Bleaching Efficacy of a Carbamide Peroxide and Lactoperoxidase Based Toothpaste

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Abstract

Aim: The aim of this clinical trial was to evaluate the effectiveness of a whitening tooth paste containing 3% of carbamide peroxide and lactoperoxydase.

Methods: Twenty-nine volunteers were included. They were instructed to brush their teeth using an enzymatic-activated dentifrice in particular procedure for three weeks. Color was recorded before and after the treatment using Vita Easy Shade spectrophotometer. L (tooth color lightness), a (the displacement along the red-green axis) and b (the displacement along the yellow-blue axis) differences were measured before and after treatment using the paired t and the Wilcoxon signed-rank tests. Color changes (ΔE) were calculated using these measurements.

Results: For the 29 subjects, ΔE was 5.38 ± 1.98 with significant tendency towards green. For the set of 348 teeth, a significant tendency towards green (lower a*) and blue (lower b*) was observed ($p < 0.05$). There were no significant differences in the lightness after treatment. When analyzing each tooth, final values of L*, a* and b* axis were significantly different from baseline values except the values of L*axis for the left maxillary central incisor and canine and right mandibular canine. The highest ΔE was for the left mandibular canine and the lowest was for the right maxillary central incisor.

Conclusions: Based on these results, it may be concluded that brushing with acarbamide peroxide and enzymatic based dentifrice is effective for whitening constitutional colorated teeth.

Keywords: Whitening Dentifrice; Carbamide Peroxide; CIELAB Parameters; Color; Spectrophotometer

Introduction

Discoloration of teeth can cause nowadays many social problems. Therefore, the popularity of tooth whitening has increased as they improve satisfaction with dental appearance.

There were many bleaching methods with different products, different procedures and different costs. The more effective and expensive treatment are in office bleaching and at-home use with customized tray. Unfortunately, many people had not sufficient financial capacity to follow this kind of treatment procedure. They tried resolving their dental problem with over the counter dentifrices. The last are the most accessible over-the-counter option to whiten mild discolorations.

Effectiveness of some whitening toothpastes is based on the capacity of abrasive agents to remove external stains. They can unfortunately roughen the external surface of enamel and are not able to change the color of teeth. Other whitening toothpastes contain peroxides. They can break down high molecular weight colored complex organic pigments of discolored teeth by releasing free radicals from the reaction of hydrogen or carbamide peroxides. Bleaching efficacy of these toothpastes is however questionable because of low concentration of peroxides and possible gingival side effects.

Aim of the Study

The aim of this study was to evaluate the bleaching efficacy of WhiteKintoothpaste+gel.

Methods

This was an open clinical trial conducted in the department of dental medicine of Fattouma Bourguiba University Hospital, Monastir, Tunisia. Subjects were recruited by convenience sampling from acquaintances of people involved in the study and via flyers. They were aged over than 18 years and were examined and selected according the following criteria (Table 1).

Inclusion criteria	Non inclusion criteria
- Vital teeth - Presence of the 12 front teeth - B2 or darker color according to the shade guide rankings of the Vita Classical guide - Plaque index (Silness and Loë) < 1 - Gingival index (Silness et Loë) < 1	- Tooth decay - Periodontal disease - Non-adapted prosthetic restoration - Resin composite restoration in the 12 front teeth. - Enamel hypoplasia, racks or fractures - Systemic illness - Previous bleaching with dentifrice (<6 months ago) or in office/at home bleaching (< 2 years ago) - Pregnant or nursing mother. - Allergy - Hypersensibility - Fluorosis and tetracycline discoloration - Smokers - Alcohol drinkers.

Table 1: *FInclusion and non-inclusion criteria.*

After explaining the study characteristics, subjects enrolled were asked to sign an informed consent form before being included in the study and underwent scaling before the treatment phase began if necessary.

Bleaching procedure

Patients were instructed to brush their teeth initially with their own dentifrice and toothbrush in standardized oral hygiene procedures than with the provided dentifrice (WhiteKin Bleaching Toothpaste+Gel; Kin Laboratory, Barcelona, Spain) and toothbrush in particular procedure for 3 week (toothbrush was applied on the surface of tooth with a circular movement). They also asked to avoid food and drink with coloring effects such as tea, coffee, red wine, red fruits, tomato sauce especially 30 min after brushing.

WhiteKinToothpaste+Gel (Laboratorios Kin, Barcelona, Spain) is a 2 joined tubes. One tube contains gel based on 3% carbamideperoxide+xylitol+sodium fluoride. The second one contains gel based on 5% lactoperoxydase. The content of both tubes is mixed in equal part on the toothbrush.

