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A comparative study evaluates the effect of Hydrogen peroxide 38% and Carbamide peroxide 35% bleaching products on enamel microhardness (In vitro study)

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Abstract

The aim of this study was to compare the effect of two professional bleaching products (in-office Opalescence Boost hydrogen peroxide 38%) and (home bleaching Opalescence carbamide peroxide 35%) on enamel microhardness.

The sample consist of thirty maxillary first premolars teeth (freshly extracted), caries free obtained from children aged 12 years old under routine orthodontic treatment. The teeth were sectioned mesiodistally parallel to the long axis of tooth and mounted on acrylic mold. The specimens were divided into two halves buccal and palatal as per treatment, the buccal half served as experimental, while the palatal half served as control [(1)] and kept in artificial saliva at $37c^0$ for two weeks. Microhardness test were obtained before and after bleaching.

Results indicated that teeth specimens submitted to Opalescence carbamide peroxide 35% showed highly significant reduction in enamel microhardness $P<0.01$, while no-significant difference in enamel microhardness in specimens submitted to Opalescence Boost 38% hydrogen peroxide $P>0.05$.

In this study Opalescence carbamide peroxide 35% leads to the significant decrease in enamel microhardness compared to Opalescence Boost hydrogen peroxide 38%.

Keywords: hydrogen peroxide, carbamide peroxide, maxillary 1st premolars, microhardness

Introduction

Bleaching is the process of lightening the color of tooth through application of chemical agent to oxidize the organic pigmentation in the tooth [(2)].

For a long time, white teeth have been considered as an indicator of health as well as an important factor of youth and beauty. With the current interest in conservative and esthetic dentistry, vital bleaching has gained popularity as a conservative technique to lighten natural teeth and to remove extrinsic and intrinsic stains [(3)]. Any noticeable discoloration of the teeth can be considered a physical handicap that impacts on a person's self confidence, physical attractiveness and employability [(4)]. Several clinical studies conducted to evaluate the efficiency of bleaching on children and adolescents teeth and the results showed that bleaching can change child's smile dramatically [(5,6)],

however, children were found to be significantly contribute bleaching efficiency compared to older age [7].

Many products and systems have appeared on the market for in-office tooth bleaching technique like hydrogen peroxide, which is used only by dentists [8]. In-office bleaching technique might require from two to three visits to achieve the desired shades and the soft tissue must be protected before the bleaching procedure [9]. Nowadays, the most frequently used bleaching agents are based on Hydrogen peroxide and Carbamide peroxide. Hydrogen peroxide is designated as hazardous substance when present at concentration above 5%. In concentration of 30% or more certain safety precaution should be taken to prevent accidents and possible injury [10'11].

Hydrogen peroxide (H_2O_2) is relatively unstable and decomposes slowly to release oxygen, it is completely soluble in water give an acidic solution [12]. Some studies have indicated that 30-35% hydrogen peroxide causes superficial alterations and reduction in the calcium-phosphorus ratio [13,14]. The effect of bleaching products base on high concentrations of hydrogen peroxide (30-38)% used in dental office on biochemical characteristics of enamel was no also evaluated, these high concentration of bleaching gels applied directly on the tooth surface in the dental chair [15,16]. Carbamide peroxide in concentration of 10-22% is the major agent for bleaching vital teeth by home night technique, while the concentration of 35% is used for professional bleaching of vital teeth in dental office.

Carbamide peroxide decomposes into urea, ammonia, carbon dioxide; water and hydrogen peroxide were the latter is the active bleaching substance [17]. Several studies have shown correlation between changes on the surface of enamel (microhardness, structural changes) and the concentration of bleaching agent [18,19].

A wide range of techniques have been used or specially developed to measure the changes occurring in tissues. These tests aimed to quantify changes in physical properties such as hardness, density or optical properties or to measure the chemical composition [20]. The high degree of enamel hardness is mainly attributed to the great amount of calcification of this tissue.

In most hardness studies devices had been used to measure the degree of penetration of a diamond indenter into the enamel, the most common tests to measure the hardness of the enamel are Vickers and Knoop hardness test [21].

