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EFFECT OF LASER AND LIGHT ACTIVATION ON MINERAL LOSS FROM ENAMEL USING 35% CARBAMIDE PEROXIDE BLEACHING AGENT – AN ATOMIC ABSORPTION SPECTROPHOTOMETRIC STUDY

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ABSTRACT

Aim: To evaluate mineral loss from enamel using carbamide peroxide bleaching agent and the effect of LED and Laser activation on mineral loss from enamel.

Methodology: Twenty human premolar crowns were divided into 80 blocks of 4x4x3mm were obtained. Samples were divided into four groups of twenty each depending upon the beaching treatment and activation method. Group I – Carbamide Peroxide without additional activation, Group II – Carbamide Peroxide with additional activation by Diode Laser, Group III – Carbamide Peroxide with additional activation by LED Light and Group IV – Control group. Amount of calcium and Phosphate loss was calculated using atomic absorption spectrophotometry.

Results: Results showed that bleaching leads to calcium and phosphate loss from enamel with additional activation resulting in higher amounts of mineral loss.

Conclusion: Activation of bleaching agents leads to increased mineral loss from enamel and must be followed by remineralisaton.

KEYWORDS : Carbamide Peroxide, Diode Laser, In-Office bleaching, LED Light.

INTRODUCTION:

Aesthetics of teeth including colour is of paramount importance to most of patients presenting to clinics. The colour of teeth is influenced by intrinsic colour and the presence of any extrinsic stains that may form on the tooth surface.[1-2] Tooth colour can be modified by a number of methods with tooth bleaching being non-invasive and comparatively safe procedure. There are number of methods and approaches that have been described in the literature for bleaching of vital teeth and In-office bleaching generally uses relatively high levels of whitening agents containing peroxides for shorter time periods. The whitening gel is applied to the teeth after protection of the soft tissues and the bleaching agent may be further activated by heat or light.[3]

Studies have shown that the rate of chemical reaction can be increased by increasing the temperature, with a 10°C rise resulting in double the rate of reaction.[3] However, excessive heating can cause irreversible damage to the dental pulp.[4] Contemporary approaches have focussed on accelerating peroxide bleaching with simultaneous illumination of the anterior teeth with various sources having a range of wavelengths and spectral power, for example halogen curing lights, plasma arc lamps, lasers and light-emitting diodes.[5] The light source can activate peroxide to accelerate the chemical redox reactions of the bleaching process.[6] In addition, it has been speculated that the light source can energize the tooth stain to aid the overall acceleration of the bleaching process.[7]

Increasing the efficacy and rate of bleaching reactions might also result in the increased damage to the enamel structure due to the high incidence of possible adverse effects. Hydrogen Peroxide has been associated to morphological changes, as well as to variations in micro-hardness, and in the mineral component of enamel and dentin.[8-10] The aim of this study was to do comparative evaluation of calcium and phosphate loss from enamel by using 35% carbamide peroxide and evaluate the effect of light emitting diode and diode laser activation on mineral loss using atomic absorption spectrophotometer (AAS).

METHODOLOGY:

Twenty human permanent premolar teeth extracted for orthodontic reasons were selected after carefully examining under magnification (×10), and those presenting cracks, caries, or structural enamel defects were excluded from the study. The selected specimens were decoronated at cementoenamel junction using a slow speed diamond disc under copious water irrigation. Each crown was divided in such a way that four blocks of enamel supported by dentin measuring 4×4×3 mm were obtained from every crown. The dentinal surface of each specimen was coated with a layer of varnish to prevent contact with the bleaching agent. The specimens were then assigned to 4-groups of twenty specimens each in such a way that one block from every tooth was allocated to one of the four groups according to the bleaching treatment performed as follows:

Group I: Bleaching without activation

35% of carbamide peroxide gel (Opalesence PF, Ultradent, USA) was applied in two cycles of 20-minutes duration with a rest period of 10-minutes without any additional activation.

