

**Clinical Research  
Collaborative**



**The Forsyth Institute**

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**BriteSmile, Inc.  
Tooth Whitening  
Follow-Up Analysis**

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Final Report  
January 2005

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# Table of Contents

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<b>EXECUTIVE SUMMARY</b> .....	1
<b>INTRODUCTION</b> .....	1
<b>MATERIALS AND METHODS</b> .....	2
EXPERIMENTAL DESIGN – OVERVIEW.....	2
SUBJECT SELECTION.....	2
<b>RESULTS</b> .....	3
SUBJECT POPULATION.....	3
PRIMARY OUTCOME.....	3
(TOOTH SHADE).....	3
<i>Range of shade change responses from Baseline to 2-Years</i> .....	4
CHROMAMETER MEASUREMENTS.....	5
<i>L* values</i> .....	5
<i>a* values</i> .....	6
<i>b* values</i> .....	7
<i>Range of b* change responses from baseline to 2-years</i> .....	8
GINGIVAL INDEX.....	9
<i>Range of Gingival Index change responses from baseline to 2-years</i> .....	10
PLAQUE INDEX.....	11
STATISTICAL ANALYSIS OF CHANGES IN ALL OUTCOME VARIABLES.....	12
<b>DISCUSSION</b> .....	13
SHADE CHANGES.....	13
CHROMAMETER CHANGES.....	13
GINGIVAL INDEX.....	13
PLAQUE INDEX.....	13
<b>CONCLUSIONS</b> .....	14

## Section

# 1

### Executive Summary

The duration, or lasting, of effects from tooth whitening has not been investigated thoroughly. It is well known that the bleaching effect seen within a few months is not as great as that seen immediately after the procedure. How the bleaching effect is maintained over the longer period is not known. Clearly it is important to the consumer/patient to know how long the effect will last. We have conducted a follow-up analysis that measures six outcome variables over a 2-year period following a single BriteSmile, *Inc.* whitening procedure.

**Experimental Design:** Approval was obtained to measure twenty-one subjects who had received a BriteSmile, *Inc.* tooth whitening procedure as part of participation in other Forsyth studies. Subjects were monitored out to a 2-year time point. To our knowledge the subjects received no further whitening treatment during this 2-year period.

**Effectiveness:** Results indicate that whitening and gingival health effects of a single BriteSmile, *Inc.* treatment can be measured two years after application. This is a surprising and important observation indicating that the effects of a single one-hour whitening treatment can persist for at least two years. The lasting of whitening effects was measured in both shade evaluation and chromameter measurements.

## Section

# 2

### Introduction

Regression, or fading of color, is a topic about which few facts are known. It is observed throughout the tooth whitening industry and is often described as "a fading of the whitening effect". It is most often ascribed to a return by the patient to poor oral habits. Little is known or been studied to date about its magnitude or progression over time in a large and consistent set of patients. Anecdotal data from participating BriteSmile, *Inc.* dentists seem to show a high degree of variation in regression from patient to patient. A few patients experience severe, early regression.

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## Materials and Methods

### Experimental design – Overview

All subjects were enrolled from two previously-completed Forsyth whitening studies. The subjects were (1) a subset of patients from the BriteSmile, *Inc.* "light plus gel" leg of the Forsyth Safety and Efficacy study and (2) a subset of patients from the BriteSmile, *Inc.* leg of the Forsyth Comparison study. All of the subjects received the standard BriteSmile, *Inc.* tooth whitening treatment. Subjects were measured at baseline, immediately post treatment and at 3, 6, 12, 18, and 24 months during and after each of the two studies. Since not all subjects cooperated with the follow-up study, the dataset has some gaps. Using all of the subjects who agreed to follow-up measurements, we monitored each participant over a 2-year period to evaluate the degree of regression, if any. The last subject was seen on December 21, 2002.

