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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF APPLICATION OF 2% SODIUM FLUORIDE, 0.4% STANNOUS FLUORIDE, 1.23% APF ON ENAMEL MICRO-HARDNESS USING 16% CARBAMIDE PEROXIDE BLEACHING AGENT BY VHN - AN IN VITRO STUDY

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ABSTRACT

Introduction: Bleaching is simplest, least invasive and least expensive means available to lighten discoloured teeth and diminish and eliminate many stains in both vital and nonvital teeth.
Aim- To compare different fluoride gel applications on micro-hardness of bleached teeth using Vicker's Hardness profiles.
Materials and method: 80 extracted human maxillary anterior teeth were selected. Roots of selected teeth were sectioned horizontally 2 mm below the level of CEJ and crown were sectioned labiopalatally. Samples were randomly divided into 3 experimental groups and one control group, 20 samples in each group and stored in artificial saliva for 10 days prior to the bleaching procedure as well as in between 2 successive bleaching procedure. Microhardness testing was done preoperative, post bleaching and post fluoride application. Bleaching was carried out for 21 days for 4 hours. Allotted fluoride application was done on 21st day for 5 minutes group A- Control, Group B- 2% Sodium Fluoride, Group C- 0.4% Stannous fluoride, Group D- 1.23% APF.
Results and Conclusion: Application of bleaching agents led to decrease in microhardness, whereas application of fluorides post bleaching helped to restore the microhardness equal to the preoperative values. APF led to highest increase in the microhardness post bleaching.

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INTRODUCTION

Esthetic dentistry has become a new frontier. Reproducing nature more precisely to reality, preferably by minimal invasive procedures, is beneficial. An attractive smile is an important social asset and is desired by all genders, generations and cultures. Hence, tooth bleaching has gained enormous popularity, due to its non-invasive approach and excellent outcomes. (Andrej and Kielbassa, 2006) Bleaching is simplest, least invasive and least expensive means available to lighten discoloured teeth and diminish and eliminate many stains in both vital and nonvital teeth. Tooth discoloration varies in etiology, appearance, localization, severity and adherence to tooth structure.In bleaching the process is facilitated by the oxidation reaction of peroxide (the bleaching agent carbamide peroxide or hydrogen peroxide), which transforms the organic substance of tooth enamel into lighter chemical intermediates. (Haywood, 1991; Frysh, 1995) Contemporary bleaching agents are typically either hydrogen peroxide (HP) or carbamide peroxide (CP).

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In-office bleaching procedures relatively use high levels of bleaching agents (25–35% HP or 35% CP) for shorter time periods while home-bleaching products typically contain low levels of whitening agent (3-6% HP or 10-16% CP), and worn overnight for desired effect. This technique involves all the steps carried out by patient at home, other than fabrication of bleaching trays. Hence the dental practitioner has very less or no control over the procedure**.** Carbamide peroxide is very unstable and immediately breaks down into its constituent parts on contact with tissue and saliva, dissociating primarily into hydrogen peroxide (H_2O_2) and urea (NH_2CONH_2) and further into oxygen (O_2), water (H_2O) and carbon dioxide (CO_2). (Langsten *et al*., 2002; Haywood, 1992)The use of dental bleaching agents may increase the incidence of negative side effects, such as tooth sensitivity, soft tissue irritation, and alteration of the structural integrity and microhardness of dental and restorative surfaces. (Ljubisamarkovic *et al*., 2014) Major side effect of extra coronal bleaching is enamel damage. (da Costa and Mazur, 2007) It has been shown that bleaching with 10% CP may result in a change in calcium, phosphate and fluoride content in enamel. (Justino *et al*., 2004) Some authors

have reported slight surface alterations, as assessed by scanning electron microscopy and a decrease in surface hardness. (Josey *et al*., 1996)To reduce the tooth sensitivity and re-establish surface hardness addition of potassium nitrate, fluoride and amorphous calcium phosphate (ACP) is done in recently developed materials. Fluoride is incorporated as a remineralizer, which is beneficial during and after bleaching. Fluoride helps in formation of calcium fluoride layer on enamel which reduces demineralization. (Featherstone *et al*., 1982) Hence study was carried out with the aim to determine the effect addition of different fluoride gel application on micro-hardness of teeth post bleaching procedure using Vickers hardness profiles.

