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EFFECT OF BLEACHOREXIA ON TEETH SHADE

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ABSTRACT

Introduction: Over-the-counter bleaching agents are considered popular cosmetic procedures that can improve the appearance of teeth. However, some individuals became obsessed by their appearance allowing high unrealistic expectations thus leading to abuse of these whitening products.

Aim: To compare the tooth shade after the proper use versus the abuse of over the counter bleaching agent.

Materials and Methods: All labial surfaces of 30 sound human maxillary incisors were protected with varnish except a window with dimensions (3mm x 3mm). Group I: Deluxe whitening kit was applied 1 hour once daily for 14 days. Group II: The kit was applied for 2 hours daily for 7 successive days (14 cycles). Group III: Bleaching for an hour twice daily for 3 days and 1 hour in the fourth day (7 cycles), then all procedures were repeated for more 7 cycles.

Results: All data was collected and statistically analyzed. By the end of bleaching cycles in both groups I & II, 50% of cases reached A1, 40% reached A2 and only 10% recorded A3. While, in group III, after the 2nd remineralizing cycle, 60% of cases recorded A2 and 40% were found with A3 values. Comparing the three groups together at each cycle, significant difference was recorded between all tested groups beginning of the 9th cycle with p value 0.047 till the end of bleaching and remineralzation cycles.

Conclusion: Proper use of bleaching agent following the manufacturer's instructions showed reliable shade improvement even if reducing the time than that proposed by the manufacturer.

KEYWORDS: Over-the-counter bleaching agent, Bleachorexia, Teeth shade.

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INTRODUCTION

The call for aesthetics has increased dramatically, since patient's demands and improvement of devices and/or materials technologies caused the advancement in the aesthetics market worldwide.[1]

Bleaching has become a popular procedure for patients with increased self-awareness of dental esthetics and for whom are seeking improvements in the perceived appearance of their teeth. In addition, it is considered one of the most conservative procedures to improve the color appearance of the teeth, because it is simple to execute, safe and effective.[2]

By definition, it is a chemical process by which oxidative decomposition of bleaching agents acts to remove external stains from the tooth structure so that a tooth becomes lighter. [1]

The success of bleaching procedures depends mainly on the identification of the color alteration origin, which is usually classified as extrinsic or intrinsic. Once the stain etiology is identified, dentists shall propose an individualized treatment to each patient considering their wishes, expectations, dental condition, and oral health.[3]

Usually, tooth bleaching is carried out in the office with more concentrated gels and reduced application time (in-office technique), or at home, under the dentist's supervision, with less concentrated gels and longer application time (at-home technique).[4-6]

Moreover, there is a niche in the oral care market comprising toothpastes, rinses, paint-on varnishes, gels, strips and flosses with bleaching or whitening properties, known as over-the-counter (OTC) products. [4] These products are highly available and are presented as an attractive alternative to improve the smile.[7,8]

In addition, such products are readily available online, in supermarkets, shopping mall and pharmacies away from professional supervision, beyond registered dental clinics. They come in other forms as tray-based tooth whiteners with many such products having no scientific studies to support them and falling into a grey zone within no regulations. [9]

Low cost, easy access, and on-demand treatments are perceived by the patients as the greatest benefits. Therefore, many individuals engage in improving their appearance through self-diagnosis and "whiten" their teeth with such OTC products. [10]

But these alternatives provide opportunities for over-using such bleaching products since the treatment is not supervised by the dentist leading to a major side effect of bleaching teeth which is the potential to develop an addiction to the bleach.[11]

People who misuse and abuse these bleaching products are in a condition called "bleachorexia" or "whitening junky" [10]. Therefore, bleachorexics are those who are convinced that their teeth aren't white enough.

Those patients may abuse these agents without respecting the manufacturer's instructions hoping to achieve more whitening results or to obtain the final results in a time lesser than that proposed by the manufacturer.

Therefore, over bleaching can be done by either using too much gel, leaving the product on the teeth for too long or using the product for too often.[12]

Dentists should inform patients with bleachorexia that long-term bleaching procedure has multiple oral health risks. Even if, these products provided an improvement in tooth shade. For longer term counseling, they should help the patient set more realistic expectations about tooth bleaching products. [10]

Therefore, the hypothesis of this research was to compare tooth shade after the proper use following the manufacturer's instructions versus the abuse of over the counter bleaching agent either by exposing the teeth to these products for longer periods or more frequently.