Tooth colors of the 12 front teeth were assessed by Vita Easy Shade spectrophotometer Advensed 4.0 at baseline and weekly using three assessment points. The reflectance spectrophotometer Vita Easy shade Advance 4.0, used in this study is programmed to record the color of dentin and deep layers of enamel, ignoring the reflection and the surface irregularities of the enamel. For matching color always at the same coronal third area of the tooth, the tip of device was surrounded by rings having 1 or 2 mm Thickness depending of the coronal height (Figure 1).

Three measures at least per tooth and per appointment were noted and repeated values were registered.
(Figure 1)

Figure 1: Tip of spectrophotometer surrounded by a ring of 1 mm of Thickness.

Color measurements

Color measurements L*, a* and b* were provided by the apparatus (Figure 2): "L" represents tooth color lightness, "a" the displacement along the red-green axis; and "b" the displacement along the yellow-blue axis according to the CIE Lab model (Figure 3). The color evaluation was performed using theses equations (1):

ΔL^* = L*final value – L*baseline value

Δa^* = a*final value – a*baseline value

Δb^* = b*final value – b*baseline value.

$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

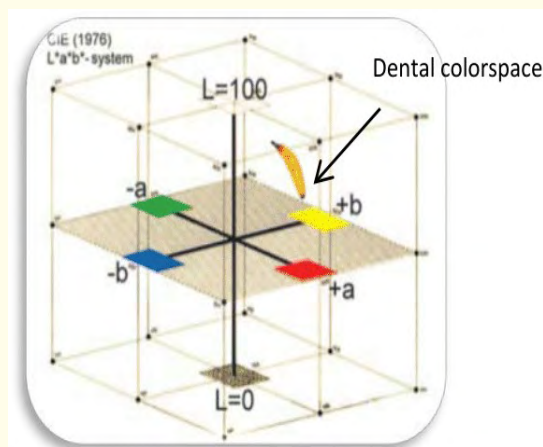*Figure 2: Screen of spectrophotometer.*

Figure 3: Munsil model.

Statistical analysis

The Kolmogrov Smirnov test was used to determine if the variables distributions were normal. Results were expressed as mean ± standard-deviation (SD) or median [First quartile Q1-Third quartile Q3]. Paired t-test or Wilcoxon test were used to compare quantitative data. All mathematical computations and statistical procedures were performed using SPSS Statistics Software (Social Package Statistical Sciences version 21.0). Significance was set at the 0.05 level.

Results

Twenty nine subjects were included in this study. Among the participants, 21 (72.4%) were female and 8 (27.6%) were male. The age range was from 17 to 65 years with the mean age ± SD = 31 ± 11.6 years.

No significant difference in tooth color between ♂ and ♀ was observed before toothpaste application (Table 2).

Mean iL* for ♂ ± SD	74.95 ± 4.68	P > 0.05
Mean iL* for ♀ ± SD	76.67 ± 7.09	
Mean ia* for ♂ ± SD	1.17 ± 0.66	P > 0.05
Mean ia* for ♀ ± SD	0.74 ± 1.19	
Mean ib* for ♂ ± SD	22.57 ± 4.47	P > 0.05
Mean ib* for ♀ ± SD	24.65 ± 4.62	

Table 2: *Difference of color between male and female.*

The mean value ± SD of ΔE was 5.38 ± 1.98 for the whole sample without correlation between age and ΔE (r = 0.13 with p = 0.5). Difference in color change was significant for a* axis (p < 0.05). However, no changes were observed for b* and L* axis according to Munsill color system (Table 3). The mean value ± SD of ΔE was 5.37 ± 1.63 when analyzing all the teeth (n = 348). There was significant displacement towards green (Δa) and towards blue (Δb)but no significant difference for L (Table 4).

N = 29	Mean ± SD	p
IL	80.82 ± 4.54	0.68
FL	80.51 ± 3.74	
ΔL	-0.3 ± 3.93	-
Ia	-0.17 ± 0.62	0.029*
Fa	-0.33 ± 0.44	
Δa	-0.16 ± 0.38	-
Ib	19.98 ± 3.34	0.34
Fb	19.62 ± 2.47	
Δb	-0.35 ± 1.98	-
ΔE	5.38 ± 1.98	-

Table 3: *L, a and b means and standard deviations for the whole sample.*
*p < 0.05: t-paired test

N = 348		Mean ± SD	p
	IL	80.82 ± 6.22	0.3
	FL	80.51 ± 5.22	
	ΔL	0.30 ± 5.47	-
	Ia	-0.17 ± 1.21	<0.01†
	Fa	-0.5[-1.1,0.3]	
	Δa	0.16 ± 0.79	-
	Ib	19.98 ± 6.18	0.04*
	Fb	19.62 ± 5.68	
	Δb	0.85 ± 0.17	-
	ΔE	5.37 ± 1.63	-

Table 4: *L, a and b means and standard deviations for the whole teeth.*
*p < 0.05: t-paired test; †p < 0.05: Wilcoxon test