MATERIALS AND METHODS

80 extracted human maxillary anterior teeth were selected for study. Roots of selected teeth were sectioned horizontally 2 mm below the level of cementoenamel junction and crown were sectioned labiopalatally by using double sided diamond disc (fine grit). Only labial surfaces were used for study. Polishing was done using 4000 grit carborundum paper discs. Samples were embedded in cold cure acrylic. Samples were stored in artificial saliva for 10 days at temp of 37°C in humid conditions prior to the bleaching procedure as well as during 2 successive bleaching. pH was maintained using potassium hydroxide at 7.

Sample were divided randomly in 4 groups. 20 samples in each group

- GROUP A - 16% Carbamide Peroxide without fluoride application
- GROUP B - 16% Carbamide Peroxide followed by application of 2% Sodium Fluoride
- GROUP C - 16% Carbamide Peroxide followed by application of 0.4% Stannous Fluoride
- GROUP D - 16% Carbamide Peroxide followed by application of 1.23% APF

Materials Used	Composition	Manufacture
Polanight Gel	16% Carbamide peroxide	SDI Pola, UK
DentiCare Pro Gel	2% Sodium Fluoride	Medicom, USA
Gel- Kam	0.4% Stannous Fluoride	Colgate Palmolive company, USA
APF	1.23% APF	Neelkanth Health Care (P.) LTD, India
Artificial Saliva.	0.103 g/L of CaCl2, 0.019 g/L MgClz 6H2O, 0.544 g/L KH2PO4, 2.24 g/L KCl, 4.77 g/L HEPES buffer acid and KOH	Central Research Laboratory, DMIMS, Sawangi, Wardha, India

Baseline VHN were determined prior to bleaching using microhardness tester (Fig 1). 3 indentations were performed on an area 5x3 mm in the middle third of the labial enamel surface of each specimen (Fig 2-A). The long axis of indenter was kept perpendicular to the labial surfaces. The first 3 baseline measurement were taken on the most mesial part of the central area. VHN values were determined (kg/mm^2) at a load of 100gm with indentations for 5 sec. Labial enamel surfaces were dried with cotton pellets. Labial surfaces were isolated with jig made by thermoplastic sheet.The labial surfaces of the specimens were covered with a 1 mm layer of the bleaching gel. Specimens were bleached for four hours.

Fig 1. Microhardness tester machine for VHN (DV 3000)

After each bleaching procedure, the gel was removed with a cotton pellets and specimens were washed and dried with an air/water syringe for five seconds. Specimens were then stored in artificial saliva at 37°C. Specimens were bleached for 21 consecutive days. After bleaching on 21st day microhardness testing was done (Fig 2-B).

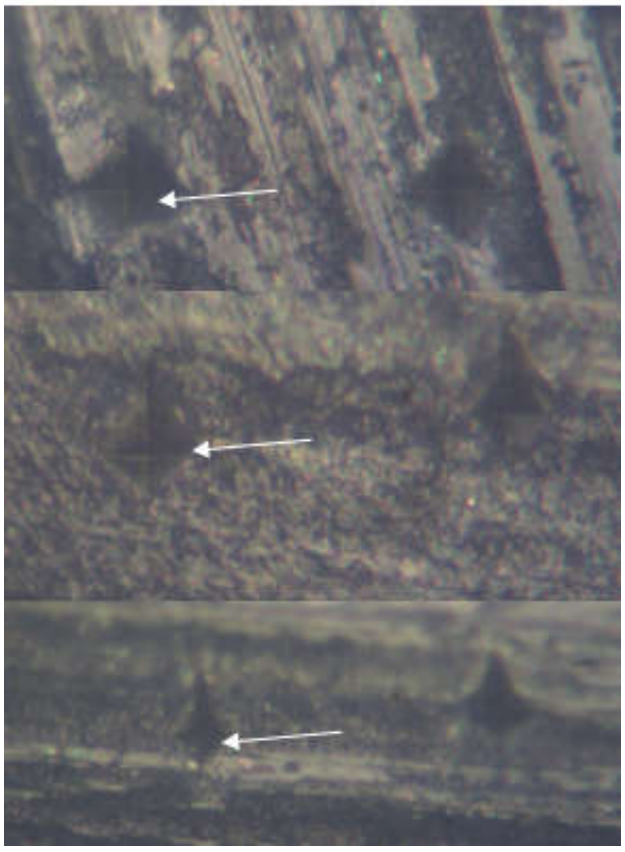
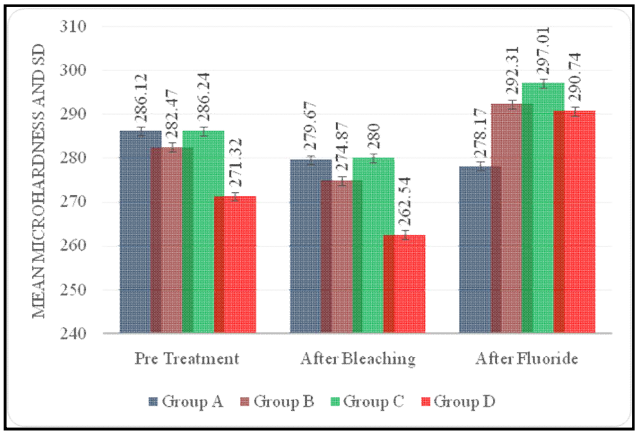


