

Eight In-office Tooth Whitening Systems Evaluated *In Vivo*: A Pilot Study

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Clinical Relevance

Rapid bleaching is the main advantage of in-office bleaching; however, there is also a rapid reversal that occurs with most in-office products after bleaching.

SUMMARY

This *in vivo* pilot study evaluated eight products with hydrogen peroxide (HP) concentrations ranging from 15% to 35%. The treatment contact

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time varied from 15 minutes to 60 minutes. Patients were evaluated for color at baseline, immediately after treatment and at one, two, four and six weeks after treatment using a colorimeter, shade guide and photos.

All eight products were effective in bleaching teeth. Colorimeter data for ΔE immediately after treatment was 6.77. At one and six weeks after bleaching, there were 51% and 65% reductions in ΔE , respectively.

INTRODUCTION

Bleaching has been accepted as the least aggressive method for treating discolored teeth. However, the effectiveness of in-office systems has been controversial. Bleaching appears to be time and concentration dependent.¹ The questions remain whether in-office tooth whitening products with lower concentrations are as effective as products with higher concentrations and whether some products are more effective than others. These types of questions have long been on the minds of dental practitioners.

Manufacturers have introduced “bleaching” lights that are reported to accelerate the bleaching process, while some researchers have stated that no accelera-

tion or increase in efficacy occurs when using light or heat sources. During in-office procedures, bleaching gel is placed on the tooth and may or may not be illuminated with a light source. The gel is then rinsed off and reapplied a second, third or more times. These gels usually contain 15% to 38% hydrogen peroxide. Because of potential side effects, the soft tissue is protected to limit the contact of peroxide with the gingiva. No anesthetic is used during the procedure, so that, if the subject experiences more than moderate sensitivity during the procedure, the process is terminated.

This double-blinded pilot study evaluated the ability of eight in-office bleaching agents to lighten tooth color by evaluating the degree of color change of the teeth, then evaluating the rebound effect associated with discontinued use. The products were applied according to the manufacturer's instructions, and they varied widely in concentration and instructions for use.

METHODS AND MATERIALS

Manufacturers with in-office products on the market² were contacted and invited to participate in this study. Manufacturers of the following products accepted the invitation: ArcBrite (Biotrol International, Louisville, CO, USA), One-Hour Smile (Den-Mat Inc, Santa Maria, CA, USA), Illumine (Dentsply Professional, York, PA, USA), Zoom! (Discus Dental, Inc, Culver City, CA, USA), Accelerated In-Office (Life-Like Cosmetics Solutions, Santa Barbara, CA, USA), PolaOffice (Southern Dental Industries Inc, Bensenville, IL, USA) and Niveous (Shofu Dental Corp, San Marcos, CA, USA). These manufacturers were invited to send representatives to help ensure that their products were being used as recommended. Four manufacturers sent representatives. All procedures, except for BriteSmile, were accomplished by one practitioner experienced in tooth whitening. Since BriteSmile (BriteSmile, Walnut Creek, CA, USA) did not provide their system, but it had such a high profile, the authors of this study identified a dental practitioner who was trained by the manufacturer and was willing to conduct four cases of in-office bleaching in order to include it in the study.

The protocol was approved by the Indiana University-Purdue University Indianapolis Institutional Review Board. All subjects provided informed consent. Thirty-two subjects who met the following inclusion/exclusion criteria were identified.

Inclusion factors were:

- Having all six maxillary anterior teeth.
- None of the maxillary anterior teeth have more than 1/6 of the labial surfaces of their natural tooth covered with a restoration.
- Be willing to sign a consent form.
- Be at least 18 years of age.

- Be able to return for periodic examinations.
- Be willing to refrain from using tobacco products during the study.
- Having their maxillary anterior teeth not lighter than shade B-54, but not darker than B-84, based on the Trubyte Bioform Color Ordered Shade Guide.

Exclusion factors included:

- Having a history of any medical disease that may interfere with the study.
- Using tobacco products during the past 30 days.
- Having used professionally applied or prescribed in-office or at-home bleaching at any time in the past.
- Having any gross pathology in the oral cavity (excluding caries).
- Having a Loe and Silness Gingival Index score greater than 1.0.³
- Being a pregnant or lactating woman.
- Having tetracycline-stained teeth.