Therefore, the purpose of this study was to compare the effect of two professional bleaching materials (hydrogen peroxide 38% and carbamide peroxide 35%) on human enamel microhardness.

Materials and Methods

The sample consist of (30) caries free maxillary first premolars recently extracted for orthodontic treatment of 12 years old children were immediately stored in normal saline at $37c^0$.

The teeth were cleaned with slurry of pumice using rubber cup in slow speed handpiece. Sectioning of teeth was performed by dividing the mesial and distal side into occlusal, central, cervical areas [22,23] and the teeth were sectioned mesiodistally parallel to the long axis at the center of the tooth. Sectioning was done by using a low-speed circular diamond disc and a copious filtered water, then the roots were cut a way and the sectioned specimens were stored in distilled

water and thymol disinfectant crystals in a glass container at 37 c^0 until they were bleached. Each surface of the tooth positioned in a manner that it's buccal or palatal surface was pressed against a clean slab and fixed by wax, the mold ring was applied over each crown and a mixture of self curing resin prepared and poured over the tooth inside the ring mold. All the specimens were tested for microhardness before the treatment with bleaching products. The specimens were then divided into two groups, (15) tooth for each group and the bleaching and the bleaching products were applied on the buccal surface of the each tooth as experimental surface, the palatal surface was left as a control. The bleaching products used were: Opalescence Boost hydrogen peroxide 38% Ultradent product INC (in-office bleaching gel) and Opalescence professional carbamide peroxide 35% Ultradent INC (home bleaching) and artificial saliva to keep the specimens. Before application of bleaching agent on enamel surfaces, the shade of all permanent premolars was on color base assessment at 2A level according to vivadent shade guide [24].

The first group of the teeth, (n=15) the buccal surface were coated with enough in-office bleaching gel (Opalescence Boost 38%) by using brush applicator to cover the enamel, then they were exposed to a Heliolux light-curing unit for 20 seconds, the gel must be left in contact with bleached enamel surface for 5 minutes, then the gel suction off but without rinsing and the activation was repeated, application typically last between 10-20 minutes prior to rinsing with distilled water and stored in artificial saliva for one week. The same procedure was repeated again after one week. The second group, (n=15) the buccal surface were coated with enough professional home bleaching gel (35% carbamide peroxide) by using brush applicator to cover the enamel for 30 minutes daily for two weeks as recommended by manufactures. After each exposure, the specimens were rinsed with distilled water and stored in artificial saliva till the next exposure. The palatal specimens of each group were left in artificial saliva as control.

Then microhardness measurements were performed after bleaching by using Vicker's Hardness Number [25] which includes the application of a standarized force or weight to the tooth surface, and each force will produce symmetrical shaped indentations. Five indentations were recorded per surface of each tooth under a force of 500 gram for 40 second, after which time the indentation depth number was taken from the dial gauge. The mean of readings were taken or recorded, the results were tabulated and t-test was done.

Results

Table (1) Figure (1) demonstrated the mean Vicker's values for the enamel microhardness of the buccal and palatal specimens (experimental and control) before and after bleaching withOpalescnce Boost hydrogen peroxide 38% and Opalescence carbamide peroxide 35% . The mean microhadness values of the buccal (experimental) before and after bleaching with hydrogen peroxide 38% was (380.28± 36.23 and 362.38 ±43.74 respectively), while the microhardness values of the buccal specimens before and after bleaching with carbamide peroxide 35% was (391.11±42.97 and 315.91± 36.03 respectively) . The mean microhardness values of the palatal specimens which were stored in artificial saliva during the time of treatment with Opalescence Boost

hydrogen peroxide 38% and Opalescence carbamide peroxide 35% were (385.51±33.73, 389.81±40.94, 386.09±34.01 and 388.75±36.87 respectively).