AIM OF THE WORK

The aim of the present study was to:

Compare the tooth shade after the proper use versus the abuse of over the counter bleaching agent.

MATERIALS

All materials used in the present study are tabulated in Table (1) involving the manufacturer, composition and website of each.

TABLE (1)

Material	Manufacturer	Composition	Website
Deluxe home whitening kit: 10mL 36% carbamide peroxide teeth whitening gel 3mL remineralizing gel (USA orders only) Boil-n-bite custom-fit mouth trays Blue LED accelerator light Tray storage case Plush blue zipper traveling case.	Beaming white: Beaming white LLC 1205 NE 95TH ST STE A Vancouver, WA 98665-8960 USA.	**Whitening gel:** Propylene Glycol, Glycerin, Hydrogen peroxide, Urea Peroxide, Carbomer, Triethanolamine, Flavor, Menthol, Disodium Edta. **Remineralizing gel:** **Active ingredient:** Sodium Fluoride 15% **Other ingredients:** Glycerin, Aqua, Potassium Nitrate, Carbomer, Sodium hydroxide, Tricalcium phosphate, Sodium Fluoride, Sodium Saccharin, Sodium Benzoate, Flavor.	www.beamingwhite.com
Artificial saliva **pH (7.0)**	Custom made in Faculty of Pharmacy Alexandria University.	1.5 mM Ca(NO3)2.4H2O, 0.9mM NaHPO4.2 H2O, 0.15M KCl,0.02 M TRIS and PPM F.	

METHODS:

Ethical issue: Research protocol had been approved by the ethics committee of the Faculty of Dentistry, Tanta University, Egypt (#R- RD-9-23-3063) following the guidelines of the institutional Review Boards (IRB). All patients signed an informed consent sheet upon participation of their extracted maxillary incisor teeth in this study.

Trial design: A randomized, controlled, statistication with 3 parallel groups. Randomization with a 1:1:1 allocation ratio was performed. Throughout this trial, Consolidated Standards of Reporting Trials (CONSORT) guidelines were performed.

Teeth collection: Thirty sound human periodontally involved maxillary incisors teeth (n=30) with enamel's shade ranging from A3 to A3.5 free from any enamel defects were extracted for orthodontic treatment at Oral Surgery Department in Faculty of Dentistry, Tanta University and collected from patients aged (35-40) then stored in artificial saliva until the time of the test to prevent their dehydration.

Sample size calculation: Sample size was estimated assuming 5% alpha and 80% study power. The minimum sample size was calculated for detecting a moderate effect size. The total sample size required = number of groups x number per group = 10 x 3 = 30.

The sample size for this study was calculated according to Arkin, 1984 using the following equation: N = (Za)2× (SD)2 (d)2 N = Total sample size Zα = Is standard normal variate and its equal 5.23 at P < 0.05 SD = Standard deviation of variable d = Absolute error or precision

The criteria used for sample size calculation were as follows: 95% confidence limit 86% power of the study.

Sample Preparation:

The coronal portion of each tooth was separated by using a cylindrical diamond disc at a high speed with an adequate coolant system.

The center of the middle-third of the labial surface of all samples was covered with an adhesive tape by having good adhesive property with dimensions 3mm x 3mm which was measured by a caliber. The enamel of all labial surfaces was protected with a transparent acid resistant nail varnish except the area covered with the adhesive tape which was removed later creating a window of labial enamel with dimensions (3mm x 3mm).

Grouping:

The prepared samples were randomly divided into three equal groups (I, II and III). Each group had ten samples (n=10). Then the jars took the code of the group number beside the tooth number.

All jars contain artificial saliva for keeping samples hydrated. The jars were kept in an incubator at 37^{o}c all over the period of research. The saliva was changed daily to prevent contamination and bacterial accumulation.

