

# Effect of Three Bleaching Agent on Surface Roughness of Enamel (*In-vivo* Study)

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## Abstract

The purpose of this study was to evaluate the effect of 20% Carbamide peroxide (CP), 10% Carbamide peroxide (CP) and 25% Hydrogen peroxide (HP) on surface roughness of enamel.

**Materials and methods:** Six young healthy dogs were used in this study. Sixteen teeth in each dog were selected (upper and lower incisors and canines) for bleaching.

Group (1): Control, no bleaching treatment (upper & lower canines in each dog).

Group (2): (1) & (2) dogs, bleaching of upper & lower incisors with 20% CP Opalescence.

Group (3): (3) & (4) dogs, bleaching of upper & lower incisors with 10% CP Opalescence

Group (4): (5) & (6) dogs, bleaching of upper & lower incisors with 25% HP Zoom2

N=24

Selected teeth on each dog were scaled and polished with a rubber cup, after that in groups 2,3,4 bleaching agents were applied for eight hours daily for two weeks. After sacrificed of the dogs, the teeth were stored in normal saline 0.9%. Enamel of labial surface of teeth was tested for surface roughness (Ra,um) using Environmental Scanning Electronic Microscope. Data were statistically analyzed using ANOVA followed by Duncan's Multiple Range Test using SAS program.

**Results:** No significant differences were found among the bleaching groups (2-3-4). However, all bleaching agents produced a significant increase in the mean surface roughness of enamel compared to the untreated control group (1) ( $p < 0.05$ ).

**Conclusion:** Different concentration of Carbamide peroxide and Hydrogen peroxide can promote alteration on enamel surface.

**Keywords:** Bleaching agents; Surface roughness; Enamel

## Introduction

Discoloration of permanent anterior teeth is an aesthetic problem, which requires effective treatment. During the last decade, tooth bleaching has undergone great development [1]. There is a wide range of bleaching products and techniques that can be used to successfully lighten the shade of teeth. In the past, in-office vital tooth bleaching techniques used preoperative acid etching, strong chemical oxidizing agents and heat to promote tooth whitening [2,3]. Oxidizing agents that included high concentrations of Hydrogen peroxide solutions (30–35%) were indicated for professional use only. As a result of these bleaching techniques, enamel has been shown to present superficial alterations [1,4,5] and a reduction in the Calcium/Phosphorus (Ca/P) ratio. Tooth whitening with Carbamide is one of most popular dental procedures, and it is also one of the least understood. The available information on safety and biological properties of peroxides for tooth whitening indicates minimal risks with appropriate use of the bleaching products [6-8].

Bleaching methods have been developed and peroxide compounds at different concentrations are used for tooth whitening procedures [2,9,10]. Peroxide-containing vital tooth whiteners are classified into three categories, according to application mode and peroxide concentration.

Bleaching procedures have gained popularity with patients and dentists as conservative techniques to lighten natural teeth in order to improve the harmony of the smile. However, the exposure of tooth hard tissues to bleaching agents can result in micro-structural changes

in the enamel surface. Some authors, through scanning electron microscopy (SEM) evaluation, have demonstrated demineralization, surface defects, and degradation of sound enamel [11,12].

Evidence demonstrates that enamel presents structural changes when exposed to 10% Carbamide peroxide, compromising its composition and morphology [13,14]. However, there is little information about the effects of whitening products that present different peroxide concentrations, formulations and application protocols on enamel surface.

The purpose of this study was to evaluate the effect of 20% Carbamide peroxide (CP), 10% Carbamide peroxide (CP) and 25% Hydrogen peroxide (HP) on surface roughness of enamel.

