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Effects of Different Bleaching Agents on Micro-Hardness and Color Changes in Human Enamel

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Running Title: Effects of Different Bleaching Agents

Abstract:
Objectives: *This single-blind in-vitro study was conducted to assess the effect of different in-office and home bleaching agents on the micro-hardness and color changes of dental enamel.*
Materials and Methods:*Twenty human premolar teeth extracted for orthodontic reasons were used in the study. After mounting, an area of 2 mm circumference was chosen in the mid buccal section of all premolars for bleaching-agent application. The specimens were divided into four (4) groups. Each group was exposed to a specific bleaching material according to its manufacturer's instructions. (GI) Control group; no treatment, teeth were immersed in artificial saliva, (GII) Fläsh, (32% hydrogen peroxide), (GIII) Opalescence Xtra Boost (40% hydrogen peroxide) and (GIV) Opalescence Home (35% carbamide peroxide). Micro-hardness and color changes were recorded for each specimen before and 24-hrs after the application of bleaching materials using Vickers Microhardness Test Machine and a Knoop diamond with 50g load applied for 10s and ColoreyeSpectro-Photometer, respectively. The value deltaE(ab)*=3.3 was used as an acceptable value in subjective visual evaluations. Statistical analysis of data was done using One-Way ANOVA and Tukey'srange test, with significance level set at 5%.*
Results: *Micro-hardness testing showed that while there was an increase in micro-hardness after use of Opalescence Home (GIV), there was a general tendency towards decreased micro-hardness with the other bleaching groups (GII) and (GIII). However, due to small sample size the difference was not statistically significant. Substantial color differences were noticed in readings of deltaE for groups subjected to bleaching.*
Conclusion: It can be concluded that using different bleaching agents can affect enamel micro-hardness and color. However, this was only a pilot study and more detailed results will be outlined once complete number of specimens is examined. Further studies with different materials are necessary to conclude a significant relation.
Keywords: *Bleaching agent,Enamel Micro-hardness, Enamel Color Changes, Home Bleaching, In-office Bleaching, Restorative Dentistry.*

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I. Introduction

During the past decade, the demand for conservative esthetic dentistry has grown dramatically. Tooth discoloration is a frequent dental finding, associated with clinical and esthetic problems . Tooth discoloration has a multi-causal etiology resulting from behavior, disease, injury, and a host of other exposures along with various physiological processes.(1) Tooth discoloration is caused by both extrinsic (surface) and intrinsic (subsurface) dental staining, with tooth appearance being a collective result of intrinsic and extrinsic stain intensity and area. (2) (3)Stains found on teeth usually differ in etiology, appearance, composition, location, severity, and firmness in adherence to the tooth surface. External tooth discoloration is quite common and may be the result of a number of causes as poor oral hygiene, existing restorations, eating habits, or the presence of chromogenic micro-organisms.(4)On the other hand, teeth may be discolored internally during tooth formation. Many factors may contribute to such discoloration as medications (tetracycline), excessive fluoride, high fevers, and trauma. Other causes as caries, metallic restorations, and leakage or recurrent caries around restorations can result in various types of intrinsic discoloration. Non-vital teeth may also show intrinsic discoloration. The pulp may become degenerated due to trauma, deep caries or irritation from restorative procedures. (5) The pursuit of an esthetic smile has stimulated the search for effective treatments and alternatives to increase its attractiveness. Tooth whitening is a highly desirable esthetic treatment, since it is conservative and can lead to satisfactory results for changing dental color. (6) Dental bleaching procedures can be performed in a dental office, with total control of the dentist, or by the patient at home, with professional supervision. Although both techniques are shown to be effective, (7) During in-office bleaching, higher concentrations of the hydrogen peroxide gel are usually used to reduce the clinical treatment time.(8) Understanding the effects of bleaching agents is of prime importance, as it can help determine which bleaching treatment will be safest to obtain the best bleaching effects with maximum preservation of the dental tissues. Although the efficiency of bleaching agents to vital and non-vital teeth is well-documented, the widespread use of bleaching techniques generates some concern about the effects promoted by these agents onto the bleached substrates.(10) Risks to soft tissues, such as burning, a possible co-carcinogenic effect and lesions, are correlated to the use of hydrogen and/or carbamide peroxide in high concentrations.(11) Alterations in the enamel and dentin, such as an increase of roughness, porosity and diminished micro-hardness have also been observed.(10,12,13,14,15,16,17) Akal et. al. reported increased enamel porosity, erosion and superficial demineralization when examining bleached enamel under scanning electron microscope (SEM).(18) Contradictory results have also been observed in spite of the chemical composition, physical and mechanical properties of human enamel undergoing bleaching with minimal alterations.(17,18) . Regarding the micro-hardness properties, there are many controversial results, possibly due to the variations in methodologies.(12,13 ,14 ,15 ,19)Therefore, the objective of this study was to evaluate the effects of In-office bleaching materials on enamel surface micro-hardness and color changes.