### Subject Selection

**Table 1.** Baseline and 2-year shade values for subjects selected from two previous Forsyth whitening studies.

Original Study	Subject Number	Shade (Baseline)	Shade (2 Years)
Forsyth ADA Study (BS1)	3	14	9
	4	10	3.5
	14	9	4.5
	16	10.5	4.5
	19	9	2.75
	30	14	5.5
	32	10	2.5
	37	8.5	2.25
	47	8	1.5
	52	8	6.5
	55	9	2
	60	14	9.5
	61	10	3
	68	10	4
	71	10	5
Forsyth Comparison Study (BS2)	87	9.5	6.25
	211	8.75	6
	237	15	6.75
	253	15.5	10
	260	10.33	5

# Section 4

## Results

### Subject population

Twelve women and eight men participated. Of the twenty subjects 17 were white, one was Hispanic, one was Asian, and one identified as Other.

Table 2. Subject Age.

N	Mean	Min	Max	StDev
20	48.15	28	66	11.10

Average subject age was 48.

### Primary Outcome

#### (Tooth Shade)

Tooth shade was reduced by an average of 8.3 shade tab values during the initial one-hour treatment. Over the next two years, the average return to darker shades was 1.3 shade tab units.

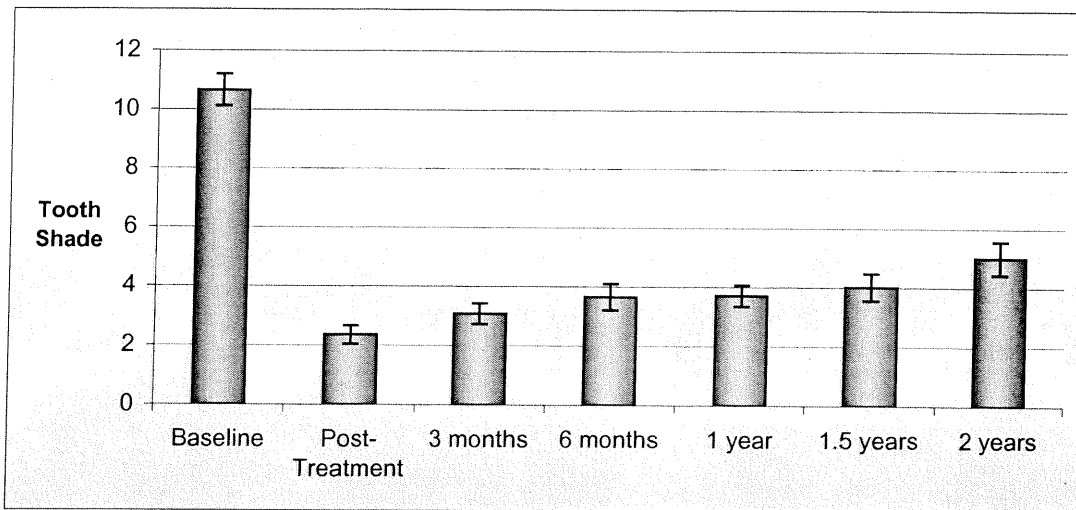


Figure 1. Tooth shade before and after treatment. Whiskers indicate standard error of the mean.

Tooth shade reduction results are summarized numerically in the following table:

**Table 3. Tooth shade values for all visits.**

Visit	N	Mean	SEM	StDev
Baseline	20	10.65	0.54	2.41
Post-Treatment	20	2.35	0.31	1.38
3 months	20	3.07	0.35	1.55
6 months	20	3.65	0.45	2.02
1 year	18	3.71	0.36	1.55
1.5 years	19	4.01	0.46	2.01
2 years	20	5.00	0.56	2.48