Table (2) showed a highly significant difference p<0.01 between the two professional bleaching agents hydrogen peroxide 38% and carbamide peroxide 35% after 14 days of treatment, the home bleaching carbamide peroxide 35% caused the most significant reduction in enamel microhardness mean values (315.91±36.03), no-significant difference in mean microhardness values of the buccal specimens before and after treatment with hydrogen peroxide38% was found p>0.05, the mean values was (380.28±36.23 and 362.38±43.73 respectively), but there was a highly significant difference in mean microhardness values of the buccal specimens treated with carbamide peroxide 35% before and after treatment p<0.01, the mean values (391.11±42.97 and 315.91±36.03 respectively). Table (3) showed no-significant difference between the palatal specimens (control) which were stored in artificial saliva during the time of the treatment p>0.05. Table (4) showed no-significant difference in the microhardness mean values for the buccal and palatal specimens after bleaching with hydrogen peroxide 38% p>o.o5, the mean values was (362.38±43.73 and 389.81±40.94 respectively), while it showed a highly significant difference p<0.01 in the mean microhardness values for the buccal and palatal specimens after bleaching with carbamide peroxide 35% (315.91±36.03 and 388.75±36.87 respectively).

Discussion

The bleaching process is designed to enable the oxidizing agent to reach sites within the enamel and dentin to allow a chemical reaction to occur. As a result of oxidation of the enamel organic and inorganic substance, the enamel matrix is dissolved and various side effects come out .The side effects appear as decrease in enamel microhardness and change of enamel morphological characteristics [26].

The effect of bleaching is directly dependent on exposure time and the concentration of bleaching agent, longer the period of exposure and the concentration of bleaching agent, a color change will be more pronounced.

The current study is the first study done in Iraq by using these new bleaching materials with high concentrations, in this study Opalescence carbamide peroxide 35% showed highly significant reduction in enamel microhardness than Opalescence Boost hydrogen peroxide 38% after completion of the treatment, this can be explained by the fact that 35% carbamide peroxide corresponds to 11.4% solution of hydrogen peroxide (the rest is urea).

Our results consistent with other results Lewinstein [27] and Oltu [28] that showed a significant decrease in enamel microhardness value after exposure to 35% carbamide peroxide which didn't reach the initial level after expected period of remeneralization.

The present study was also in agreement with other study Tatjana [29] which found that the enamel microhardness will decrease significantly after treatment with 35% carbamide peroxide this may be due to high concentration of carbamide peroxide 35% and long period and treatment, while this study disagree with other study Sulieman [30] which didn't observe a significant change in microhardness of enamel after application of 35% carbamide peroxide

for 30 minutes, this may be due to the short period of treatment .

Other study Boriana [31] mentioned that they have not detected any subsequent enamel alteration for a highly concentrated 38% Opalescence Boost hydrogen peroxide bleaching product. This study was in agreement with other study Grobler [32] who showed that there was no-significant changes in enamel microhardness after treatment with Opalescence Boost hydrogen peroxide 38% , also this study was in agreement with other study Huseyin [33] who showed no changes in enamel microhardness after treatment with Opalescence Boost 38% hydrogen peroxide, this may be due to the effect of the storage media of artificial saliva on enamel microhardness, it was found that microhardness of bleached enamel increased significantly after 14 days immersion in artificial saliva, this was in accordance with Hebatalla and Toteda [34,35] who revealed that saliva can reverse some mineral loss caused by bleaching treatment and reduction in bleached enamel microhardness may be reverted by a period of remeneralization following the whitening procedure and any micro structural defects promoted by bleaching agents may be repaired by the absorption and precipitation of the salivary components present in artificial saliva.

Our study disagree with the Zantner [36] who found a reduce in the microhardness of enamel surface for Opalescence Boost hydrogen peroxide 38%.This may be due to the absence of urea in the composition of Opalescence Boost 38% which kept the PH close to the critical level for enamel demineralization and storage in distilled water.

The microhardness of the palatal specimens (control) showed no-significant difference during the treatment ,this may be due to their immersion in artificial saliva for 14 days, artificial saliva was used as a storage medium to evaluate the remenaralization potential of the artificial saliva and whether it can restore microhardness of the enamel [37].

Conclusion

1- Opalescence carbamide peroxide 35% showed highly significant reduction in enamel microhardness.
2- Opalescence Boost hydrogen peroxide 38% showed no-significant reduction in enamel microhardness.
3- More investigations are needed into the area of tooth whitening to evaluate how long it will take after bleaching to reverse the deterioration of the physical properties of enamel observed in this study.