## Materials and Methods

Six young healthy dogs, aged between one and two years old with

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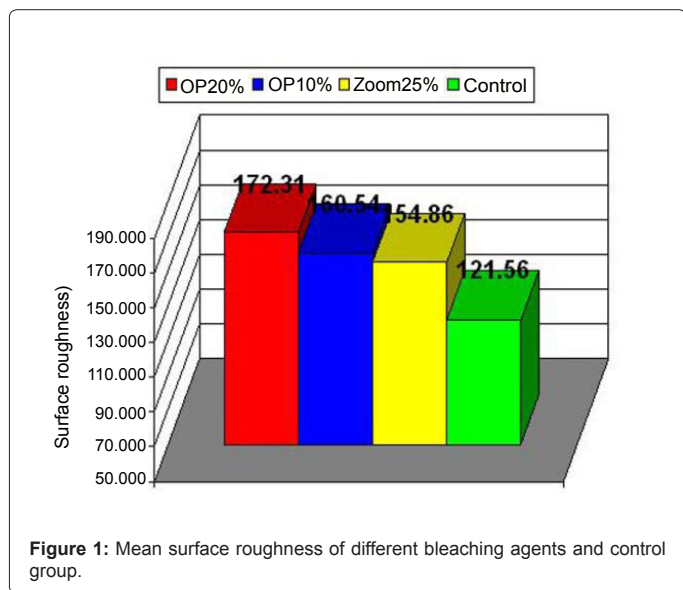
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Bleaching agents	Mean	S.D.	Min.	Max.	dt
Control group (no bleaching)	121.56	30.39	71.34	234.33	b
Opalescence 20% CP	172.31	19.32	114.08	297.12	a
Opalescence10% CP	160.54	33.72	90.5	291.34	a
Zoom 25% HP	154.86	32.9	95.29	288.13	a

S.D.=Standard deviation; dt = Duncan's Multiple Range Test. Means with the same letter within each column are not significantly different at  $p \leq 0.05$

**Table (1):** Descriptive statistics and test of significance for surface roughness of the tested bleaching agents.



Group (4): (5) & (6) dogs, bleaching of upper & lower incisors with 25% HP Zoom2 (Discus Dental Product Inc, 13-2595 122706-USA)

N=24

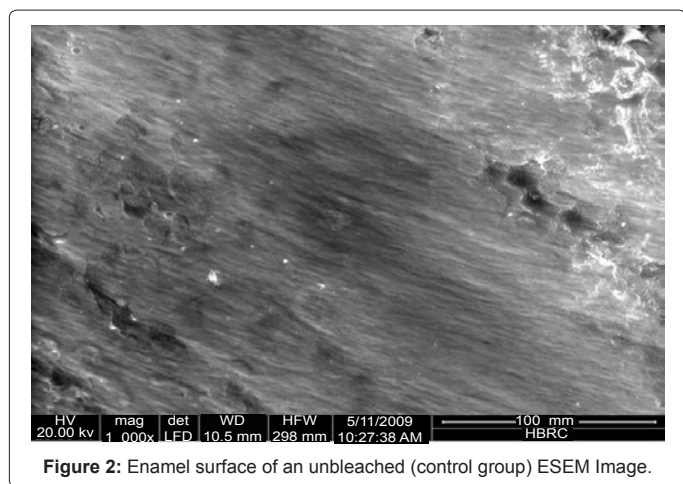
The animals were pre-medicated with Atropine sulphate at a dose of 0.05-0.1 mg/kg body weight, subcutaneously and Xylazine hydrochloride at a dose of 1 mg/kg body weight, intramuscularly. Ten minutes later, the anesthesia was induced and maintained by using Thiopental sodium, at a dose of 5 mgm/kg of 2.5% solution intravenously. Selected teeth on each dog were scaled and polished with a rubber cup, after that in groups 2,3,4 bleaching agents were applied for eight hours daily for two weeks. Adequate measures were taken to minimize the pain or discomfort to the animals. Animals of all groups were supplied a diet composed of fresh vegetables, powdered milk and water ad libitum. The experimental procedure was conducted in compliance with ethical principles for animals research as reviewed and approved by institutional guidelines of Kasr Alainy animal and experimental laboratory (Faculty of Medicine, Cairo University).