**Range of shade change responses from Baseline to 2-Years**

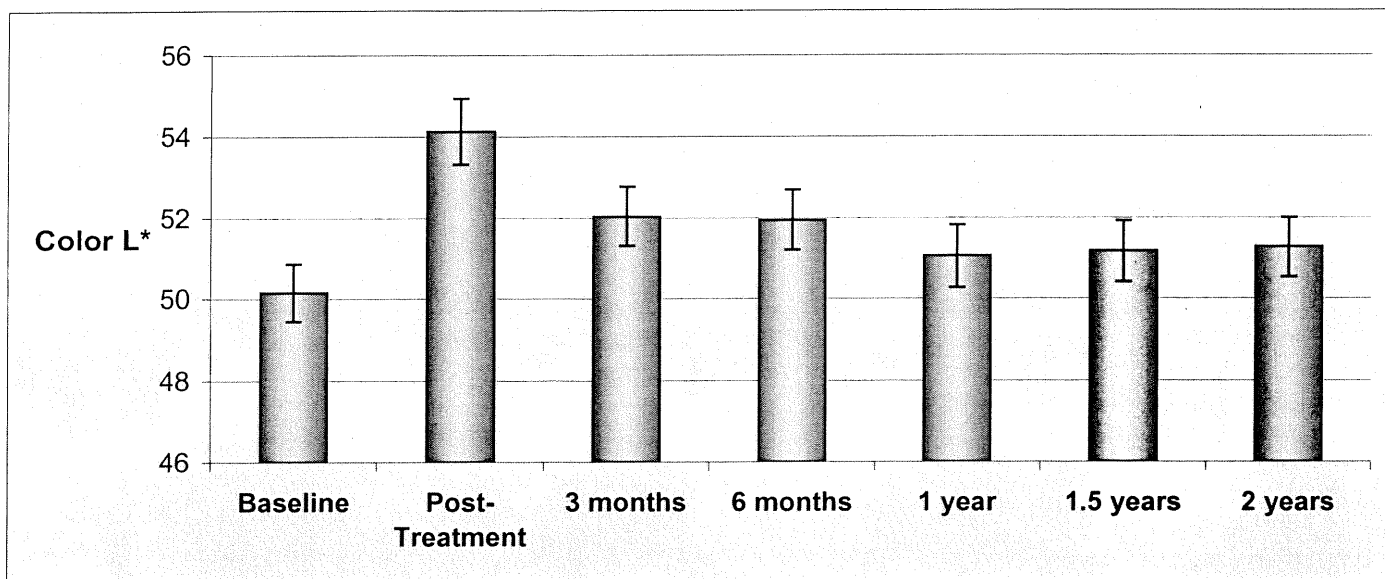
**Table 4. Percentage of original shade reduction remaining after 2 years.**

Subject	Baseline	Post-Treatment	2 Years	Baseline to Post-Treatment Decrease	Post-Treatment to 2-Year Return	% of Effect Remaining At 2 Years
52	8	4	6.5	4	2.5	37.50%
60	14	2	9.5	12	7.5	37.50%
87	9.5	1.25	6.25	8.25	5	39.39%
211	8.75	2.25	6	6.5	3.75	42.31%
3	14	2.75	9	11.25	6.25	44.44%
71	10	1	5	9	4	55.56%
253	15.5	5.75	10	9.75	4.25	56.41%
14	9	2	4.5	7	2.5	64.29%
68	10	1	4	9	3	66.67%
260	10.33	2.5	5	7.83	2.5	68.07%
237	15	3	6.75	12	3.75	68.75%
30	14	2	5.5	12	3.5	70.83%
32	10	1	2.5	9	1.5	83.33%
37	8.5	1	2.25	7.5	1.25	83.33%
55	9	1	2	8	1	87.50%
61	10	2	3	8	1	87.50%
19	9	2	2.75	7	0.75	89.29%
16	10.5	4	4.5	6.5	0.5	92.31%
47	8	1.5	1.5	6.5	0	100.00%
4	10	5	3.5	5	-1.5	130.00%
<b>Mean</b>				<b>8.304</b>	<b>2.65</b>	<b>70.25%</b>
<b>Median</b>						<b>68.41%</b>

These data indicate that approximately 70% of the initial treatment effect (68.41%) remained two years after initial treatment.