References

1- 1-Grando L, Tames D, Tomas R. In vitro study of alterations of dental enamel. Dent.Medium 1998; 6 (1): 24-35.
2- Sturdevant C, Roberson T, Heymann H. The art and science of operative dentistry. 3rd ed. St. Louis. Mosby.1995.
3- Kugel G, Ferreiras S. The art and science of tooth whitening. J. Mass. Dent.Soc.2005; 53(4):34-7.
4- Kelleher MG, Roe J. The safety in use peroxide for bleaching teeth under the supervision of a dentist. British Dent.J.2002; 187 (4A):925-929.
5- Donly K, Rojer C, Garcia G. Tooth whitening in children. Comp. Cont. Educ. Dent.2002;23(1A):22-28.
6- Kugel G, Zhoux M, Gerlach R. Daily use of whitening strips on tetracycline-stained teeth: Comparative results after two months. Comp. Cont. Educ.2002; 223-225.
7- Gerlach R. Clinical trails on the use of whitening strips in children and adolescents. Gene. Dent. J. 2002;50(3):242-245.

8- Perdigao J, Baratieri LN, Aracari GM. Contemporary trends and techniques in tooth whitening: a review. Pract. Proced Aesthet Dent.2004; 16(3):185-92.
9- 9-Feinman RA, Goldstein RL, Garber DA. Bleaching teeth. Chicago: Quintess. Publish. 2006; P 14.
10- Walton R, Torabinejad M. Principles and practice of endodontic. 2nd ed. Philadelphia W.B.Saunders Comp. 1996; ch.23; p: 386-400.
11- Laurence J, Walsh I. Safety issues relating to the use of hydrogen peroxide in dentistry. Austr. Dent. J. 2000; 45(4): 257-269.
12- Stewart H, Albert C, Goerig F. An in vitro comparison of different bleaching agents in the discolored tooth. Endo.1989; 15(3): 106-111.
13- Lee CQ, Cobb CM, Zargartalebi F. Effect of bleaching on microhardness morphology and color of enamel. J. Dent.1995; 43: 158-62.
14- 14-Mc Guckin RS, Babin JF, Meyer BJ. Alterationin human enamel surface morphology following vital bleaching. J. Prosthet. Dent. 1992;68:754-60.
15- V.B. Haywood. History, safety and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique:Quintessence International. 1992; vol.23,no.7, p:471-488.
16- Y. Li. Biological properties of peroxide-containing tooth whiteners; Food and Chemical Toxicology. 1996; vol.34.no.9; p: 887-904.
17- Goldstein R, Garber D. Complete dental bleaching. Chcago. Berlin, London: Quintess publishing Co. Inc. 1995.
18- Cimili H, Pameijer CH. Effect of carbamide peroxide bleaching agents on the physical properties and chemical composition of enamel. Am .J Dent. 2003; 14:63-6.
19- Rotstein I, Danker E, Goldman A, Heling I, Stabholz A, Zalkind M. Histochemical analysis of dental hard tissues following bleaching.J Endod. 1996; 22;23-5.
20- Featherstone JBD, Tencate M, Shariati J, Arends.Comrarision of artificial caries like lesions by quantitative microradiography and microhardness profiles. Caries Res.1983;17:385-391.
21- 21-Sao C. Microhardness and chemical composition of human tooth. Materials Res. 2003;6(3):1-13.
22- Hintze H, Westkukp M, Wenzle A. Diagnostic outcome of methods used for caries validation. A comparison of clinical examination, Radiography and Histology following Hemi- and serial tooth sectioning. J. Oral. Radio. 2003; 9(1):23-45.
23- Hosoya H, Marshall G. The Nano-hardness and Elastic modulus of carious and sound primary canine dentin. J. Oper. Dent. 2004; 29(2): 142-149.
24- Barghi N,Thomas G, Abraham G. Clinical comparision of two in-office bleaching systems. Cont. Esth. Res. Practice. 1997; 1(3): 10-15.
25- Attin T, Schmidlin P.R, Wegchaupt F, Weigand A. Influence of the impact of bleaching agents on dental enamel microhardness. Dental Materials. 2009; (25):143-157.
26- Arend J, Tenbsch JI. Demineralization and remineralization evaluation techniques. J. Dent. Res. 2006; (71):924.
27- Lewinstein I, Fuhrer N, Churaru N, Cardash H. Effect of different peroxide bleaching regimens and subsequent fluoridation on the hardness of human enamel and dentin. J. Prosthet. Dent. 2004; 92: 337-42.
28- Oltu U, Gurgan S. Effects of three concentrations of carbamide peroxide on structure of enamel. J. Oral Rehabil. 2000; 27: 332-40.
29- Tatjana Savic-Stankovic, Branislav Karadzic. The effect of bleaching agents on human enamel micro-hardness. Serbian Dental Journal. 2010; vol. 57. n.4.
30- Sulieman M, Addy M, Macdonald E, Rees JS. A safety study in vitro for the effects of an in-office bleaching system on the integrity of enamel and dentin. J. Dent. 2004; 32:581-90.
31- Boriana M, Arndt K, Ursula E. Side effects of non-peroxide- based home bleaching agent on dental enamel . J. of Biomedical Materials Research vol. 88A. Issue 1.2009; P:195-204.
32- Grobler SR. Majeed A, Moola MH. Effect of various tooth whitening products on enamel microhardness. SADJ. 2009; 64(10): 474-9.
33- Huseyin T, Cigdem A, Ozlem E, Ercument K. Susceptibility of enamel treated with bleaching agents to mineral loss after cariogenic challenge. International J. of Dentistry. 2011; 8 pages.
34- Hebatalla M, Dalia A, Inas A. Effect of dental bleaching on caries resistance of human enamel. (In vitro study). Cairo Dental Journal. 2009; (25). n. 3.p:449-455.
35- Toteda M, Philpotts CT, Cox T.F, Joiner A. Evaluation of 6% hydrogen peroxide