Group II: Bleaching with LASER activation

35% of carbamide peroxide was applied to the enamel surface of each specimen and activated by diode laser (SIRO Laser Advance), wavelength = 970 +/-15 nm, power = 7 W.Each test sample was subjected to two cycles of bleaching procedure, each cycle lasting for 20 min as in group I. Diode laser activation was done for 180secs in each cycle (18sec after every 2 min). The laser tip was kept at a distance of 10 mm from the sample which was standardized by a custom made wooden jig.

Group III: Bleaching with LED activation

35% carbamide peroxide was applied and activated by LED (C-Bright-I) Wavelength = 420-490 nm, 100-240 V, 50/60 Hz, and 2.5 A. Each test sample was subjected to two cycles of bleaching procedure, each cycle lasting for 20 min as in Group I. LED activation was done for 180secs in each cycle (18sec after every 2 min).The LED light was kept at a distance of 10 mm from the sample which was standardized by using a scale.

Group IV: Control – No bleaching

No bleaching agent was applied. The samples were stored for 15 days in polycarbonate test tubes with deionised water.

The bleaching agent was evenly applied to each specimen except control group in 1mm thickness to the enamel surface which was standardized by using electronic micropipette. After each application, the bleaching agent was removed using de-ionized water and collected in polyethylene test tubes and homogenized in tube shaker after that the samples were stored in 100% relative humidity at 37°C using a humidifier for 24-hours. The collected samples were subjected to atomic absorption spectrophotometric analysis (Perkin Elmer, USA, AAS 800) for evaluation of calcium and phosphate content in solution (µg/ml).

For statistical analysis mean, range and standard deviation of calcium and phosphate loss in each group was calculated. The data was analyzed by using one way ANOVA analysis. A P value of <0.05 was considered as statistically significant.

RESULTS

Results showed that bleaching agent causes loss of calcium and

phosphate from the enamel and any form of activation of bleaching agent results in increased amount of mineral loss (Table 1). Highest amount of calcium and phosphate loss was observed when bleaching agent was activated with Laser followed by activation with LED light as compared to group I in which bleaching agent was used without any additional activation. Statistical analysis showed significant mineral loss caused by Laser activation of bleaching agent while as there was insignificant increase in loss of minerals from enamel surface with activation using LED (Table 2). Overall, in all groups less amount of phosphate loss was noted as compared to calcium loss.

Table 1. Mean, Standard deviation (SD) and Range of Calcium and Phosphate release (µg/ml) from enamel treated with 35% Carbamide Peroxide

Group Activation Mode	Calcium Release (µg/ml)			P - Value	Phosphate Release (µg/ml)			
	Mean	SD	Range		Mean	SD	Range	P - Value
Group I No Activation	1.08	0.079	0.9-1.2	<0.001	0.62	0.083	0.4-0.7	<0.001
Group II Diode Laser Activation	1.15	0.082	1.01-1.3		0.77	0.093	0.6-0.9	
Group III LED Activation	1.12	0.072	1.03-1.3		0.70	0.265	0.3-1.6	
Group IV Control Group	0.15	0.084	0.07-0.3		0.05	0.028	0.01-0.09	

P <0.05 = statistically significant difference

Table 2. Intergroup comparison of Calcium and Phosphate release (µg/ml) from enamel treated with 35% Carbamide Peroxide

Calcium Release (µg/ml)		Phosphate Release (µg/ml)	
Comparison	P - Value	Comparison	P - Value
Group I vs Group II	0.003	Group I vs Group II	0.003
Group I vs Group III	0.091	Group I vs Group III	0.111
Group I vs Group IV	<0.001	Group I vs Group IV	<0.001
Group II vs Group III	0.167	Group II vs Group III	0.136
Group II vs Group IV	<0.001	Group II vs Group IV	<0.001
Group III vs Group IV	<0.001	Group III vs Group IV	<0.001

P <0.05 = statistically significant difference

DISCUSSION:

Bleaching has been accepted as one of the most effective methods of treating discolored teeth and considered to be a conservative approach towards obtaining esthetic or cosmetic results rather than other methods such as veneering or crowning. Procedures that utilize different concentrations of carbamide peroxide (CP) or hydrogen peroxide (HP) have been commonly used by dentists as "in-office" or by patients as "home bleaching" applications. Procedures apparently rely on an extended period of contact between the bleaching agent and the teeth to accomplish the bleaching. The decomposition of hydrogen peroxide results in the formation of oxygen and per-hydroxyl free radicals that oxidize the stained macromolecules and break down them into smaller fragments which are lighter in color the fragments diffuse across the tooth surface resulting in the bleaching effect.[11] The oxidation reaction should not exceed the saturation point in which the organic and inorganic elements of enamel and dentin are damaged.

Carbamide peroxide bleaching agents are usually designed for home bleaching purposes. Carbamide peroxide is better than hydrogen peroxide as it constituently splits into urea and hydrogen peroxide. The larger core of urea serves to mitigate the acidic effect of hydrogen peroxide by the production of carbon dioxide and ammonia however, it also has an adjuvant effect that helps in compensating for the lesser amount of hydrogen peroxide by softening the enamel proteins such as enamelin and amelogenin, which lie in the interprismatic area of the enamel. Enamel contains 96% inorganic and 4% organic constituents; this allows the penetration of the hydrogen peroxide to the deeper layers. This penetration to the deeper layers is not self limiting, and may even reach the pulp, that can lead to pulpal damage and ultimately dentinal sensitivity or even non vitality of the pulp; this could be explained by the theory proposed by Hsu et al.[12]

In this study 35% carbamide peroxide was used as in office bleaching agent with and without additional activation to determine the mineral loss due to carbamide peroxide when used as in office bleaching agent. In order to eliminate sample selection bias due to different composition of teeth from different individuals, one specimen from every tooth was distributed to each study group. In the present study, on making the intra-group comparison, statistically significant difference was found when mineral ion (calcium and phosphate) release of groups treated with 35% CP activated with diode laser (Group II) was compared with control group (Group IV) and the group in which no additional mode of activation was used (Group I). This adverse effect of bleaching on the enamel mineral ions was noted by many researchers. It may be due to the concentration or type of the bleaching agent used. This agrees with many studies like done by Pinto C et al[13] they showed that after treatment with high concentration of hydrogen peroxide demineralization (loss of minerals) results in decrease in enamel micro hardness. This may be due to high concentration of hydrogen peroxide and formed free radical is higher in laser activated group than in the LED activated group (group III), so causes more demineralization to the enamel. In a similar study performed previously using 35% hydrogen peroxide, higher amounts of calcium and phosphate loss was measured from the enamel surface as compared to 35% carbamide peroxide used in this study.[14]The decreased release of calcium ions with carbamide peroxide use can be attributed to low concentration of hydrogen peroxide released. The 35% CP degrades in to 10% of hydrogen peroxide and 25% of urea The HP further degrades into oxygen and water, while the urea degrades into ammonia and carbon dioxide. The ammonia and carbon dioxide elevate the pH. Hence, a CP solution will supply urea and may raise the pH of solution and hence neutralizes the effects of hydrogen peroxide. In our study the means of release of calcium ions is more than phosphate ion release that may be due to high concentration of calcium ions than the phosphate ions in the enamel surface of permanent teeth. The results are in conformity with the research done by Justino et al.[15]

Results of present study showed that any mode of additional activation of bleaching agents results in more loss of minerals from enamel surface. Hence, the outcome of powered bleaching must be weighed against the excessive mineral loss and every form of bleaching must be followed by re-mineralization protocol. Also there is need to compare the effects of powered bleaching in terms of color change using lasers and lights with that of bleaching without additional activation especially in case of carbamide peroxide so as to determine the viability of 35% carbamide peroxide as in-office bleaching agent.

CONCLUSION:

Within its limitation this study showed that use of 35% carbamide peroxide results in lower mineral loss of enamel although any mode of additional activation of bleaching agent results in increased amount of mineral loss.

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