## Chromameter measurements

### L\* values



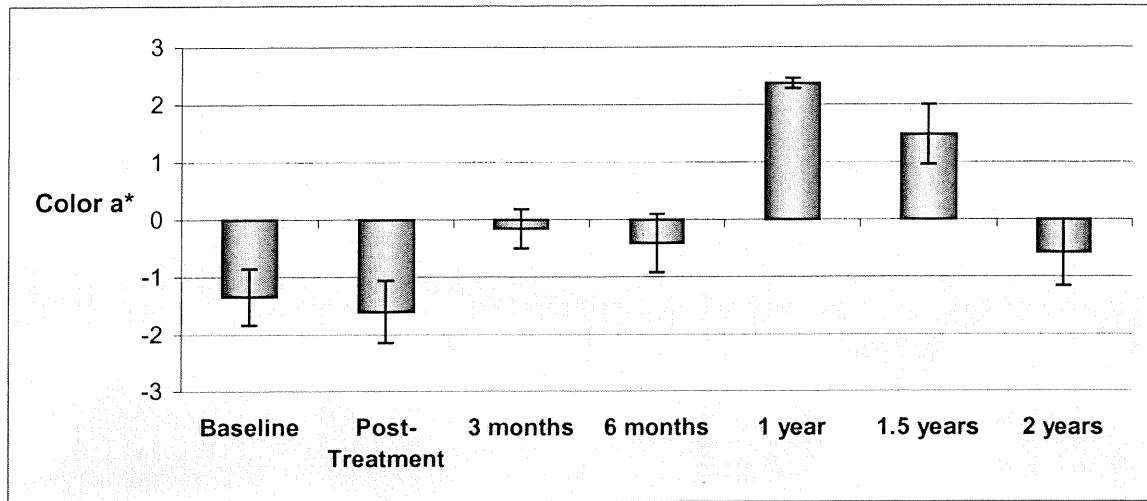
**Figure 2.** Color L\* values before and after treatment. Whiskers indicate standard error of the mean.

The whitening effect that was measured using the chromameter L\* parameter (lightness) increased by four units immediately after treatment, fell by one-half to two units by six months and remained approximately one unit higher throughout the observation period. The effect on the L\* parameter was not statistically significant by the end of the 2-year observation period ( $p=0.13$ , Table 12). The change in the L\* parameter is summarized in the following table.

**Table 5.** Color L\* all-visit Data

Visit	N	Mean	SEM	StDev
Baseline	20	50.15	0.70	3.15
Post-Treatment	20	54.13	0.81	3.63
3 months	20	52.03	0.74	3.29
6 months	19	51.94	0.75	3.28
1 year	18	51.04	0.78	3.33
1.5 years	19	51.16	0.76	3.30
2 years	17	51.26	0.74	3.04

**a\* values**

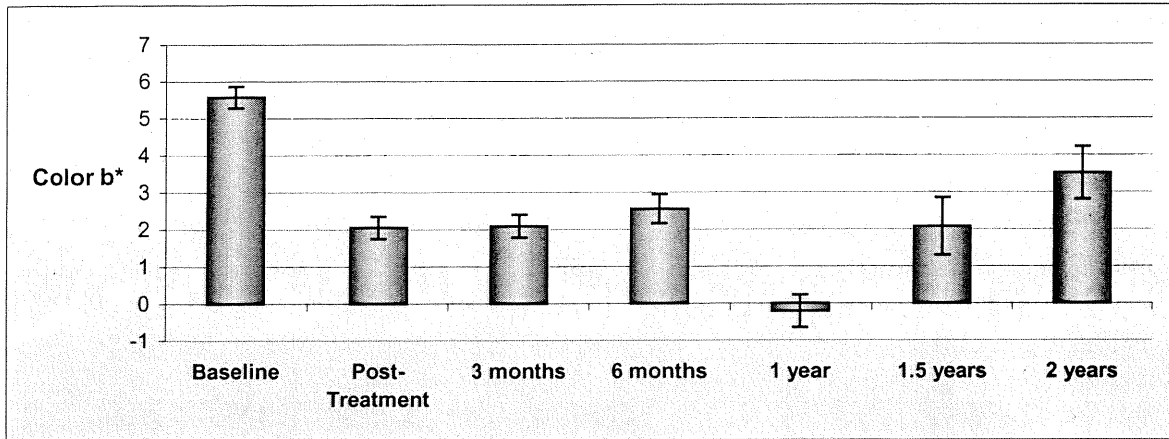


**Figure 3.** Color a\* values before and after treatment. Whiskers indicate standard error of the mean.

**Table 6.** Color a\* all-visit data.

Visit	N	Mean	SEM	StDev
Baseline	20	-1.34	0.49	2.19
Post-Treatment	20	-1.60	0.54	2.40
3 months	20	-0.16	0.34	1.51
6 months	19	-0.41	0.51	2.20
1 year	18	2.37	0.09	0.39
1.5 years	19	1.48	0.52	2.27
2 years	17	-0.58	0.58	2.40

**b\* values**



*Figure 4.* Color b\* values before and after treatment. Whiskers indicate standard error of the mean.

*Table 7.* Color b\* all-visit data.