tooth whitening gel on enamel microhardness after extended use. Quintessence International. 2008; (39): 853-858.
36- Zantner C, Behin Schwarz back N, Neumann K, Keilbassa A.M. Surface microhardness of enamel after different home bleaching procedures. Dental Materials. 2007; (23): 243-250.
37- Efeoglu N, Wood DJ, Efeoglu C. Thirty five percent carbamide peroxide causes in vitro demineralization of enamel. Dental Materials. 2007; (23): 900-904.

Table (1) Descriptive statistics of microhardness values for buccal & palatal specimens before & after bleaching

		Mean	±SD	Min.	Max.
Experimental Group (Buccal)	**Before bleaching with Hydrogen Peroxide 38%**	380.28	36.23	320.0	455.30
	bleached with Hydrogen Peroxide 38%	362.38	43.73	300.4	426.0
	Before bleaching with Carbamide Peroxide 35%	391.11	42.97	320.0	470.3
	bleached with Carbamide Peroxide 35%	315.91	36.03	260.2	382.3
Control Group (Palatal)	**Before bleaching with Hydrogen Peroxide 38%**	385.51	33.73	302.8	466.0
	bleached with Hydrogen Peroxide 38%	389.81	40.94	320.0	460.0
	Before bleaching with Carbamide Peroxide 35%	386.09	34.01	301.8	465.0
	bleached with Carbamide Peroxide 35%	388.75	36.87	320.7	466.0