Subjects who met the inclusion/exclusion criteria had an alginate impression taken of their maxillary arch. A positioning jig with full palatal coverage was constructed on their maxillary cast. The jig was indexed to ensure the light-measuring device could be returned to its predetermined position at each evaluation. Extrinsic tooth stain was removed with a dental prophylaxis using a paste (NUPRO, Dentsply Int, York, PA, USA) with fluoride. The prophylaxis occurred at least one week prior to initiation of the active treatment phase of the study.

The subjects were randomly assigned to groups of four, with the exception of the BriteSmile patients. The objective evaluations consisted of color measurements using a colorimeter (Chroma Meter, Model 321, Minolta, Ramsey, NJ, USA) in CIELAB values.⁴ Using a positioning jig, triplicate colorimeter measurements in the L*a*b* color system were taken of the six maxillary anterior teeth.

This CIELAB system was defined in 1967 by the International Commission on Illumination.⁴ L* represents the value of lightness or darkness, a* is the measurement along the red-green axis and b* is the measurement along the yellow-blue axis. A positive a* value indicates the red direction, a negative a* value represents the green direction, a positive b* value signifies the yellow direction, and a negative b* value indicates the blue direction. The L*, a* and b* values were recorded in the measuring head of the instrument and transferred electronically to the Data Processor DP-301 (Minolta, Osaka, Japan). This process ensured that no errors were made in transcribing the data for analysis.

Product	Manufacturer Location	Concentration	Isolation	# of Applications	Length of Each Application	Light Activation Accomplished
ArcBrite	Biotrol International Louisville, CO, USA	30% HP	Paint-on Dam	3	20 minutes	Yes
BriteSmile	BriteSmile Walnut Creek, CA, USA	15% HP	Paint-on-Dam	3	20 minutes	Yes*
One-Hour Smile	Den-Mat Corp Santa Maria, CA, USA	35% HP	Paint-on-Dam	3	15 minutes	Yes*
Illumine	Dentsply Professional York, PA, USA	15% HP	Tray	3	20 minutes	No
Zoom!	Discus Dental, Inc. Culver City, CA, USA	25% HP	Paint-on-Dam	3	20 minutes	Yes*
Accelerated	Life-Like Cosmetics In-Office, Santa Barbara, CA, USA	40% HP** & 30% HP	Rubber Dam	5	3 minutes	No
PolaOffice	Southern Dental Industries, Inc Bensenville, IL, USA	35% HP	Paint-on-Dam	3	12 minutes	Yes
Niveous	Shofu Dental Corp San Markos, CA, USA	25% HP	Paint-on-Dam	3	15 minutes	Yes

*Proprietary light used
**Different concentration used in pre-treatment of teeth

Total color differences or distances between two colors (ΔE) was calculated using the formula: $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

The subjective evaluations consisted of comparing Trubyte Bioform Color Ordered Shade Guide tabs (Dentsply International) with the color of the middle portion of the maxillary anterior teeth. Two evaluators subjectively evaluated four different products. One evaluator examined ArcBrite, Pola- Office, BriteSmile and Zoom!, while the other analyzed Accelerated In-Office, Niveous, Illumine and One-Hour Smile. The evaluators were calibrated with each other and were blind as to which products the subjects used. Photographs recorded the study, using Ectachrome Elite 100, 35 mm film (Kodak, Rochester, NY, USA).

Each treatment appointment followed immediately after the initial color evaluation. At the treatment appointment, the manufacturer's instructions were followed for the in-office bleaching of the subject's maxillary anterior teeth. Table 1 lists the products and procedures used in this study. Unless the manufacturer recommended the use of a proprietary light, a halogen light (VIP BISCO, Inc, Schaumburg, IL, USA) was used. In addition to baseline measurements, the color evaluations were accomplished immediately and at one, two, four and six weeks after treatment.

