Original Article

The Effect of Remin Pro and MI Paste Plus on Bleached Enamel Surface Roughness

Haleh Heshmat[1], Maryam Hoorizad Ganjkar[1]✉, Solmaz Jaberi[2], Mohammad Javad Kharrazi Fard[3]

[1]Assistant Professor, Department of Operative Dentistry, Islamic Azad University, Dental Branch, Tehran, Iran
[2]Dentist
[3]Epidemiologist, Dental Research Center, Tehran University of Medical Sciences

Abstract

Objective: The growing demand for enhanced esthetic appearance has led to great developments in bleaching products. The exposure of hard tissues of the tooth to bleaching agents can affect the roughness of the enamel surface. The freshly bleached enamel surface exposed to various surface treatments such as fluoride and other remineralizing agents have been assessed in this study.

The aim of this experimental study was to compare the effect of Casein Phosphopeptide-Amorphous Calcium Phosphate with Fluoride (MI Paste Plus) and Remin Pro on the enamel surface roughness after bleaching.

Materials and Methods: Thirty enamel samples of sound human permanent molars were prepared for this study. After initial roughness measurement with profilometer, the samples were exposed to 37% carbamide peroxide bleaching agent 20 minutes twice, and randomly divided into three groups of ten. In group 1, a CPP-ACPF containing paste (MI Paste Plus) and in group 2, Remin Pro were applied to the teeth during a 15 day period for 5 minutes, twice a day. Samples of group 3 (control) were immersed in artificial saliva for 15 days .The roughness of all samples were measured at the beginning, after bleaching and after the study intervention and statistically analyzed.

Results: The surface roughness significantly increased in all groups following bleaching, and then it showed a decrease after application of both Remin Pro and CPP-ACPF in comparison to using bleaching agent ($P<0.005$). The surface roughness after using Remin Pro and CPP-ACPF was statistically similar to each other ($P>0.05$).

Conclusion: There was no difference between surface roughness of MI Paste Plus and Remin Pro groups.Also the surface roughness was decreased compared to theinitial enamel surface roughness.

Key Words: CPP-ACP; Surface properties, Tooth Remineralization; Bleaching Agents

✉ Corresponding author:
M. Hoorizad, Department of Operative Dentistry, Islamic Azad University, Dental Branch, Tehran, Iran

mahoorizad@yahoo.com

Received: 11 July 2013
Accepted: 6 December 2013

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2014; Vol. 11, No. 2)

INTRODUCTION

The growing demand for bleaching as an esthetic improvement has led to a concideable development in bleaching products [1]. Bleaching agents have created micro structural changes on the enamel surface. Studies demonstrated demineralization, degradation, and alteration on surface microhardness and roughness of sound enamel surface, through scanning electron microscopy (SEM) evaluation [1-4]. Roughness is considered a predisposing factor for bacterial adhesion and stain absorption [4-6].

Remineralization occurs when calcium and phosphate in the environment among the enamel or dentin crystals recrystallize on the surface crystal remnants. The calcium and phosphate come primarily from saliva [7]. Saliva does not exert a uniform effect in the mouth and it mostly acts as distinct localized effects [8]. Fluoride therapy has been strongly advised to avoid such side effects [2,9].

In order to overcome the side effects of bleaching agents, enamel surface demineralization could be controlled by saliva, artificial saliva, remineralizing solutions and fluoride. In some studies, enamel polishing has also been recommended to restore enamel smoothness and its lustrous surface. However, polishing procedures can result in removal of a few micrometers of the enamel, reducing its thickness and loss of the superficial layer [9].

Some attempts for enhancing remineralization have been carried out, in which the use of fluoride is the most well known. A newer concept for remineralization is taking advantage of dairy products and their derivatives that appear to have a protective effect against demineralization [10].

Remineralization is a simple chemical process which requires no growth factor and soft-tissue biological process in order to take effect [7]. In other words, remineralization is defined as the process whereby calcium and phosphate ions are supplied from an external source to the tooth to promote ion deposition into crystal voids in demineralized enamel to produce net mineral gain [11].