Group I:

The samples were subjected to bleaching by applying a small bead of bleaching gel (less than 0.5 mL) included in Deluxe home whitening kit on the labial enamel window sixty minutes once a day for fourteen days (fourteen cycles) according to the manufacturer's instructions. After each bleaching cycle, each sample was rinsed by distilled water then dried by chip syringe followed by shade detection using Vita Easy Shade V. All samples were stored in artificial saliva between bleaching cycles.

Then, samples were subjected to the remineralizing gel included within the Deluxe home whitening kit on the same labial enamel window by placing enough remineralizing gel for 10 minutes according to the manufacturer's instructions without mouth rinsing. Then, shade was detected.

Group II:

The same procedures previously performed in group I were followed except for the bleaching regimen which was done according to a proposed patient's abuse of sixty minutes twice a day (twelve hours' interval) for seven days (fourteen cycles) to minimize the time proposed by the manufacturer. Then, samples were subjected to remineralization followed by shade detection.

Group III:

The samples were subjected to bleaching by applying the same bleaching agent on the labial enamel window according to a proposed patient's abuse. Bleaching was performed for sixty minutes twice daily (twelve hours' interval) for seven cycles followed by shade detection. Then, the remineralizing agent was applied. Shade measurements were revaluated as done previously in group I. All of these procedures were repeated again for another seven cycles. Then, samples were subjected to remineralization followed by shade detection.

All data was collected and analyzed using descriptive statistics and Chi square test to compare shade percentage after all cycles in the three tested groups. Whenever a significance difference was detected, the Wilcoxon test comparison was performed to detect the difference between baseline versus each bleaching cycle in the three tested groups. One-way analysis of variance (ANOVA) was used comparing means of the three tested groups together at each cycle. Post Hoc test was used for multiple comparisons

RESULTS

All data of each group was subjected to statistical analysis using descriptive statistics to describe the data using frequency and percentage also chi square test is used to show the independence between durations and score at each tested group individually. Table 2 revealed data of group I that was analyzed comparing different periods to record a highly statistical significant difference (p-0.000). This difference was recorded at day 6 where 30% of the cases recorded A2. This difference became even more obvious and significant at day 8 where 60% of the cases recorded A2 and 30% recorded A3. In day 13 the difference was more significant showing 40% of cases A1 and 50% of cases with shade A2. At day 14 by the end of bleaching cycles 50% of cases reached A1and 40% reached A2 and only 10% recorded A3. These values remained the same after remineralization.

Regarding group II, as shown in table 3, all 14 bleaching cycles were performed in 7 days. A highly statistical significant difference was found between the performed cycles with p value of 0.000. This difference in the shade was observed at the third day in the 5th bleaching cycle where 30% of cases recorded shade A2. Both cycles of the 4th day recorded 50% of the cases with shade A2 and 40% with A3. In the 5th day the significant difference was observed at 9th cycle 70% of the cases recorded A2. In the last day 50% of the cases recorded A1, 40% recorded A2 and only 10% recorded A3. These were the same results obtained for group I after 14 days. Again these results were stable after remineralization.

Concerning group III, as presented in table 4, 14 cycles were performed with a remineralizing cycle for 10 minutes after the first 7 bleaching cycles and another one by the end of the bleaching cycles. A significant difference was recorded with p value of 0.000. This significant difference was observed after the first 7 cycles where none of the cases recorded A4 and 20% were found to have A2 while 80% were observed with A3. These values were stable after 1st remineralizing cycle. The values were different after 10th bleaching cycle where 30% of the cases recorded A2. By the end of bleaching cycles none of the cases recorded A1, while 50% recorded A2 and 50% were observed with A3. After the 2nd remineralizing cycle 60% of cases recorded A2 and 40% were found with A3 values. These values were inferior to both groups I and II.

Comparing the bleaching cycles together as shown in table 5, group I revealed a statistical significant difference at the 8th day where there was a significant difference recorded with p value 0.041 between 1st day versus 8th day.

Concerning table 6 showing comparisons of the shade values between different bleaching and/or remineralizing cycles of group II, the significant difference was obvious beginning from the 9th cycle versus the 1st bleaching cycle with p value 0.014.

Regarding data showing the shade values of group III, Comparisons of the values between different bleaching and/or remineralizing cycles were recorded as presented in table 7. The significant difference was found between 1st cycle versus 7th cycle with p value of 0.042 demonstrating that the shade difference was observed at the 4th day.