II. Materials and Methods

Prior to conduction of the experiment, the protocol of the study was approved by the Ethics Committees at the College of Dentistry, King Saud University. This study involvedtwenty extracted human premolars extracted for orthodontic purposes. After extraction, teeth were debride and stored in 0.05% thymol to prevent fungal and bacterial growth until used for the purpose of the study. All of the teeth were collected within 15 days and stored for no longer than four (4) weeks. The enamel surfaces were examined to be devoid of any stains, enamel cracks, fractures, or other defects. After cutting the roots at the cemento-enamel junction(CEJ), 2 × 3 × 4 mm dental blocks were prepared from each tooth using a diamond disk (Imicryl, Konya, Turkey) under water cooling. The dental blocks were embedded individually in self-curing acrylic resin (Imicryl), with mid-buccal enamel surfaces exposed for application of bleaching agents. The enamel surfaces were flattened with wet 600, 1000, and 1200 grit mounted aluminum oxide abrasive papers (3 mol/l aluminum oxide abrasive paper sheet, USA) using Automata machine (Meisinger, Neuss, Germany) and were polished with (6, 3, 1, and 1/2 µm) grit diamond pastes (Ultradent Diamond Polishing Paste, MPN 5540; Ultradent Products Inc., South Jordan, Utah, USA). Specimens were examined under a stereomicroscope (SZ-CTY; Olympus, Tokyo, Japan) with ×10 magnification to verify the absence of dentin. The specimens were then randomly divided into four (4) groups; (n = 5 samples per group) according to the bleaching and micro-abrasion material used. Group I: Control group (No treatment; stored in artificial saliva throughout the experiment time). Group II: Fläsh; 32% hydrogen peroxide in-office bleaching (WHITEsmile, Birkenau, Germany). Group III: Opalescence Xtra Boost; 38% hydrogen peroxide in-office bleaching (Ultradent Products, Inc. USA). Group IV: Opalescence Home; 35% carbamide peroxide (Ultradent Products, Inc. USA). All materials were used according to manufacturer instructions.In-office bleaching protocol: The 38% hydrogen peroxide in-office bleaching protocol (Opalescence Xtra Boost; Ultardent Products Inc. USA) and 32% hydrogen peroxide in-office bleaching protocol (Fläsh; WHITEsmile Germany) were performed in a total of four sessions, two sessions per week. Each session consists of three stages; each stage will take fifteen (15) minutes-period with a five (5) minutes interval between one stage to another. After every treatment session, each enamel sample was gently washed with deionized distilled water using a cleaned toothbrush in order to remove the residual material.Home bleaching protocol: 35% carbamide peroxide (Opalescence Home; Ultradent Products, Inc. USA) was performed for a total of for four hours per day for two weeks. Each day after the active treatment period the specimens were rinsed with distilled water to remove the bleaching agents. After Home bleaching and In-office bleaching, surface roughness, micro-hardness and color changes were re-measured. All specimens were stored in artificial saliva and renewed daily at 37°C during the entire experiment. The composition of the artificial saliva is 0.058 ppm fluoride, 1.55 mmol calcium, and 0.92 mmol phosphate.Surface color and micro hardness measurements: In order to determine changes in enamel color, Color-eye Spectro-Photometer was used according to the Commission Internationale de I'Eclairage (CIE) L*a*b* color scale (UV-2450; Shimadzu Corp.). Vickers surface micro-hardness (SMH) measurement was also used to measure the small changes in enamel surface hardness. It is a simple method for determining the mechanical properties of enamel and dentin surfaces and it is related to a loss or gain of mineral of the dental structure. It has been previously shown to be a suitable method for determining small changes in SMH of enamel and dentin following erosive challenges from acids and acidic beverages. (20,21)

III. Results

Micro-hardness testing showed that while there was a general tendency towards decreased micro-hardness with the other bleaching groups (GIIFläsh; 32%HP) and (GIII Opalescence Xtra Boost; 38%HP) There was an increase in micro-hardness after use of Opalescence Home (GIV Opalescence Home; 35%CP), compared to Control group (GI).Color change was determined by the difference between the data obtained before and after treatments. GIII and GII showed high-color change (3.11 ± 1.55) and (2.76 ± 1.70) respectively, whereas GIV presented lower color change (2.23 ± 0.26) ($p \leq 0.05$) compared to control group. All the experimental groups, except the GIV group (35% HP), showed a slight reduction in the micro-hardness values and higher color changes in relation to the control group (G1). However, due to small sample size the difference was not statistically significant.

IV. Discussion

The possible effects that peroxides can have on dental tissues have generated numerous studies. Many authors have shown that bleaching gels can alter dental tissue, such as enamel micro-hardness, Directly after bleaching, 84 (51%) treatments showed micro-hardness reduction compared to baseline, whereas 82 (49%) did not yield micro-hardness reduction. After the post-treatment episode, 20 (29%) treatments showed hardness reduction and 49 (71%) did not. A significant higher number of bleaching treatments resulting in enamel micro-hardness reduction were observed, when artificial instead of human saliva was used for storage of the enamel samples in the intervals between the bleaching applications[22]. Whereas inSulieman M, et. al. study showed that there were no significant changes in hardness values for enamel and dentine[23]. Also, in Araujo Fde O, et.al. study reported that The different tested light sources did not significantly influence the micro-hardness[24]**.** The alterations in micro-hardness can be related to the loss or gain of minerals (demineralization and remineralization) of the dental structure. Some studies showed that micro-hardness tests are adequate to determine small differences in the superficial enamel, which can be caused by the effects of acids, colas, and also bleaching gels.[25]

V. Conclusion:

It can be concluded that using different bleaching agents can affect enamel micro-hardness and color. However, this was only a pilot study and more detailed results will be outlined once complete number of specimens is examined. Further studies with different materials are necessary to conclude a significant relation.

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