Table 2: Baseline Color (N=4 per group)

Product Concentrations	L*		a*		b*		Shade	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Accelerated (40%)	45.76	2.73	-0.54	0.67	3.26	3.20	19.33	2.54
Illumine (15%)	44.72	1.76	-0.40	0.64	3.13	3.01	20.75	2.49
Niveous (27%)	45.83	0.61	-0.20	0.33	4.51	2.23	20.00	2.07
One-Hour Smile (35%)	45.24	2.58	-0.68	0.23	1.29	1.76	18.21	0.96
ArcBrite (30%)	48.19	1.73	-1.04	0.36	1.12	2.69	15.25	3.37
BriteSmile (15%)	46.31	2.86	0.04	1.03	5.32	2.84	18.71	3.77
PolaOffice (35%)	46.51	2.59	-0.37	0.12	4.01	1.48	17.00	2.48
Zoom! (25%)	45.00	3.56	-0.33	0.93	3.43	0.80	19.50	3.12

RESULTS

Baseline values are reported in Table 2. The graphic illustration of tooth whitening and the changes for up to six weeks post-bleaching are evident for L* (Figure 1), a* (Figure 2), b* (Figure 3), ΔE (Figure 4) and shade guide (Figure 5). The overall mean ΔE immediately after bleaching for the eight products was 6.77. The products with the highest means (ΔL^* , a*, b*, E) and Δ shade guide immediately after bleaching were Niveous at 6.61, Illumine at -1.03, BriteSmile at -5.30, Niveous at 8.30 and BriteSmile at -13.04, respectively. One week post-bleaching, the overall mean ΔE value was 3.31, which was a 51% reversal. Also, one week post-bleaching, the products with the highest ΔL^* , a*, b*, E and Δ shade guide were Zoom! (4.19), Illumine (-0.80), Zoom! (-3.90), Zoom! (5.94) and Zoom! at (-10.83), respectively. The mean ΔE value six weeks after bleaching was 2.34, which was a 65% reversal from that found

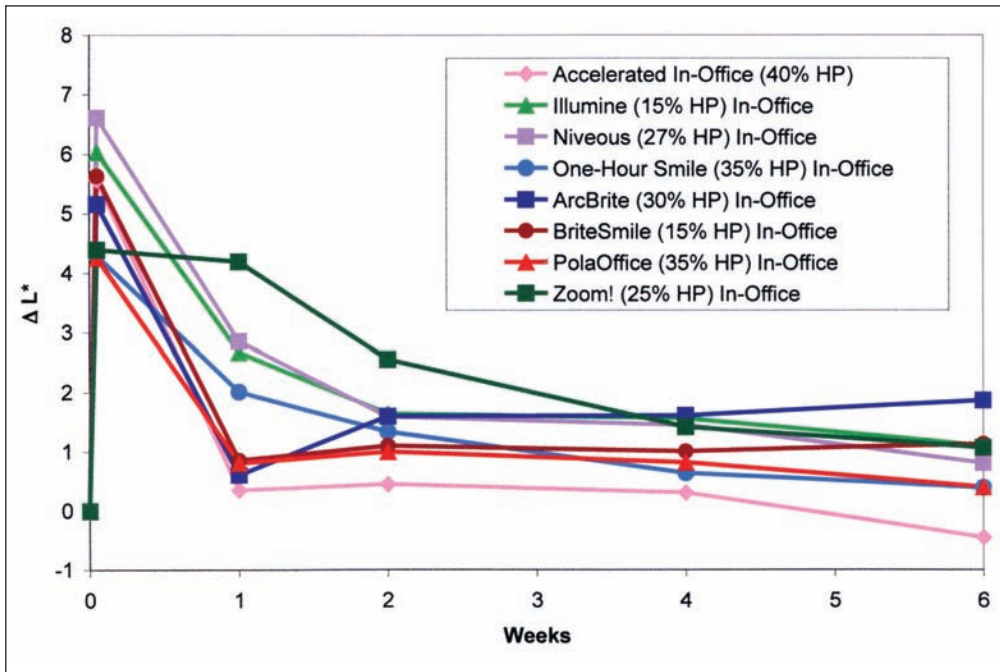


Figure 1: Mean change in L* for eight in-office bleaching agents.