TABLE (2) Descriptive statistics to describe the data using frequency and percentage in group I.

Procedure	Group I shade					
	A1	A2	A3	A4	Total	Chi-Square test
	N(%)	N(%)	N(%)	N(%)	N(%)	(p-value)
Baseline	0(0%)	0(0%)	16(53.3%)	14(46.7%)	30(100%)	
1-bleaching cycle per hour	0(0%)	0(0%)	5(50%)	5(50%)	10(100%)	
2- bleaching cycle per hour	0(0%)	0(0%)	5(50%)	5(50%)	10(100%)	
3- bleaching cycle per hour	0(0%)	0(0%)	5(50%)	5(50%)	10(100%)	
4- bleaching cycle per hour	0(0%)	1(10%)	4(40%)	5(50%)	10(100%)	
5- bleaching cycle per hour	0(0%)	1(10%)	6(60%)	3(30%)	10(100%)	
6- bleaching cycle per hour	0(0%)	3(30%)	4(40%)	3(30%)	10(100%)	
7- bleaching cycle per hour	0(0%)	3(30%)	6(60%)	1(10%)	10(100%)	139.146
8- bleaching cycle per hour	0(0%)	6(60%)	3(30%)	1(10%)	10(100%)	(0.000**)
9- bleaching cycle per hour	1(10%5)	5(50%)	4(40%)	0(0%)	10(100%)	
10- bleaching cycle per hour	1(10%)	6(60%)	3(30%)	0(0%)	10(100%)	
11- bleaching cycle per hour	1(10%)	6(60%)	3(30%)	0(0%)	10(100%)	
12- bleaching cycle per hour	2(20%)	6(60%)	2(20%)	0(0%)	10(100%)	
13- bleaching cycle per hour	4(40%)	5(50%)	1(10%)	0(0%)	10(100%)	
14- bleaching cycle per hour	5(50%)	4(40%)	1(10%)	0(0%)	10(100%)	
Remineralization 10 min	5(50%)	4(40%)	1(10%)	0(0%)	10(100%)	

TABLE (3) Descriptive statistics to describe the data using frequency and percentage in group II.

Procedure	Group II shade					
	A1	A2	A3	A4	Total	Chi-Square test
	N(%)	N(%)	N(%)	N(%)	N(%)	(p-value)
Baseline	0(0%)	0(0%)	16(53.3%)	14(46.7%)	30(100%)	
1 day-bleaching cycle per hour	0(0%)	0(0%)	6(60%)	4(40%)	10(100%)	
bleaching cycle per hour	0(0%)	0(0%)	6(60%)	4(40%)	10(100%)	
2 day - bleaching cycle per hour	0(0%)	0(0%)	6(60%)	4(40%)	10(100%)	
- bleaching cycle per hour	0(0%)	1(10%)	5(50%)	4(40%)	10(100%)	
3 day - bleaching cycle per hour	0(0%)	3(30%)	4(40%)	3(30%)	10(100%)	
- bleaching cycle per hour	0(0%)	3(30%)	4(40%)	3(30%)	10(100%)	
4 day - bleaching cycle per hour	0(0%)	5(50%)	4(40%)	1(10%)	10(100%)	142.563
- bleaching cycle per hour	0(0%)	5(50%)	4(40%)	1(10%)	10(100%)	(0.000**)
5 day - bleaching cycle per hour	0(0%)	7(70%)	3(30%)	0(0%)	10(100%)	
- bleaching cycle per hour	1(10%)	7(70%)	2(20%)	0(0%)	10(100%)	
6 day - bleaching cycle per hour	2(20%)	6(60%)	2(20%)	0(0%)	10(100%)	
- bleaching cycle per hour	2(20%)	6(60%)	2(20%)	0(0%)	10(100%)	
7 day - bleaching cycle per hour	5(50%)	4(40%)	1(10%)	0(0%)	10(100%)	
- bleaching cycle per hour	5(50%)	4(40%)	1(10%)	0(0%)	10(100%)	
Remineralization 10 min	5(50%)	4(40%)	1(10%)	0(0%)	10(100%)	

TABLE (4) Descriptive statistics to describe the data using frequency and percentage in group III.