Dogs were sacrificed by using an overdose (0.5 grams) of 10% solution of Thiopental sodium intravenously. The jaws were immediately dissected free, and the teeth were separated from the jaws by the use of saw. The teeth were stored in normal saline 0.9%. Enamel of labial surface of teeth was tested for surface roughness (Ra,um) using Environmental Scanning Electronic Microscope (Quanta200-FEI-collected at Nether land). Data were statistically analyzed using ANOVA followed by Duncan's Multiple Range Test using SAS program.

## Results

The mean surface roughness (Ra, um) values and standard deviation, for all tested groups after 8 h for 14 consecutive days are displayed in Table 1 and Figure 1. No significant differences were found among the bleaching groups (2-3-4), on the other hand Zoom 25% HP showed the least mean surface roughness (154.86), while the Opalescent 20%CP showed the highest mean value (172.31). However all bleaching agents produced a significant increase in the mean surface roughness of enamel compared to the untreated control group ( $p < 0.05$ ).

Environmental scanning Electronic Microscope (Quanta 200) image for all groups were showed in Figure 2,4,6,8. Enamel surface roughness of all groups which described by ESEM software program



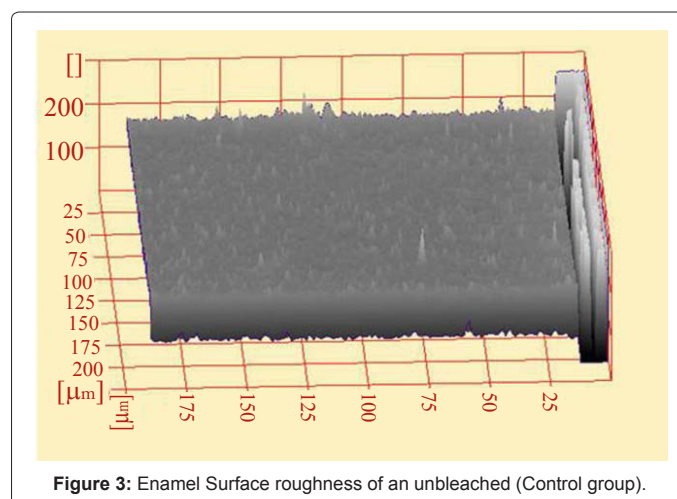
**Figure 2:** Enamel surface of an unbleached (control group) ESEM Image.

an average weight of 10 kg were used in this study. Sixteen teeth in each dog were selected (upper and lower incisors and canines) for bleaching.

Group (1): Control, no bleaching treatment (upper & lower canines in each dogs).

Group (2): (1) & (2) dogs, bleaching of upper & lower incisors with 20% CP Opalescence (ultra Dent Products Inc, South Jourdan, UT, USA)

Group (3): (3) & (4) dogs, bleaching of upper & lower incisors with 10% CP Opalescence (ultra Dent Products)



**Figure 3:** Enamel Surface roughness of an unbleached (Control group).

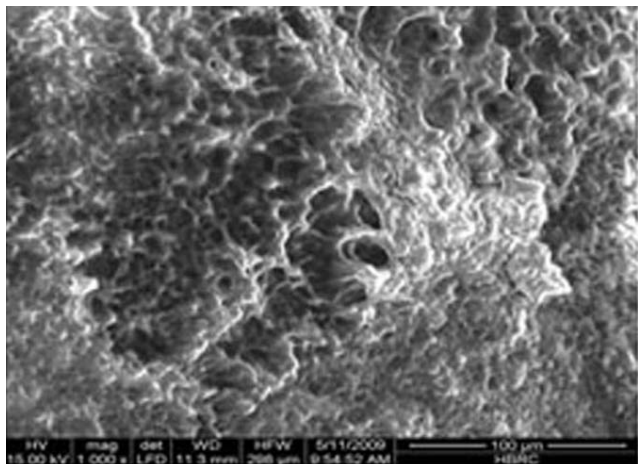


Figure 4: Enamel surface exposed to 20% Opalescence CP (ESEM Image).