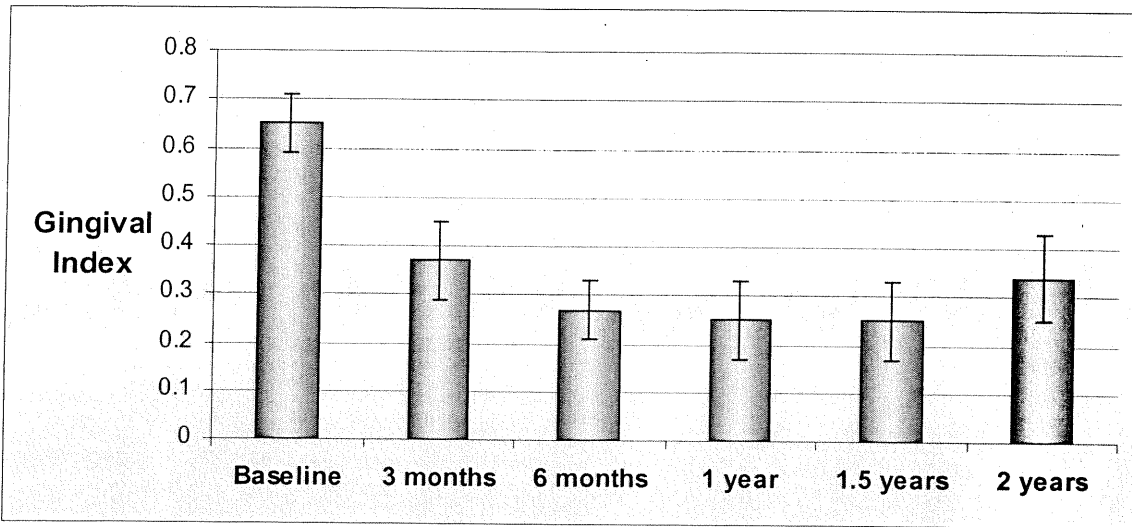
Visit	N	Mean	SEM	StDev
Baseline	20	5.57	0.29	1.30
Post-Treatment	20	2.05	0.30	1.32
3 months	20	2.09	0.31	1.38
6 months	19	2.55	0.39	1.68
1 year	18	-0.21	0.44	1.86
1.5 years	19	2.07	0.77	3.36
2 years	17	3.51	0.71	2.95

**Range of b\* change responses from baseline to 2-years.**

**Table 8.** Percentage of reduction in original Color b\* values visible at 2 years.

<b>Subject</b>	<b>Baseline</b>	<b>Post-Treatment</b>	<b>2 Years</b>	<b>Baseline to Post-Treatment Decrease</b>	<b>Post-Treatment to 2-Year Return</b>	<b>% of Effect Remaining At 2 Years</b>
253	4.4531	0.2872	7.9825	4.1658	7.6953	-84.72%
260	5.7619	1.1914	9.5639	4.5706	8.3725	-83.18%
211	4.0317	1.0269	5.3433	3.0047	4.3164	-43.65%
237	4.8817	1.4519	5.8764	3.4297	4.4245	-29.00%
19	7.3833	4.2042	6.6550	3.1792	2.4508	22.91%
3	6.8692	3.8000	5.4617	3.0692	1.6617	45.86%
55	5.5933	0.2875	2.9808	5.3058	2.6933	49.24%
71	4.7125	0.5650	2.5417	4.1475	1.9767	52.34%
52	4.4983	2.8075	3.5983	1.6908	0.7908	53.23%
32	4.4550	1.7283	2.0850	2.7267	0.3567	86.92%
68	7.1033	1.5258	1.3275	5.5775	-0.1983	103.56%
61	7.5000	2.8133	2.6350	4.6867	-0.1783	103.81%
16	6.8000	2.3825	1.6417	4.4175	-0.7408	116.77%
47	6.2308	3.6517	2.8692	2.5792	-0.7825	130.34%
37	4.6958	1.3567	-0.1125	3.3392	-1.4692	144.00%
14	5.8783	2.1567	-1.6875	3.7217	-3.8442	203.29%
4	7.4817	5.0983	0.8892	2.3833	-4.2092	276.61%
<b>Mean</b>				<b>3.6468</b>	<b>1.3715</b>	<b>67.55%</b>
<b>Median</b>						<b>53.23%</b>

## Gingival Index



**Figure 5.** Gingival Index before and after treatment. Whiskers indicate standard error of the mean.

Gingival index was immediately reduced by a single BriteSmile, *Inc.* treatment and remained lower than baseline throughout the monitoring period.