Procedure	Group III shade				
	A1	A2	A3	A4	Total
	N(%)	N(%)	N(%)	N(%)	N(%)
Baseline	0(0%)	0(0%)	16(53.3%)	14(46.7%)	30(100%)
1 day-bleaching cycle per hour	0(0%)	0(0%)	4(40%)	6(60%)	10(100%)
bleaching cycle per hour	0(0%)	0(0%)	4(40%)	6(60%)	10(100%)
2 day - bleaching cycle per hour	0(0%)	0(0%)	4(40%)	6(60%)	10(100%)
- bleaching cycle per hour	0(0%)	0(0%)	4(40%)	6(60%)	10(100%)
3 day - bleaching cycle per hour	0(0%)	1(10%)	6(60%)	3(30%)	10(100%)
- bleaching cycle per hour	0(0%)	1(10%)	6(60%)	3(30%)	10(100%)
4 day - bleaching cycle per hour	0(0%)	2(20%)	8(80%)	0(0%)	10(100%)
Remineralization 10 min	0(0%)	2(20%)	8(80%)	0(0%)	10(100%)
5 day - bleaching cycle per hour	0(0%)	2(20%)	8(80%)	0(0%)	10(100%)
-bleaching cycle per hour	0(0%)	2(20%)	8(80%)	0(0%)	10(100%)
6 day - bleaching cycle per hour	0(0%)	2(20%)	8(80%)	0(0%)	10(100%)
- bleaching cycle per hour	0(0%)	3(30%)	7(70%)	0(0%)	10(100%)
7 day - bleaching cycle per hour	0(0%)	3(30%)	7(70%)	0(0%)	10(100%)
- bleaching cycle per hour	0(0%)	3(30%)	7(70%)	0(0%)	10(100%)
8-day bleaching cycle per hour	0(0%)	5(50%)	5(50%)	0(0%)	10(100%)
Remineralization 10 min	0(0%)	6(60%)	4(40%)	0(0%)	10(100%)

TABLE (5) Wilcoxon test comparing the bleaching cycles together in group I.

Group I shade			
Durations	**p-value**	**Durations**	**p-value**
Baseline vs. 1 hour	1.000	**1** hour vs. **2** hours	1.000
Baseline vs. 2hour	1.000	**1** hour vs. **3** hours	1.000
Baseline vs. 3hour	1.000	**1** hour vs. **4** hours	1.000
Baseline vs. 4hour	1.000	**1** hour vs. **5** hours	1.000
Baseline vs. 5hour	0.999	**1** hour vs. **6** hours	0.923
Baseline vs. 6hour	0.807	**1** hour vs. **7** hours	0.491
Baseline vs. 7hour	0.230	**1** hour vs. **8** hours	0.041*
Baseline vs. 8 hours	0.004*	**1** hour vs. **9** hours	0.001*
Baseline vs. 9 hours	0.000**	**1** hour vs. **10** hours	0.001*
Baseline vs. 10 hours	0.000**	**1** hour vs. **11** hours	0.000**
Baseline vs. 11 hours	0.000**	**1** hour vs. 1**2** hours	0.000**
Baseline vs. 12 hours	0.000**	**1** hour vs. 13 hours	0.000**
Baseline vs. 13 hours	0.000**	**1** hour vs. **14** hours	0.000**
Baseline vs. 14 hours	0.000**	**1** hour vs. Remineralization 10 min	0.000**
Baseline vs. Remineralization 10 min	0.000**	**2** hours vs. **3** hours	1.000

TABLE (6) Wilcoxon test comparing the bleaching cycles together in group II.