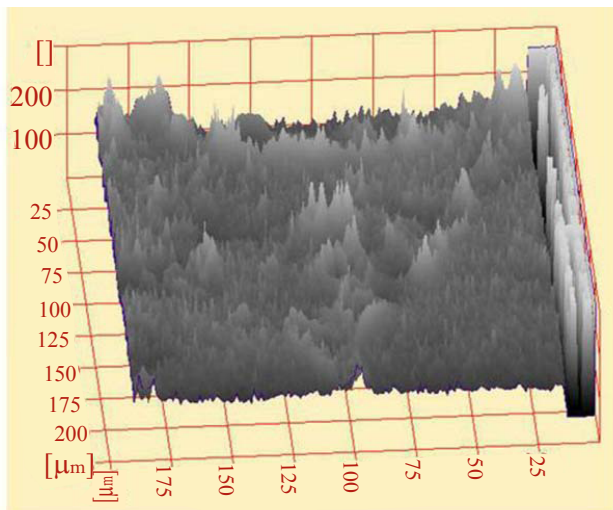


Figure 5: Enamel Surface roughness after exposed to 20% CP.

(XT Document for image analysis) were showed in Figure 3,5,7,9.

## Discussion

This *in vivo* study revealed that surface roughness of enamel for all groups (CP10%- CP20%- HP25%) has no significant differences. However all bleaching agents produced a significant increase in the mean surface roughness of enamel compared to the untreated control groups.

Bleaching agents with Hydrogen peroxide are believed to lighten the discolored tooth structure through decomposition of peroxides to give unstable free radicals. These free radicals breakdown the large pigmented molecules in enamel into smaller, less pigmented molecules through either oxidation or reduction reactions [15,16].

The mechanism of the action of bleaching agents is thought to be due to the ability of hydrogen peroxide to form oxygen free radicals that interact with adsorbed colored organic molecules and oxidize these macromolecules and pigmented stains into smaller and lighter molecules [17].

Oxidizing agents that included high concentrations of Hydrogen peroxide solutions (30–35%), has been shown to present superficial alterations of enamel [11,18,19] and reduction in the Calcium/Phosphorus (Ca/P) ratio [20]. Enamel surface in contact with high

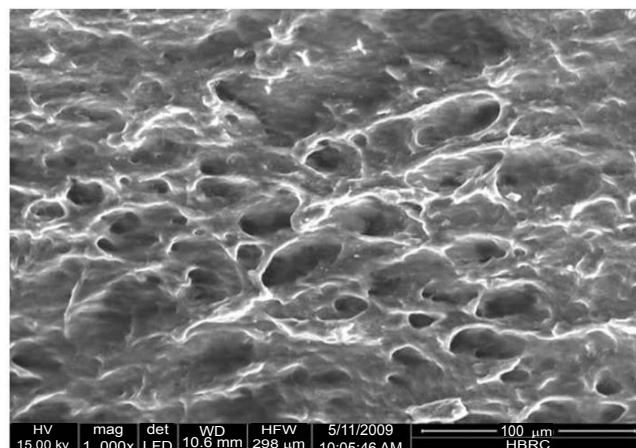


Figure 6: Enamel surface expose to 10% Opalescence CP (ESEM).

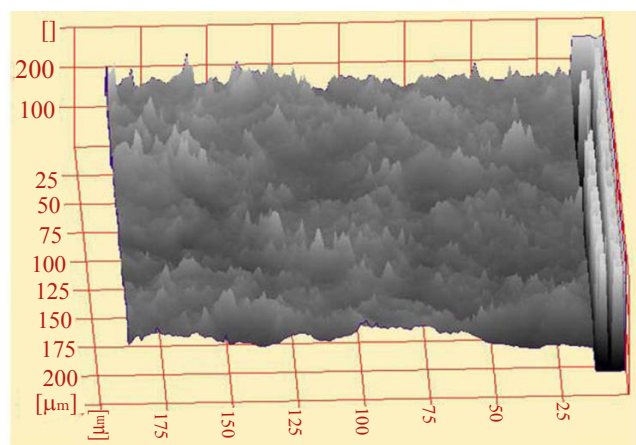


Figure 7: Enamel Surface roughness after to 10%.