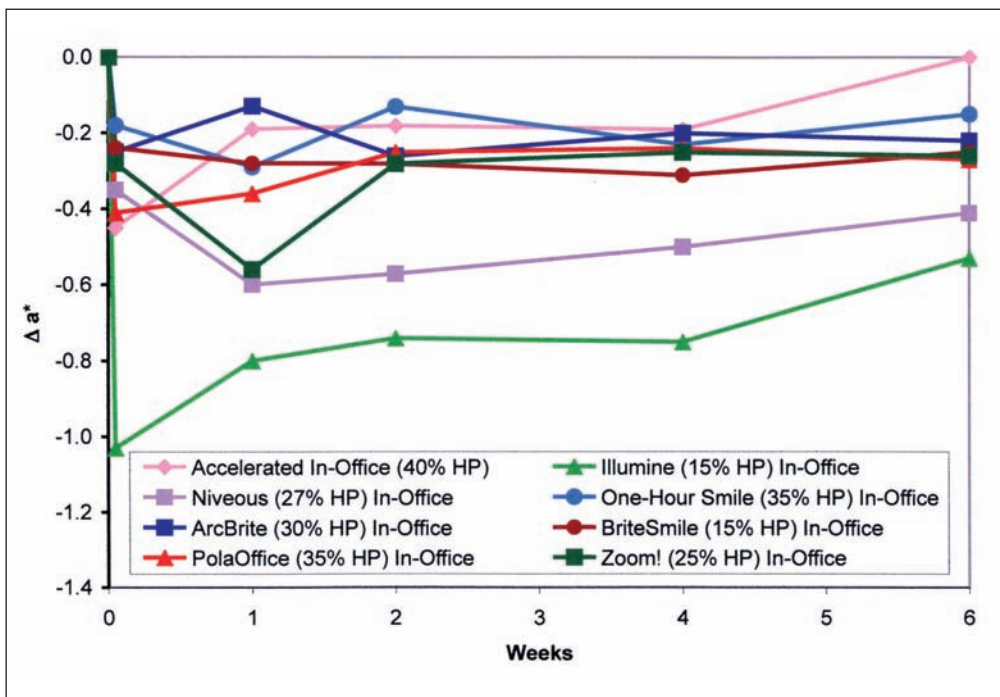


Figure 2: Mean change for a* for eight in-office bleaching agents.

immediately after bleaching. At six weeks post-bleaching, the products with the highest ΔL^* , a^* , b^* , E and Δ shade guide were ArcBrite (1.13), Illumine (-0.53), Zoom! (-2.29), Zoom! (2.95) and Illumine (-7.83), respectively. Due to the small number of subjects, statistical analysis of the various products was not possible.

DISCUSSION

This study evaluated eight in-office products used on 32 subjects. After baseline measurements, each product was evaluated on four subjects immediately after placement, and at one, two, four and six weeks post-bleaching. No at-home post-bleaching gel in trays was used, as One-Hour Smile provides and recommends and BriteSmile, Illumine and Zoom! provide, but do not require.

Some in-office products lighten teeth immediately to the same degree after bleaching as occurs with at-home tray-based bleaching agents, but the color reversal in most of the products occurred more rapidly than was found in at-home tray-based bleaching products. Some studies have stated that some of the initial lighter color changes may be due to dehydration.⁵⁻⁶

Some studies have suggested that concentration and contact time are very important for in-office bleaching.⁷ In this study, three of the four in-office products with the lowest concentrations had the highest ΔE values immediately after bleaching. The three products with the shortest contact time also had the three lowest ΔE values. From this study, it appears that contact time is important, while concentration is not as important a factor. To be more effective in whitening teeth, other agents, which are added to the product, must catalyze the peroxide, since concentration was not the critical factor

in tooth whitening. In the subjective evaluation, three out of the four lowest shade changes were products with the lowest contact times. The contact time of bleaching, therefore, appears to be an important factor for in-office bleaching.

