—Four-week photograph of anterior teeth treated with the tray-delivery system. Note the difference between the maxillary teeth that received whitening treatment compared with the mandibular teeth that did not receive whitening treatment.



**Figure 1C**—Eight-week photograph of anterior teeth treated with the polyethylene strip-delivery system, when whitening treatment was complete for both arches.



**Figure 2C**—Eight-week photograph of anterior teeth treated with the tray-delivery system, when whitening treatment was complete for both arches.

ly half of the gel in a syringe into the custom-fabricated, plastic delivery tray provided. The tray was filled and placed in the mouth after toothbrushing each night, and worn overnight while sleeping.

**T**he use of peroxide is now generally recognized as a safe and effective method for tooth whitening.

Subjects assigned to the 6.5% hydrogen peroxide polyethylene strip group were asked to place 1 strip over the maxillary anterior teeth for 30 minutes twice per day, once in the morning and once in the evening. A standard dentifrice was given to each subject for use throughout the study (Crest® Cavity Protection<sup>b</sup>).

Subjects returned for follow-up appointments and product resupply 2 and 4 weeks later,

when digital images and clinical photographs were taken (Figures 1B and 2B), and an oral soft tissue examination and interview were conducted. After 4 weeks of treatment on the maxillary teeth, the entire process was repeated for the mandibular teeth (Figures 1C and 2C).

The tooth color of the facial surfaces of the anterior teeth was computed from the intraoral digital images. Tooth color was represented in a three-dimensional  $L^*$ ,  $a^*$ ,  $b^*$  color space, where  $L^*$  indicates lightness and  $a^*$  and  $b^*$  are chromatic coordinates. Changes in tooth color ( $\Delta L^*$ ,  $\Delta a^*$ ,  $\Delta b^*$ ) were calculated by comparing each parameter with its baseline value. Larger  $L^*$  indicates increased lightness,  $a^*$  ranges from green to red, and  $b^*$  ranges from blue to yellow. All digital images were analyzed to obtain a single  $L^*$ ,  $a^*$ ,  $b^*$  color value for the facial surfaces of teeth included in this study. Treatment comparisons were tested 2-sided with a 5% significance level using analysis of covariance. The corresponding baseline tooth color was included as a covariate.

**Table 1—Baseline Demographic Characteristics and Tooth Color**

All Subjects Randomized

Baseline Demographic Characteristic	Strip (n = 71)	Tray (n = 35)
<b>Age (Years)</b>		
Mean (SD)	14.7 (1.71)	14.7 (1.74)
Range	11–18	12–18
<b>Gender</b>		
Female	39 (54.9%)	22 (62.9%)
Male	32 (45.1%)	13 (37.1%)
<b>Race</b>		
Black	2 (2.8%)	1 (2.9%)
White	25 (35.2%)	15 (42.9%)
Hispanic	41 (57.7%)	18 (51.4%)
Other	3 (4.2%)	1 (2.9%)
<b>Tooth Color</b>		
Mean b* (SD)	17.92 (1.550)	17.85 (1.474)
Mean L* (SD)	76.49 (1.577)	76.80 (1.372)
Mean a* (SD)	8.44 (0.775)	8.53 (0.577)

SD = standard deviation

## Results

The study enrolled 106 children and adolescents aged 11 to 18 years. This population included 61 girls and 45 boys, with a mean age of 14.7 years. Treatment groups were balanced with respect to demographic characteristics and baseline tooth colors (Table 1).

Tables 2 and 3 summarize the efficacy findings. Both the experimental 6.5% hydrogen peroxide polyethylene strips and the 10% carbamide peroxide night tray exhibited significant ( $P < 0.0001$ ) tooth-whitening improvement relative to baseline. Color change was greater in the maxillary teeth than in the mandibular teeth, irrespective of the treatment regimen used.

The color change for the maxillary teeth was not significantly different between the two systems evaluated. However, the tray system demonstrated significantly greater ( $P < 0.05$ ) tooth-whitening effectiveness for the mandibular teeth.

Both treatment regimens were generally well tolerated. Minor tooth sensitivity and oral irritation were the most common complaints,

reported by 49% of the subjects assigned to the strip group and 43% of the subjects assigned to the tray group. There was a single case of examiner-observed, minor oral irritation in the strip group. All other events were symptomatic in nature. Of note, these symptoms did not contribute to any early withdrawal or reported treatment modification.

## Discussion

This study evaluated the clinical response of children and adolescents to vital bleaching. Two systems were compared—an easy-to-use 6.5% hydrogen peroxide bleaching strip, and a marketed 10% carbamide peroxide tray that served as the experimental control. To ensure robustness, outcomes were compared relative to baseline and control during an extended 8-week treatment period, with efficacy measured and tolerability assessed objectively by 2 independent examiners. This controlled research demonstrates that children and adolescents can significantly whiten their teeth using either of these systems.