Fig. 2. Microscopic images of enamel surface after indentation for microhardness determination (A-pretreatment, B- after bleaching, C- post bleaching)

After 21st day specimens from Group B, C, D received allotted fluoride for 5 min. After 5 minutes fluoride was wiped off using cotton, and specimens were stored in artificial saliva. On 35th day (14 Days post fluoride application) VHN values were determined. The last 3 measurement were taken on the most distal part of the central area (Fig 2-C).

Statistical analysis

Data was analysed using t test, one way ANOVA, Tukey test. Paired t test was used for before and after comparison. Followed by one way ANOVA, and Tukey's t test for comparison between different groups, significant difference of following parameter, VHN values were analysed.



Graph 1. Comparison of microhardness in Group A, B, C and D

When all the groups were compared for pre-treatment, after bleaching and post bleaching, group D showed highest statistically significant difference between post bleaching and post fluoride VHN values (t=5.68, p=0.0001).

DISCUSSION

Bleaching is believed to occur due to alterations in the chemical structure of organic substances in tooth, by unstable free radicals which are liberated from these compounds, either by oxidation or reduction reaction. Despite the fact that tooth bleaching is not referred so as to create macroscopically visible defects, but microscopic alterations could cause undesirable effects. It is well known that rough surfaces are predisposed for extrinsic staining, plaque maturation, bacteria adhesion and further leading to periodontal disease as well. (Browning *et al*., 2004) In literature a great deal of controversy concerning the effects of this bleaching agent on the micro-hardness of dental hard tissues, particularly enamel has been noted. In present study alterations in the surface morphology has been noted and microhradness of enamel is decreased after application of bleaching agent. The results are accordance with Igor Potcnik *et al*. (2000) Majid Ghanbarzadeh *et al*. (2015) Fluoride may render the tooth surface harder, more resistant to demineralization, and more prone to remineralization. Different topical fluoride agents are used for protection against erosive challenges. (O'Toole *et al*., 2016) After application of fluoride in experimental groups microhardness values were restored to baseline values in almost all the samples. In group B -Sodium fluoride promotes remineralization and inhibits demineralization of dental hard tissues. It favors the formation of a calcium-fluoride like layer. This deposited layer is further dissolved, leading to fluoride release into the underlyingplaque layercovering the tooth, enamel or saliva. (Lussi *et al*., 2012) In group C – Stannous fluoride group - stannous fluoride has been shown to react with enamel to form a tin fluorophosphate complex which coats the surface of enamel as quoted by Toole et al. (2016). In group D- APF group - Acidulated phosphate fluoride applied to enamel leads to remineralization by formation of fluorapatite and fluoridated hydroxyapatite. Reaction with hydroxyapatite crystals occurs directly or it promotes the transformation of other calcium phosphate phases. The formation of fluorapatite and fluoridated hydroxyapatite can reduce the solubility of hydroxyapetite crystals. (Lewinstein *et al*., 2004) Application of 1.23% APF has shown highest reversal of microhardness. These results are similar to Toole *et al*. (2016), Delbem *et al*. (2002). This study tried to replicate clinical conditions. Artificial saliva was used as a storage medium for specimen prior to, in-between and after bleaching procedure. Artificial saliva was used in this study, still there was no positive effect in remineralization was seen either during or after bleaching treatment. Study conducted by (Justino *et al*., 2004). Showed positive effects of artificial saliva in regaining the microhardness. The saliva and it substitutes provides conditions to maintain the pH above the critical pH which is helpful for remineralization. After comparing the pre- operative, after bleaching and post remineralization microhardness values (Days – 0, 21 and 35) it can be stated that microhardness was restored with the help of remineralizers (At day –35) which was reduced after the bleaching procedure (At day-21).

Conclusion

As per the results of this study it can be concluded that the microhardness of the dental hard tissues were adversely affected by the concentration of peroxide in the bleaching agent. . Postoperative treatment with fluorides helped to restore the microhardness of enamel after bleaching. APF showed highest potential and percentile gain in remineralization.

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