While the use of light in bleaching has been shown to be effective in some studies,⁸⁻¹⁰ it is not effective in other studies.¹¹⁻¹² A recent systematic review of in-office bleaching concluded, "...the benefit of the additional use of light is limited."¹³

Studies have shown that there is no evidence of deleterious effects from bleaching on enamel or dentin.¹⁴ The deleterious effects that have been documented in previous studies¹⁵ may have been due to the pH of in-office product formulations.¹⁶ Concern has been expressed regarding the deterioration of dental materials during bleaching. The use of high concentrations of HP has not been shown to damage the surface finish¹⁷ or hardness¹⁸ of restorations.

A study to determine how much additional tooth whitening would occur if one accomplished two separate sessions of in-office tooth whitening would be an important follow-up study. Another follow-up study would be to determine if, and how much, an in-office tooth whitening procedure would boost the time it takes to attain "maximum lightness potential"¹⁹ for a patient who follows an in-office tooth whitening procedure immediately with an at-home tooth whitener.

CONCLUSIONS

The eight tooth-whitening products evaluated in this study were effective. There was a mean ΔE reversal of 51% and 65% after one and six weeks post-bleaching, respectively, in the eight products evaluated.

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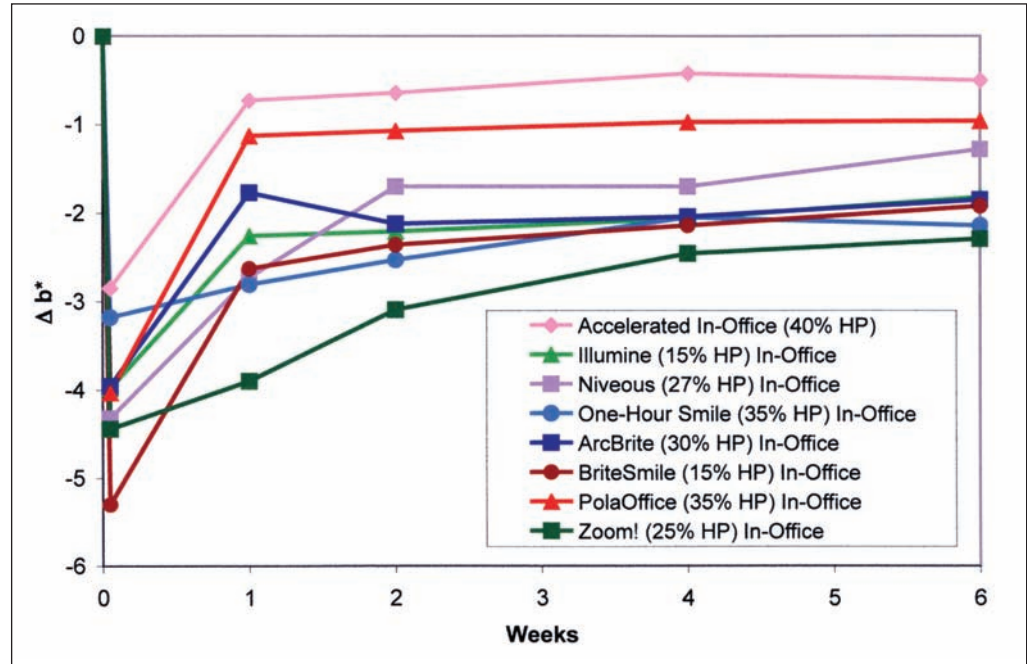


Figure 3: Mean change in b^* for eight in-office bleaching agents.