The main results of the present study were (Table 5):

N= 348		Mean ± SD	p	N= 348	Mean ± SD	p
Right maxillary canine	IL	76.2 ± 6.48	0.02*	Left maxillary canine	78.1 ± 5.37	0.06
	FL	76.31 ± 4.07			77.03 ± 4.79	
	ΔL	0,11 ± 4.10	-		-1.06 ± 4.82	-
	Ia	0.86 ± 1.08	< 0.01*		0.67 ± 0.90	< 0.01*
	Fa	0.93 ± 1.01			0.77 ± 0.82	
	Δa	0.06 ± 0.49	-		0.10 ± 0.36	-
	Ib	25.46 ± 4.69	< 0.01*		25.94 ± 3.88	< 0.01*
	Fb	26.01 ± 3.3			26.17 ± 2.91	
	Δb	0.55 ± 2.26	-		0.22 ± 2	-
	ΔE	5.27 ± 3.10	-		5.36 ± 2.68	-
Right mandibular canine	IL	80.4 ± 4.79	0.05	Left mandibular canine	79.82 ± 4.5	0.015*
	FL	80.17 ± 4.86			80.1 ± 5.37	
	ΔL	-0.22 ± 4.33	-		0.27 ± 4.79	-
	Ia	0.44 ± 1	< 0.01*		0.16 ± 1.18	< 0.01*
	Fa	0.18 ± 0.86			0.24 ± 0.96	
	Δa	-0.26 ± 0.56	-		0.072 ± 0.49	-
	Ib	25.84 ± 4.29	< 0.01*		25.44 ± 6.1	< 0.01*
	Fb	24.8 ± 4.12			24.8 ± 4.12	
	Δb	-1.04 ± 2.62	-		-0.1 ± 3.31	-
	ΔE	5.46 ± 2.26	-		6.45 ± 3.67	-
Right maxillary lateral incisor	IL	80.41 ± 6.23	0.01*	Left maxillary lateral incisor	80.6 ± 5.22	0.04*
	FL	79.87 ± 5.13			79.73 ± 4.33	
	ΔL	-0.53 ± 5	-		-0.86 ± 4.09	-
	Ia	-0.67 ± 0.87	0.01*		-0.84 ± 0.67	< 0.01*
	Fa	-0.76 ± 0.5			-0.77 ± 0.58	
	Δa	-0.09 ± 0.53	-		0.07 ± 0.39	-
	Ib	18.51 ± 5.15	< 0.01*		17.99 ± 4.07	< 0.01*
	Fb	13.64 ± 3.88			18.32 ± 3.19	
	Δb	0.12 ± 2.36	-		0.33 ± 3.24	-
	ΔE	6.14 ± 3.17	-		4.89 ± 4.03	-

Right mandibular lateral incisor	IL	81.71 ± 6.65	< 0.01*	Left mandibular lateral incisor	82.4 ± 4.91	0.01*
	FL	82.25 ± 4.75			82.69 ± 4.70	
	ΔL	0.53 ± 4.07	-		0.29 ± 4.15	-
	Ia	0.11 ± 1.19	< 0.01*		-0.25 ± 0.96	0.01*
	Fa	-0.51 ± 0.68			-0.53 ± 0.5	
	Δa	-0.62 ± 0.65	-		-0.27 ± 0.62	-
	Ib	19.78 ± 4.37	<0.01*		18.2 ± 4.69	< 0.01*
	Fb	17.92 ± 3.54			18.22 ± 2.87	
	Δb	-1.85 ± 2	-		0.01 ± 2.17	-
	ΔE	5.34 ± 2.60	-		5.26 ± 2.37	-
Right maxillary central incisor	IL	81.67 ± 7.14	< 0.01*	Left maxillary central incisor	82.75 ± 6.97	0.13
	FL	80.86 ± 5.07			80.8 ± 5.09	
	ΔL	-0.81 ± 3.52	-		-1.94 ± 4.47	-
	Ia	-0.98 ± 1.18	0.01*		-1.31 ± 0.68	0.23
	Fa	-1.19 ± 0.68			-1.27 ± 0.71	
	Δa	-0.21 ± 0.52	-		0.03 ± 0.47	-
	Ib	15.6 ± 3.93	< 0.01*		14.79 ± 4	< 0.01*
	Fb	14.34 ± 4.13			14.41 ± 3.17	
	Δb	-1.25 ± 2.26	-		-0.38 ± 2.27	-
	ΔE	4.73 ± 2.81	-		5.71 ± 3.58	-
Right mandibular central incisor	IL	82.83 ± 6.4	< 0.01*	Left mandibular central incisor	82.9 ± 6.56	< 0.01*
	FL	83.1 ± 5.23			83.22 ± 4.68	
	ΔL	0.26 ± 3.91	-		0.31 ± 4.18	-
	Ia	-0.4 ± [-0.95,0.45]	0.02*		-0.22 ± 0.99	< 0.01*
	Fa	-0.7 ± [-1.25,-0.25]			-0.63 ± 0.63	
	Δa	-0.43 ± 0.66	-		-0.41 ± 0.52	-
	Ib	16.41 ± 5.02	< 0.01*		15.82 ± 4.13	< 0.01*
	Fb	15.88 ± 4.38			15.43 ± 3.7	
	Δb	-0.52 ± 1.88	-		-0.38 ± 1.89	-
	ΔE	4.83 ± 1.86	-		5.04 ± 2.51	-