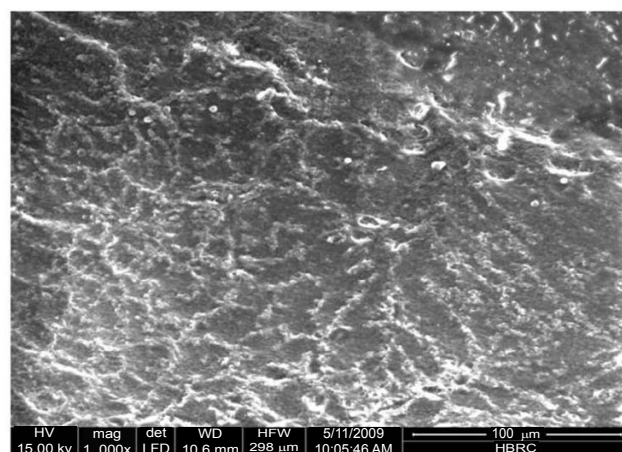


Figure 8: Enamel surface exposed to Zoom 25% HP (ESEM Image).

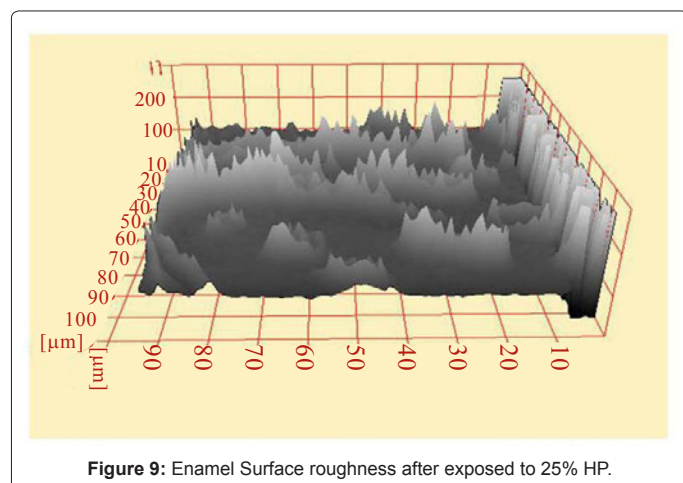


Figure 9: Enamel Surface roughness after exposed to 25% HP.

concentrated Carbamide peroxide gels provided morphologic changes, causing increase in the surface roughness with etching-like appearance [20].

Tooth whitening with Carbamide peroxide is one of most popular dental procedures, Carbamide peroxide (CP) dissociates into Hydrogen peroxide and urea when in contact with saliva at oral temperatures. Peroxide can diffuse through enamel and dentin due to its low molecular weight. Hydrogen peroxide degrades into oxygen and water; urea degrades into ammonia and carbon dioxide. A general concern is expressed regarding possible weakening of the tooth structure [21-23]. Other studies showed that some carbamide peroxide formulations caused calcium dissolution from enamel [24]. Urea is a by-product of such bleaching agents and has been shown to be able to remove enamel proteins and related mineral elements [25], attacking the core or intra-prismatic area and producing porosities at prism surfaces [26]. A significant decrease in Ca and P concentration after Carbamide peroxide bleaching can also produce morphological alterations in the most superficial enamel crystallites [27,28].

The 10–15% Carbamide peroxide solutions dissociate into 3–5% Hydrogen peroxide and approximately 7–10% urea. Despite the low Hydrogen peroxide concentration released, at-home tooth-whitening materials are used over prolonged periods and for extensive application time. This raises concerns of possible damage to the hard tissue that is exposed to the highest concentration [29].

The daily application of Carbamide peroxide for 8 h for 14 consecutive days used in the current study simulated home-applied vital bleaching technique [30].

## Conclusions

This *in vivo* investigation showed that the surface roughness can be affected depending on the bleaching agent. Different concentration of Carbamide peroxide and Hydrogen peroxide can promote alteration on enamel surface.

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