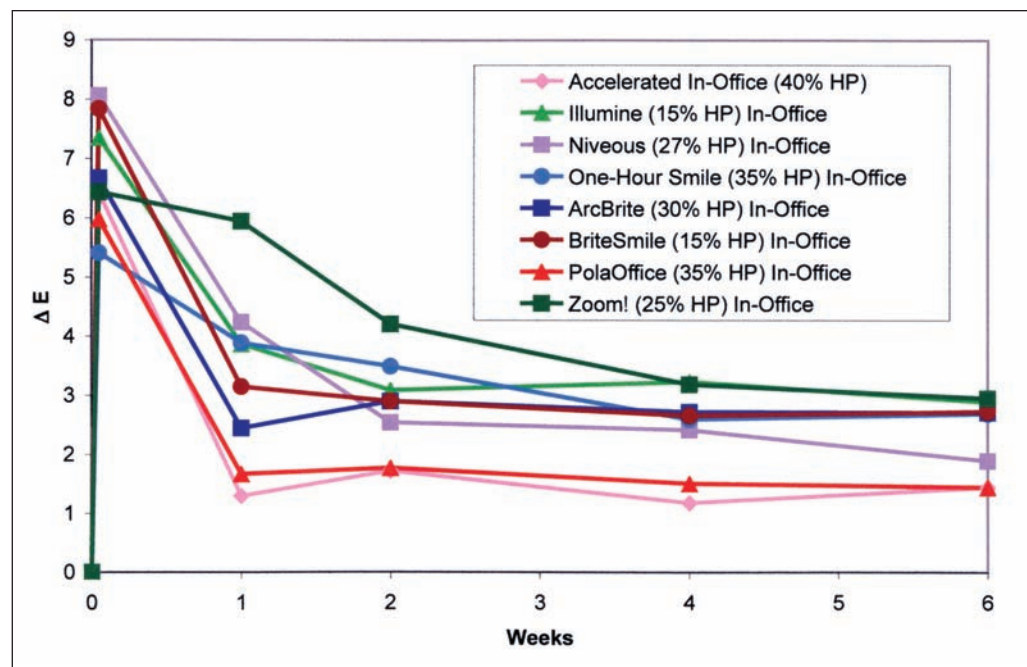


Figure 4: Mean change in E for eight in-office bleaching agents.

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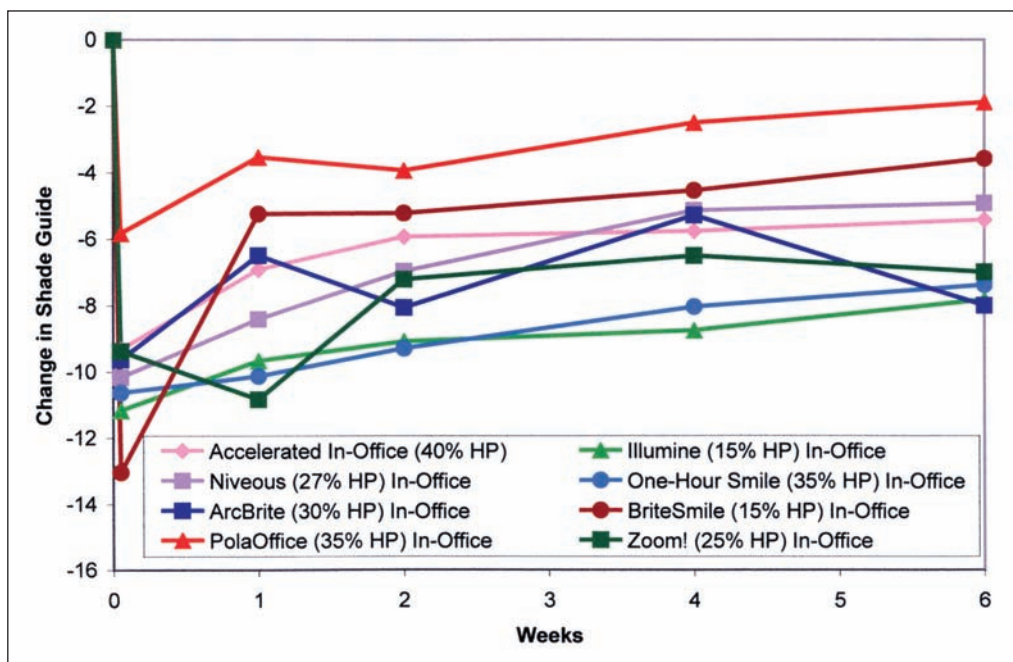


Figure 5: Mean change in shade guide for eight in-office bleaching agents.

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