MI Paste Plus (GC, Japan) containing Casein Phosphopeptide- Amorphous Calcium Phosphate with 900ppm Fluoride (CPP-ACPF) are used as remineralization agents. The adhesive CPP part of the CPP_ACP/ACPF complex binds readily to the enamel and biofilm, providing calcium and phosphate ions exactly where they are needed. The calcium and phosphate ions leave the CPP complex, enter into enamel rods, and increase hydroxyapatite crystals density [11-14]. CPP-ACPF consists of calcium, phosphate and 900ppm fluoride ions. For every two flouride ions, ten calcium ions and six phosphate ions are required to form one unit cell of flouroapatite [$Ca_{10}(po_4)_6F_2$] [11]. The same proportions have been taken into account in the production of CPP-ACPF.

Remin Pro(VOCO,Germany) is another type of remineralizing paste which in contrast to CPP-ACP products, contains calcium, phosphate in the hydroxyapatite form. In addition, Fluoride and Xylitol have also been included in this product [15]. If such products have proven remineralizing properties, it would be logical to observe a reduction of surface roughness in bleached teeth.

Therefore, this study was performed to evaluate the possible effect of topical application of CPP-ACPF and Remin Pro in bringing about remineralization changes and reduction in enamel roughness that has been exposed to bleaching agent.

MATERIALS AND METHODS

Thirty freshly extracted third molar teeth with intact enamel surfaces and devoid of any restoration, carious lesion, erosion, microcracks and stain on the lingual and facial surfaces were collected for the study. The teeth were thoroughly cleaned of debris and soft tissues attached to the root surfaces and then stored in 0.1% thymol solution for 48 hours to prevent fungal and bacterial growth. All teeth were sectioned mesiodistally into buccal and lingual halves using a diamond disk bur under cool water spray.

The initial enamel roughness of the samples were measured using profilometer in micrometer as the next procedure. Afterwards, a thin layer of an office bleaching agent (PolaOffice gel, SDI) containing 37.5% hydrogen peroxide was applied directly on the enamel surface of all samples, smeared over the teeth and remained for 8 minutes. The procedure was repeated 3 times according to the manufacturers' instructions (24 minutes in total). The surfaces were rinsed off and the application procedure was repeated accordingly.

Then the samples were irrigated for 10 seconds using physiological serum and the enamel roughness of the samples were measured. The samples were stored in artificial saliva (kin saliva, Aus) medium at 37°C.

The samples were randomly assigned to two experimental and one control group (n=10). In group 1, MI Paste Plus and in group 2, Remin Pro was applied for 5 minutes on the enamel surfaces twice a day.

These procedures were repeated for 15 consecutive days. In group 3, which served as the control, the teeth remained intact. All samples were stored in artificial saliva during the 15 day study period.

The artificial saliva had a mineral content devoid of calcium (i.e, xylitol, potassium chloride, sodium chloride, magnesium, potassium phosphate and sodium saccharin) that was changed daily. After the 15-day study period, all samples were subject to roughness measurement as follows.

Roughness measurement:

The method used to measure roughness was by means of a diamond stylus which scanned with 0.08 mm per second speed across the enamel surface under a constant load (15.0mN) and the displayed numeric values representing the roughness of that was recorded (Ra). In this study, Ra value was obtained using a TR200 profilometer. The findings of the study were analyzed using repeated measures ANOVA tests. The level of significance was set at 0.05 for all stages.

RESULTS

The mean, maximum, minimum and standard deviation values of roughness for all groups and at each stage are presented in Table 1.

The mean surface roughness value in all groups were significantly increased after bleaching ($P<0.05$). There was no significant differences between the surface roughness changes of two treatment groups ($P>0.05$). In addition, the roughness of surface enamel after using Remin Pro and CPP-ACPF was significantly lower than their previous bleached stage ($P<0.05$) (Table 2). The final mean surface roughness in group 1 (0.106±0.094) and group 2 (0.058±0.084) were significantly lower than group 3 (0.568±0.190) ($P<0.05$).

Table 1. The Values of Mean, SD, Maximum and Minimum of Surface Roughness (µm) in Groups

Group	Ra	Mean±SD	Minimum	Maximum
Group 1	Initial	0.275±0.234	0.013	0.773
	Bleach	0.603±0.229	0.140	0.923
	Final	0.568±0.084	0.002	0.277
Group 2	Initial	0.272±0.100	0.147	0.432
	Bleach	0.638±0.171	0.360	o.860
	Final	0106±0.094	0.001	0.267
Group 3(control)	Initial	0.246±0.186	0.013	0.580
	Bleach	0.568±0.190	0.161	0.759
	Final	0.551±0.192	0.160	0.74

DISCUSSION

According to the results of this study, the enamel surface roughness increased after bleaching with a 37.5% peroxide hydrogen gel. Followed by application of either Remin Pro and CPP-ACPF, the enamel roughness showed a significant reduction in comparison to the control group.