Group II shade			
Durations	p-value	**Durations**	p-value
Baseline vs. 1 day	1.000	1 day vs. bleaching 1	1.000
Baseline vs. bleaching 1	1.000	1 day vs.2 days	1.000
Baseline vs. 2day	1.000	1 day vs. bleaching 2	1.000
Baseline vs. bleaching 2	1.000	1 days vs. 3days	0.989
Baseline vs. 3day	0.812	1 day vs. bleaching 3	0.989
Baseline vs. bleaching 3	0.812	1 days vs. 4days	0.266
Baseline vs. 4day	0.021*	1 day vs. bleaching 4	0.266
Baseline vs. bleaching 4	0.021*	1 days vs. 5 days	0.014*
Baseline vs. 5 days	0.000**	1 day vs. bleaching 5	0.000**
Baseline vs. bleaching 5	0.000**	1 days vs. 6 days	0.001*
Baseline vs. 6days	0.000**	1 day vs. bleaching 6	0.000**
Baseline vs. bleaching 6	0.000**	1 days vs. 7 days	0.000**
Baseline vs. 7 days	0.000**	1 day vs. bleaching 7	0.000**
Baseline vs. bleaching 7	0.000**	1 day vs. Remineralization 10 min	1.000
Baseline vs. Remineralization 10 min	0.000**	Bleaching 1 vs. 2 days	1.000

TABLE (7) Wilcoxon test comparing the bleaching cycles together in group III.

Group III shade			
Durations	p-value	**Durations**	p-value
Baseline vs. 1 day	1.000	1 day vs. bleaching 1	1.000
Baseline vs. bleaching 1	1.000	1 day vs.2 days	1.000
Baseline vs. 2day	1.000	1 day vs. bleaching 2	1.000
Baseline vs. bleaching 2	1.000	1 days vs. 3days	0.933
Baseline vs. 3day	0.990	1 day vs. bleaching 3	0.933
Baseline vs. bleaching 3	0.990	1 days vs. 4days	0.042*
Baseline vs. 4day	0.033*	1 day vs. Remineralization 10 min	0.042*
Baseline vs. Remineralization 10 min	0.033*	1 days vs. 5 days	0.042*
Baseline vs. 5 days	0.033*	1 day vs. bleaching 5	0.042*
Baseline vs. bleaching 5	0.033*	1 days vs. 6 days	0.042*
Baseline vs. 6days	0.033*	1 day vs. bleaching 6	0.009*
Baseline vs. bleaching 6	0.005*	1 days vs. 7 days	0.009*
Baseline vs. 7 days	0.005*	1 day vs. bleaching 7	0.009*
Baseline vs. bleaching 7	0.005*	1 day vs. Remineralization 10 min	0.000**
Baseline vs. Remineralization 10 min	0.000**	Bleaching 1 vs. 2 days	0.000**

TABLE (8) Statistical analysis showing range, mean and standard deviation of the three tested groups together at each cycle.