*Sample size is 15 teeth

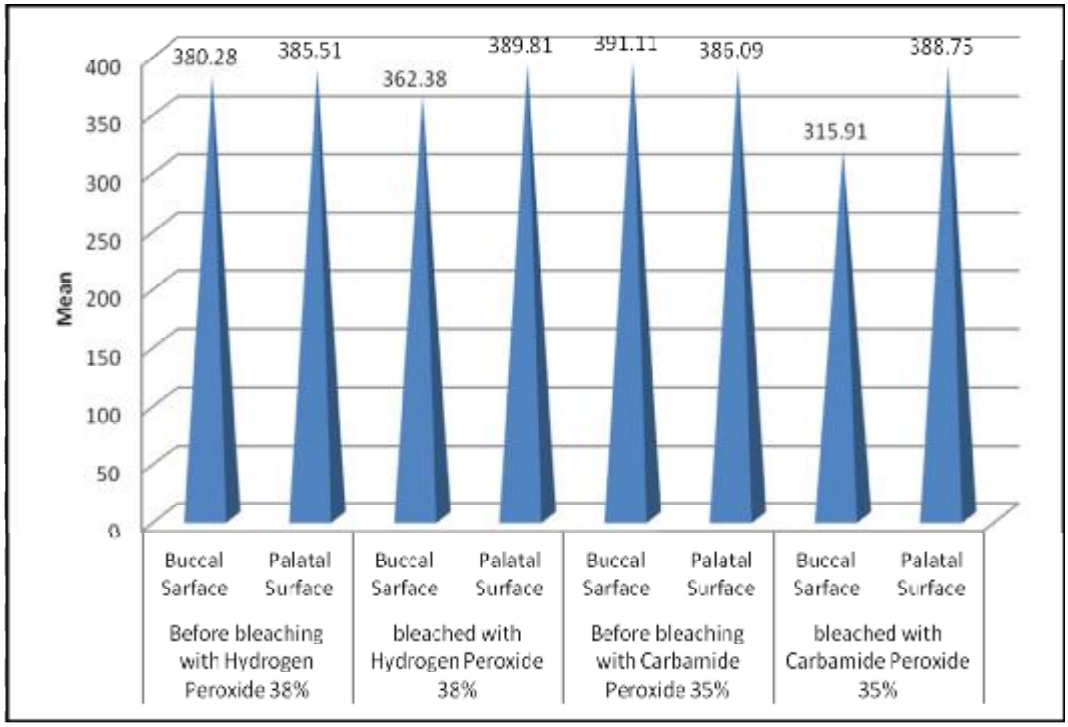

Figure (1) Buccal & Palatal Specimens before & after Bleaching

Table (2) t-test of Microhardness means values for the buccal specimens before & after bleaching

	Mean	±SD	t-test	p-value
bleached with Hydrogen Peroxide 38%	362.38	43.73	3.18	0.0037□ □ □
bleached with Carbamide Peroxide 35%	315.91	36.03		
Before bleaching with Hydrogen Peroxide 38%	380.28	36.23	1.22	0.23□
bleached with Hydrogen Peroxide 38%	362.38	43.73		
Before bleaching with Carbamide Peroxide 35%	391.11	42.97	5.19	0.000□ □ □
bleached with Carbamide Peroxide 35%	315.91	36.03		

*NS: Non significant at level P > 0.05
***HS: Highly Significant at level P < 0.01

Table (3) t-test of Microhardness means values for the Palatal specimens before & after bleaching

	Mean	±SD	t-test	p-value
bleached with Hydrogen Peroxide 38%	389.81	40.94	0.07	0.94□
bleached with Carbamide Peroxide 35%	388.75	36.87		
Before bleaching with Hydrogen Peroxide 38%	385.51	33.73	0.31	0.76□
bleached with Hydrogen Peroxide 38%	389.81	40.94		
Before bleaching with Carbamide Peroxide 35%	386.09	34.01	0.21	0.84□
bleached with Carbamide Peroxide 35%	388.75	36.87		

*NS: Non significant at level P > 0.05

Table (4) t-test of Microhardness means values for the buccal& palatal specimens after bleaching

	Mean	±SD	t-test	p-value
bleached with Hydrogen Peroxide 38% (Buccal Surface)	362.38	43.73	1.77	0.087□
bleached with Hydrogen Peroxide 38% (Palatal Surface)	389.81	40.94		
bleached with Carbamide Peroxide 35% (Buccal Surface)	315.91	36.03	5.47	0.000□ □ □
bleached with Carbamide Peroxide 35% (Palatal Surface)	388.75	36.87		

*NS: Non significant at level P > 0.05
***HS: Highly Significant at level P < 0.01