Many previous studies demonstrate that bleaching agents have negative effects on the enamel structures in terms of hardness, roughness and surface morphology [2, 4, 9]. In this study, the enamel surface roughness is measured using profilometer [2, 5, 9].

Mahmoud and colleagues used AFM and found larger size enamel grains in bleached samples with deep micro porosities in between when compared to sound enamel [3]. However, other studies have reported no significant difference in surface roughness between intact and bleached enamel specimens [16]. The extent of surface roughness changes mainly related to the concentration of hydrogen peroxide in bleaching agents [9, 17]. In the current study, Pola office, a 37.5% hydrogen peroxide product was used. The advantage of this product is that it is devoid of fluoride, anti allergenic, or remineralizing components that could possibly act as confounding factors. The oxidizing component and the acidic pH=4.2 of this agent increase demineralization and subsequently increase surface roughness [18].

It can be proposed that the acid diffuses into the tooth and dissolvesthe carbonated hydroxyapatite, resulting in a demineralized porous enamel resembling carious lesions.

It is argued that Saliva is able to remineralize enamel crystals mainly due to its ability in providing calcium and phosphate ions. At a physiological pH level, unstimulated and stimulated and whole saliva are supersaturated with calcium and phosphate ions [19]. But on the other hand, precipitation of calcium phosphate phases from saliva normally does not occur, due to the presence of salivary proteins, particularly statherin and proline-rich phosphoproteins [20, 21].

Fluoride ions in the presence of calcium and phosphate ions can help replace the lost mineral of early caries lesions by remineralization, however fluoride alone cannot remineralize [7,11]. Ideally, a remineralization system should supply calcium, phosphate and fluoride ions that could be able to affect subsurfaces rather than deposition only in the surface layer [13]. The remineralized outcome is more resistant to acid than the original enamel or dentin mineral, especially if fluoride is present to enhance remineralization and to be incorporated into the new crystal surfaces [7, 13,22,23]. In this study, remineralization agents were used for 15 days based on statements that the average time for CPP-ACP to remineralize after acid exposure is 14 days [12].

Table 2. Comparison of the Changes in Roughness in the Three Study Groups (µm)

Ra / Group	Initial-Bleached	Bleached -Final	Initial-Final	P Value
Group 1	-0.327±0.110	0.545±0.073	0.218±0.071	<0.05 /=0
Group 2	-0.366±0.042	0.532±0.064	0.166±0.035	<0.05 /=0
Group 3	-0.321±0.052	0.017±0.02	-0.204±0.04	>0.05
P Value	>0.05	>0.05	<0.05	

Several studies have investigated the effect of CPP-ACP on enamel surface roughness [14, 22]. Other studies, using DIAGNOdent® (KaVo) and scanning electron microscope (SEM) have also shown that both CPP-ACP and CPP-ACPF are capable of remineralizing artificially induced carious lesions. These results are somehow in line with the results of the current study, showing the ability of CPP-ACPF to improve the surface properties of the enamel [10]. Roughness measurements were performed using profilometry in this study, which has an advantage of precisely measuring the surface roughness, without the need for additional quantitative analysis. The surface roughness of the enamel could be analyzed by the profilometric method, an effective quantitative evaluation [5,9]. It has been shown in a microscopic analysis that CPP-ACPF solutions in MI Paste Plus produced greater remineralization than their CPP-ACP relatives, and the mineral formed in the subsurface lesions was consistent with hydroxyapatite and fluoroapatite for remineralization with CPP-ACP and CPP-ACFP [24,25]. Accordingly, in these studies we compared the effect of Remin Pro and CPP-ACPF on the enamel surface roughness. Remin Pro consists of fluoride, hydroxyapatite (calcium and phosphate) and xylitol in which manufacturers claim that it promotes remineralization by filling porous areas, forming a protective film on the tooth surface and thereby impeding the adhesion of bacterial plaque. As no specific instructions for using this product was found, it was used in the same manner as CPP-ACPF. Although SEM and microradiographic assessment are considered as a routine in such studies, they could not be accomplished in the current investigation because all samples served as their own controls and could not be manipulated and deteriorated for SEM purposes.