Table 5: *L, a and b means and standard deviations for each tooth.*
*p < 0.05: t-paired test

- Mandibular teeth were brighter in comparison to the maxillary one;

- There were tendency to green and blue for maxillary teeth more than mandibular teeth;

- Maxillary central incisors showed significantly greater L* and a greater tendency towards green (lower a*) and blue (lower b*) than the maxillary lateral and canine. The same occurred in mandibular teeth;

- Left teeth were more bright, bluish and greenish than the one right;

- Lightness increased significantly for all teeth (P < 0.05), except the left maxillary canine, left maxillary central incisor and right mandibular canine;

- There were significant tendency towards green and blue for all the teeth except tendency towards green for the left maxillary central incisor

- The highest ΔE was for the left mandibular canine and the lowest was for the right maxillary central incisor.

Discussion

Nowadays, many people are large consumers of bleaching products. Toothpaste application is among many kind of over the counter products proposed by industry to satisfy whitening tooth trend.

In our study, we tested WhiteKinToothpaste+Gel. It is a bleaching dentifrice which must applied at least during 3 weeks. Its bleaching effect is due to the action of free radical oxygen species produced by carbamide peroxide.

In fact, these compounds pass through the pores in the enamel and dentine. They break down the high molecular weight colored complex organic molecules [1,2]. The smaller molecules so produced reflect less light from the tooth tissue with the result that the tooth tissue appears lighter in color.

WhiteKinToothpaste+Gelcontains 3% of carbamide peroxide. It's a low concentration producing a low quantity of free radical oxygen species; hence its bleaching efficacy was discussed.

This clinical trial aimed to measure tooth shade change after toothpaste application by calculating ΔE from determining the CIELAB parameters. Itis an objective way of quantifying color change. It was calculated from L*, a* and b* values given by the Vita Easy shade Advance spectrophotometer. This device is programmed to register the color of dentin and deep layers of enamel, ignoring the reflection and the surface irregularities of the enamel.

In our study and according to the National Bureau of Standards (NBS) [3] system of expressing color differences, appreciable and remarkable shade change was clinically observed (ΔE ranged from 4.73 to 6.45). When comparing ΔE, bleaching efficacy of whitekintoothpaste+gel was in the same range with that of Leopaldo Forner and Carmen Llena studies.

Color change in our study was due to the more tendency towards blue and green (reducing the yellow and red appearance of teeth) and not to the increase of lightness. Our results were different from those of Leopaldo Forner [4] who found that color was changed mainly through increased lightness. Carmen Llena [5] found also that color was changed through increased lightness and through decreased values of b* axis reducing the yellow appearance of teeth.

Different reasons of color change between studies could be due to different initial values of L*, a* and b* in each sample. Bleaching efficacy was more remarkable for dark, yellowish and reddish teeth. For our sample, left maxillary central incisor had the lowest initial value in a* axis (-1.31), so bleaching efficacy was the lowest with ΔE=4.73.

Teeth with a low initial value in a*, b* axis looked initially like bleached teeth and were less bleached than Teeth with a high initial value in a*, b* axis.

To allow more shade change, time of application could last longer. However, Carmen Llena [4] didn't find significant difference in color change between control group, 3 weeks and 12 weeks of application.

To minimize the margin error of the spectrophotometer, we registered recurring values for each tooth when checking color parameters. However, some inaccurate measures could have been noted especially when flat surface of the Vita tip didn't conform to the convex surface of the teeth.

Results could also be influenced by the renewed interest in tooth brushing (with a more frequently and appropriate daily application) and by the improved behavior of participants who were aware of being observed ('Hawthorn effect') [6].

This study has some methodological limitations such as the non-inclusion of controls and the relatively small sample size (29 participants). Future research with a larger sample size aiming to compare the bleaching effect of this enzymatic activated dentifrice to a non-whitening one is welcome.

Conclusion

For discolorations due to age ethnic and some food or drinks, whitekintoothpaste+gel could lead to appreciable or remarkable tooth bleaching despite the low concentration of carbamide peroxide. Further studies with higher level of evidence, especially long term controlled trials, will be needed to corroborate our findings.

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