**Table 9.** Gingival Index values for all visits.

Visit	N	Mean	SEM	StDev
Baseline	19	0.65	0.06	0.26
3 months	19	0.37	0.08	0.34
6 months	19	0.27	0.06	0.26
1 year	17	0.25	0.08	0.31
1.5 years	18	0.25	0.08	0.32
2 years	19	0.34	0.09	0.37

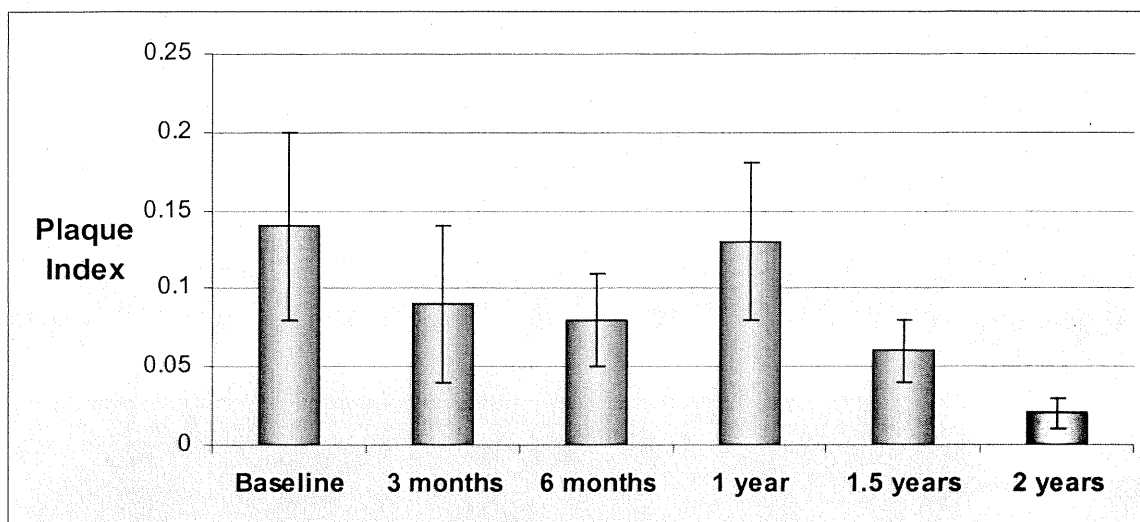
**Range of Gingival Index change responses from baseline to 2-years.**

*Table 10. Percentage reduction in Gingival Index from baseline to 2 years.*

<b>Subject</b>	<b>Baseline</b>	<b>2 Years</b>	<b>% Reduction</b>
87	0.3913	1.0833	-176.85%
30	0.1667	0.4583	-175.00%
237	0.3500	0.6500	-85.71%
260	0.6667	1.0417	-56.25%
253	0.7500	0.7500	0.00%
52	0.7917	0.7500	5.26%
60	0.6957	0.6364	8.52%
16	0.4583	0.2500	45.45%
55	0.8750	0.2500	71.43%
32	0.6667	0.1250	81.25%
4	0.8333	0.1250	85.00%
14	0.9583	0.0000	100.00%
19	0.7500	0.0000	100.00%
37	0.8750	0.0000	100.00%
47	0.6667	0.0000	100.00%
61	0.7727	0.0000	100.00%
68	0.9167	0.0000	100.00%
71	0.7500	0.0000	100.00%
3	0.0000	0.2917	
		<b>Mean</b>	<b>27.95%</b>
		<b>Median</b>	<b>76.34%</b>

As indicated, the Gingival Index increased in 4 patients and decreased in 14. The mean effect was a reduction of 27.95%.

### Plaque Index



**Figure 6.** Plaque Index before and after treatment. Whiskers indicate standard error of the mean.

The plaque index generally decreased throughout the observation period as indicated in Fig. 7 and Table 13.