When worn for 30 minutes twice per day,

the experimental 6.5% hydrogen peroxide strip was generally as effective as the 10% carbamide peroxide gel delivered in a customized plastic tray and worn overnight. The disposable strips offered the convenience of not needing to make an impression to fabricate a delivery tray. Subjects were instructed to wear the strips for 30 minutes in the morning and 30 minutes in the afternoon or evening, with the flexibility of wearing the strips when it was most convenient. Many of the participants wore the strips on their way to school in the morning and were pleased that they could just dispose of the strip.

While both systems were effective, statistically significant between-group differences were limited to the mandibular arch at the end of treatment. At that time, the tray system had approximately 224 contact hours and the strip system had 28 contact hours. Misalignment may also have contributed to this response, because this panel was not selected based on tooth alignment, and because there were cases of meaningful malocclusion (especially crowding) in the mandibular anterior teeth. Otherwise, the treatment response of the easy-to-use strip system group was similar to that observed in the overnight tray system group. This may be of particular

relevance for adolescent patients where compliance is a concern.

As with adults, some children in this study experienced minor tooth sensitivity during bleaching. A total of 35% of all participants reported tooth sensitivity, with equal incidence in each treatment group. Because of the lack of well-controlled clinical trials in this population age group, there were no available data with which to form a prediction of expected sensitivity during tooth whitening. There could be speculation that adolescents would have greater sensitivity

**M**any of the participants wore the strips on their way to school in the morning and were pleased that they could just dispose of the strip.

than adults, because they have less dentin thickness. On the other hand, there could be less sensitivity because the pulp chambers are larger and able to recover more rapidly. Overall, approximately half of all participants

**Table 2—Adjusted Mean Change (CIE units) From Baseline and Standard Error After 2 Weeks of Treatment Use**

Color Parameter	Maxillary Teeth		Mandibular Teeth	
	Strip	Tray	Strip	Tray
$\Delta b^*$	-3.3 (0.13)	-3.5 (0.18)	-2.3 (0.16)	-2.9 (0.22)
$\Delta L^*$	2.8 (0.14)	3.0 (0.20)	2.2 (0.15)	2.7 (0.21)
$\Delta a^*$	-1.0 (0.05)	-1.0 (0.07)	-0.9 (0.07)	-1.0 (0.09)

**Table 3—Adjusted Mean Change (CIE units) From Baseline and Standard Error After 4 Weeks of Treatment Use**

Color Parameter	Maxillary Teeth		Mandibular Teeth	
	Strip	Tray	Strip	Tray
$\Delta b^*$	-4.1 (0.16)	-4.4 (0.22)	-2.8 (0.17)	-3.6 (0.23)
$\Delta L^*$	2.9 (0.14)	3.5 (0.19)	2.3 (0.15)	3.0 (0.20)
$\Delta a^*$	-1.1 (0.06)	-1.1 (0.08)	-0.9 (0.06)	-1.2 (0.09)

experienced some minor oral discomfort during this extended-use, 8-week trial.

While it is more common in adults, significant tooth yellowing represents one possible indication for bleaching in children and adolescents. Other indications include white spots on anterior teeth that may be apparent and undesirable. White spot lesions, even when remineralized, often maintain a white discoloration.<sup>28,29</sup> The increase reported in fluorosis involves white discolorations in the tooth enamel.<sup>30,31</sup> To camouflage these discolorations, tooth whitening can be beneficial.

**W**hile it is more common in adults, significant tooth yellowing represents one possible indication for bleaching in children and adolescents.

Bleaching may represent a conservative first approach for many cosmetic conditions. This may be especially true for children and adolescents, for whom treatment may be readily accomplished without local or general anesthetics, and without permanent alteration to the enamel surfaces. Such conservative therapy limits the need for lifelong maintenance associated with some restorative care.

Although no data are available regarding the desire of children and adolescents to have their teeth whitened, we have observed a great number of pediatric patients who request bleaching, and have similarly heard numerous reports of heightened self-esteem after such care. Of course, different research would be indicated to establish these benefits, but, already, there is a well-defined place in the contemporary dental practice for tooth whitening in children.

## Conclusion

The two systems evaluated in this clinical study, the disposable 6.5% hydrogen peroxide gel strips and the 10% carbamide peroxide customized gel trays worn overnight, effectively whitened teeth. Both treatment regimens were well tolerated.

## Disclosure

This research was supported, in part, by The Procter & Gamble Company.

## Acknowledgments

The authors would like to recognize Pat Walters RDH, MS (Clinical Research Associate, The Procter & Gamble Company), Phyllis Hoke, MEd (Clinical Data Manager, The Procter & Gamble Company), Fran Ramirez (Clinical Trials Coordinator, University of Texas Health Science Center at San Antonio, Department of Pediatric Dentistry), and Rachel Syma (Study Coordinator, University of Texas Health Science Center at San Antonio, Department of Pediatric Dentistry) for their work in completing this project.

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*Academy of General Dentistry Accepted National Sponsor  
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