		Range			Mean	±	S. D	F. test	p. value		
0-bleaching cycle per hour	**Group I**	3	–	3.5	3.25	±	0.26			P1	0.673
	Group II	3	–	3.5	3.2	±	0.26	0.122	0.886	P2	1.0
	Group III	3	–	3.5	3.25	±	0.26			P3	0.673
1-bleaching cycle per hour	**Group I**	3	–	3.5	3.25	±	0.26			P1	0.671
	Group II	3	–	3.5	3.2	±	0.26	0.370	0.694	P2	0.671
	Group III	3	–	3.5	3.3	±	0.26			P3	0.397
2- bleaching cycle per hour	**Group I**	3	–	3.5	3.25	±	0.26			P1	0.671
	Group II	3	–	3.5	3.2	±	0.26	0.370	0.694	P2	0.671
	Group III	3	–	3.5	3.3	±	0.26			P3	0.397
3- bleaching cycle per hour	**Group I**	3	–	3.5	3.25	±	0.26			P1	0.671
	Group II	3	–	3.5	3.2	±	0.26	0.370	0.694	P2	0.671
	Group III	3	–	3.5	3.3	±	0.26			P3	0.397
4- bleaching cycle per hour	**Group I**	2	–	3.5	3.15	±	0.47			P1	0.787
	Group II	2	–	3.5	3.1	±	0.46	0.646	0.532	P2	0.420
	Group III	3	–	3.5	3.3	±	0.26			P3	0.284
5- bleaching cycle per hour	**Group I**	2	–	3.5	3.05	±	0.44			P1	0.387
	Group II	2	–	3.5	2.85	±	0.63	0.516	0.603	P2	1.0
	Group III	2	–	3.5	3.05	±	0.44			P3	0.387
6- bleaching cycle per hour	**Group I**	2	–	3.5	2.85	±	0.63			P1	1.0
	Group II	2	–	3.5	2.85	±	0.63	0.410	0.668	P2	0.440
	Group III	2	–	3.5	3.05	±	0.44			P3	0.440
7- bleaching cycle per hour	**Group I**	2	–	3.5	2.75	±	0.54			P1	0.402
	Group II	2	–	3.5	2.55	±	0.60	0.634	0.538	P2	0.833
	Group III	2	–	3	2.8	±	0.42			P3	0.297
8- bleaching cycle per hour	**Group I**	2	–	3.5	2.65	±	0.58			P1	0.682
	Group II	2	–	3.5	2.55	±	0.60	0.545	0.586	P2	0.539
	Group III	2	–	3	2.8	±	0.42			P3	0.309
9- bleaching cycle per hour	**Group I**	2	–	3.5	2.45	±	0.60			P1	0.513
	Group II	2	–	3	2.3	±	0.48	2.567	0.047*	P2	0.134
	Group III	2	–	3	2.8	±	0.42			P3	0.036*
10- bleaching cycle per hour	**Group I**	1	–	3	2.3	±	0.67			P1	0.435
	Group II	1	–	3	2.1	±	0.57	4.081	0.028*	P2	0.058
	Group III	2	–	3	2.8	±	0.42			P3	0.010*
11- bleaching cycle per hour	**Group I**	1	–	3	2.2	±	0.63			P1	0.462
	Group II	1	–	3	2	±	0.67	3.619	0.041*	P2	0.073
	Group III	2	–	3	2.7	±	0.48			P3	0.015*
12- bleaching cycle per hour	**Group I**	1	–	3	2	±	0.67			P1	1.0
	Group II	1	–	3	2	±	0.67	4.366	0.023*	P2	0.016*
	Group III	2	–	3	2.7	±	0.48			P3	0.016*
13- bleaching cycle per hour	**Group I**	1	–	3	1.7	±	0.67			P1	0.724
	Group II	1	–	3	1.6	±	0.70	9.425	0.001*	P2	0.001*
	Group III	2	–	3	2.7	±	0.48			P3	0.001*
14- bleaching cycle per hour	**Group I**	1	–	3	1.6	±	0.70			P1	1.0
	Group II	1	–	3	1.6	±	0.70	6.451	0.005*	P2	0.004*
	Group III	2	–	3	2.5	±	0.53			P3	0.004*
Remineralization 10 min	**Group I**	1	–	3	1.6	±	0.70			P1	1.0
	Group II	1	–	3	1.6	±	0.70	5.143	0.013*	P2	0.010*
	Group III	2	–	3	2.4	±	0.52			P3	0.010*

Comparing the three groups together at each cycle as shown in table 8. The significant difference was found at 9th cycle in group II versus group III showing p value of 0.036.

In the 10th cycle both group I versus II and II versus III showed a significant difference with p values 0.05 and 0.010 respectively. In the 11th cycle also significant difference was detected p2 and p3 with p values of 0.073 and 0.015 respectively. This significant difference was repeated at 12th, 13th,14th of remineralization cycle.

The difference between all tested groups was recorded beginning of the 9th cycle with p value 0.047 and 10th cycle with p value of 0.028 and so on till the end of bleaching and remineralzation cycles. This indicates that group III was responsible for repeated significant difference, even though, this group had inferior values compared to both groups I and II.

DISCUSSION

The relatively recent increase of bleachorexics especially among young patients is due to the prevalence of OTC methods[13] which allows them to take whitening into their own hands for rapid and immediate action, this further underlines the importance of testing the effect of these materials on the teeth shade when used according to the manufacturer's instructions or misused.