**Table 11.** Plaque Index values for all visits.

Visit	N	Mean	SEM	StDev
Baseline	19	0.14	0.06	0.27
3 months	19	0.09	0.05	0.20
6 months	19	0.08	0.03	0.13
1 year	17	0.13	0.05	0.19
1.5 years	18	0.06	0.02	0.09
2 years	19	0.02	0.01	0.04

## STATISTICAL ANALYSIS OF CHANGES IN ALL OUTCOME VARIABLES

The difference between measurements at baseline and 2-years were evaluated using a paired t-test. The results of this testing procedure on each of the six parameters that were measured is summarized in the following table.

**Table 12.** Paired sample t-tests on baseline *versus* 2-year subject-visit averages for all data.

	Tooth Shade	Gingival Index	Plaque Index	Color		
				L*	a*	b*
N	20	19	19	17	17	17
Mean Baseline	10.65	0.65	0.14	50.52	-1.62	5.78
Mean 2-Year	5.00	0.34	0.02	51.26	-0.58	3.51
Mean Difference	5.65	0.31	0.12	-0.74	-1.04	2.28
95% CI	4.83	0.06	-0.01	-1.73	-3.15	0.55
	6.48	0.56	0.25	0.26	1.07	4.00
StDev Difference	1.77	0.52	0.28	1.94	4.10	3.36
t	14.3	2.6	1.9	-1.6	-1.1	2.8
df	19	18	18	16	16	16
Probability	<b>&lt;0.001</b>	<b>0.02</b>	0.07	0.1	0.3	<b>0.01</b>

## Discussion

### Shade Changes

Analysis of this whitening duration data set suggests that the maximum amount of regression occurs in the first three months after application. The amount of incremental regression is small thereafter and mean regression tends to slowly approach the original level (Fig. 1, Table 3). Despite the effect of shade regression, 68.41% of the original shade change was present after two years (Table 4).

It should be noted that the shade of patients # 47 and #4 increased over time (Table 4). A similar large change was also seen in the  $b^*$  (yellowness) parameter (Table 8) for the two patients and several others. Although we know that these subjects did not receive any further treatment from us over the 2-year period, it cannot be ruled out that they received it elsewhere and did not tell us. In addition several effective over-the-counter (OTC) whitening products (e.g., Crest White Strips) entered the market during the regression study observation period.

### Chromameter Changes

Changes in  $L^*$  (Figure 2, Table 5) and  $b^*$  (Figure 4 and Table 7) support the observation that the tooth whitening effect persists for two years. The lightness parameter ( $L^*$ ) increased by approximately 4 units immediately following treatment, maintained a 2 unit improvement through 6 months and fell to one unit from 1 to 2 years. The value of  $L^*$  at 2 years was still greater than at baseline but this difference was not statistically significant ( $p=0.1$ , Table 14). The yellowness parameter ( $b^*$ ) decreased by 3.5 units immediately following treatment and maintained that level of reduction through the 1.5 year observation period. At 2 years the  $b^*$  parameter appears to be increasing but is still significantly less than that at baseline ( $p=0.01$ , Table 14). As previously observed, the  $a^*$  parameter did not significantly change over the evaluation period.

### Gingival index

One of the most surprising findings of this study is that the reduction in gingival index that followed whitening application persisted throughout the 2-year monitoring period (Fig 6, Table 11). This finding has been observed repeatedly in three Forsyth whitening studies. We also are able to state that the reduction in Gingival Index that occurs following a BriteSmiles, *Inc.* treatment lasts for at least two years. This would suggest that a permanent microbiological change may occur in the mouths of those treated.

### Plaque index

At least part of the BriteSmiles, *Inc.* effect on Gingival Index may be explained by a reduction in Plaque Index (Figure 7, Table 13). By its nature, evaluation of Plaque Index tends to be variable. Here we observed a continual reduction in Plaque Index over the 2-year observation period. This more likely speaks to changes in home care than to a primary effect on bacterial growth by a single

BriteSmiles, *Inc.* treatment. Be that as it may, at the end of the 2-year observation period, the changes in Plaque Index values relative to baseline approached statistical significance ( $p=0.07$ , Table 14).

Section

**6**

## **Conclusions**

Clearly a single BriteSmiles, *Inc.* treatment can increase tooth whiteness and decrease gingival redness. Some of the therapeutic effect can remain up to two years after initial application.