In the present study, maxillary incisors were selected due to the fact that, they are slightly more yellow than mandibular anterior teeth.[14] In general, natural tooth color has a significant tendency to increase with the age generally becoming darker and more yellow and this happened due to number of factors as the dental pulp shrinks so leaving secondary dentin in its wake and the surrounding dentin becomes harder and less permeable.[15]

Currently, the selected teeth were immersed in artificial saliva between bleaching cycles for keeping them hydrated trying to mimic the clinical situation. In addition, saliva is considered as a natural source of remineralization restoring the minerals of the demineralized bleached enamel as reported by many authors.[12]

A number of methods are available for measuring teeth color and the color changes undergone during tooth whitening procedures. Current study utilized instrumental measurements by using a digital imaging device - VITA Easyshade® V digital spectrophotometer (VITA Zahnfabrik, Germany) since it demonstrated the most accurate, useful instruments for overall color matching in dentistry. This allowed standardized measurements to be repeatedly taken over time and changes in shade to be recorded numerically allowing for statistical analysis.[16]

Cervically, the tooth often has a dark appearance due to the close approximation of dentin below the enamel. Moreover, cervical third has a height of contour, which will prevent complete adaptation of the spectrophotometer tip. Meanwhile, transparent incisor third can scatter light, resulting in defective color recording.

Therefore, the center of the middle-third of the labial surface was chosen as a site of color measurement in the current study because the main shade of the tooth is presented in the middle third, in addition to the wide and flat surface.[17]

Researches shows that, a whitening endpoint is usually reached at 6 weeks independent of concentration and type of peroxide used. The present study followed up teeth shade for 2 weeks. This is critical as purely OTC systems are entirely patient controlled and may be used indiscriminately or inappropriately without prior diagnosis of tooth discoloration. Accordingly, the dental professional may not be aware of the use of such products by the patient. [18,19]

Although remineralization agents can help repair the erosive effects of bleaching, this only works if patients are properly informed to commence application upon the onset of whitening treatment. However, users of OTC products further their plight by not reading the instructions. Thus, even when side effects are indicated in the user's manual, most consumers remain oblivious to the need for these remineralization agents. [11]

Based on the results of the current study, all tested groups produced a whitening effect after treatment with the same whitening outcomes in both groups I and II. However, reliable shade improvement was noted in group I following the manufacturer's instructions. While, same results recorded in group II denoting that, there is no additional effect of teeth whitening was obtained when abusing in an attempt to achieve more shade improvement by minimizing the time proposed by the manufacturer. On the other hand, less shade improvement was observed in group III at the end of the cycles. Such results are in agreement with previous research[20] which reported that low concentrations of peroxide are able to provide acceptable color change.

Concerning the shade improvement, in terms of chemical degradation of carbamide peroxide in the oral environment, [21] it's dissociation produces hydrogen peroxide and urea byproducts, where urea further decomposes into a strong base of CO_2 ammonia. With the presence of a strong base and strong free radicals, these byproducts are very reactive with organic pigments during the whitening process.[22]

Another possible explanation for such shade improvement, was the use of lights that purportedly accelerate the whitening process. The current study used light irradiations in conjunction with carbamide peroxide. Though the utility of light for tooth whitening remains controversial [23, 24], one potential benefit of using light is that the heat from the light may activate the peroxide and increase its breakdown rate and the number of free radicals available to oxidize complex organic compounds in tooth hard tissues.[25] Several studies have shown that light irradiation can increase the reactivity of peroxide, resulting in a shorter treatment time while achieving the same whitening outcomes.[26-28]

In contrast to other study[29] which demonstrated that, no conclusions can be made regarding the additional effect of light activation on the whitening effect of the materials. The results were different between the two light activation systems tested compared with the non-light activation system used, while no significant difference was found between the two systems. The different findings between studies may be due to the different bleaching gel concentrations used, the baseline color of the examined teeth, and the bleaching gel exposure period.[30]

The difference between all tested groups was recorded beginning of the 9th cycle till the end of bleaching and remineralzation cycles. This indicates that group III was responsible for repeated significant difference, even though, this group had inferior values compared to both groups I and II. This was in contrast to the results obtained by Ahrari et al.[31], who compared four bleaching protocols and found no significant difference between tested groups at different cycles.

The study's null hypothesis was not accepted because the tested groups had significant difference in teeth shade when tested post-bleaching and remineralizing cycles.

Future direction for research may consider a larger sample size in a double- blinded randomized clinical trials to further investigate the efficacy of proper use versus the abuse of the over the counter bleaching products on teeth's surface roughness.

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