CONCLUSION

According to the findings of this study, remineralizing products such as MI Paste Plus and Remin Pro can decrease the surface roughness of enamel surfaces that have been previously roughened by bleaching agents. There was no difference between the surface roughness of MI Paste Plus and Remin Pro groups.

REFERENCES

1- Hilgenberg SP, Pinto SC, Farago PV, Santos FA, Wambier DS. Physical-chemical characteristics of whitening toothpaste and evaluation of its effects on enamel roughness. Braz Oral Res. 2011 Jul-Aug;25(4):288-94.

2- Worschech CC, Rodrigues JA, Martins LR, Ambrosano GM. In vitro evaluation of human dental enamel surface roughness bleached with 35% carbamide peroxide and submitted to abrasive dentifrice brushing. Pesqui Odontol Bras. 2003 Oct-Dec;17(4):342-8.

3- Mahmoud SH, Elembaby Ael S, Zaher AR, Grawish Mel-A, Elsabaa HM, El-Negoly SA, Sobh MA. Effect of 16% carbamide peroxide bleaching gel on enamel and dentin surface micromorphology and roughness of uremic patients: an atomic force microscopic study. Eur J Dent. 2010 Apr;4(2):175-82.

4- Singh RD, Ram SM, Shetty O, Chand P, Yadav R. Efficacy of casein Phosphopeptidee-amorphous calcium phosphate to prevent stain absorption on freshly bleached enamel: An in vitro study. J Conserv Dent. 2010 Apr;13(2):76-9.

5- Mathias J, Kavitha S, Mahalaxmi S. A comparison of surface roughness after micro abrasion of enamel with and without using CPP-ACP: An in vitro study. J Conserv Dent. 2009 Jan;12(1):22-5.

6- Mei L, Busscher HJ, van der Mei HC, RenY. Influence of surface roughness on streptococcal adhesion forces to composite resins. 2011 Aug;27(8):770-8.

7- Featherstone JD. Remineralization, the natural caries repair process--the need for newapproaches. Adv Dent Res. 2009;21(1):4-7.

8- Schlesinger DH, Hay DI. Complete covalent structure of statherin, a tyrosine-rich acidic peptide which inhibits calcium phosphate

precipitation from human parotid saliva. J Biol Chem. 1977 Mar 10;252(5):1689-95.
9- Pinto CF, Oliveira Rd, Cavalli V, Giannini M. Peroxide bleaching agent effects on enamel surface microhardness, roughness and morphology. Braz Oral Res. 2004 Oct-Dec;18(4):306-11.
10- Jayarajan J, Janardhanam P, Jayakumar P; Deepika. Efficacy of CPP-ACP and CPP-ACPF on enamel remineralization - an in vitro study using scanning electron microscope and DIAGNOdent. Indian J Dent Res. 2011 Jan-Feb;22(1):77-82.
11- Cochrane NJ, Cai F, Huq NL, Burrow MF, Reynolds EC. New approaches to enhance demineralization of tooth enamel. J Dent Res. 2010 Nov;89(11):1187-97.
12- Reynolds EC.Casein Phosphopeptidee-amorphous calcium phosphate: the scientific evidence. Adv Dent Res. 2009;21(1):25-9.
13- Vashisht R, Kumar A, Indira R, Srinivasan MR, Ramachandran S. Remineralization of early enamel lesions using casein Phosphopeptidee amorphous calcium Phosphate: an ex-vivo study. Contemp Clin Dent. 2010 Oct;1(4):210-3.
14- Pulido MT, Wefel JS, Hernandez MM, Denehy GE, Guzman-Armstrong S, Chalmers JM, QianF.The inhibitory effect of MI paste, fluoride and a combination of both on the progression of artificial caries-like lesions in enamel. Oper Dent. 2008 Sep-Oct;33(5):550-5.
15- VOCO. Instructions for use of Remin Pro. 2010 Aug 1; Available at: http://www.voco.com/asia/products/_products/Remin_Pro/GI_Remin_Pro_16 spr_0210.pdf. Accessed Jan 6, 2012.
16- Gürgan S, Bolay S, AlaçamR. In vitro adherence of bacteria to bleached or unbleached enamel surfaces. J Oral Rehabil. 1997 Aug; 24(8):624-7.
17- Sa Y, Sun L, Wang Z, Ma X, Liang S, Xing W, et al. Effects of two in-office bleaching agents with different pH on the structure of human enamel: an in situ and in vitro study. Oper Dent. 2013 Jan-Feb;38(1):100-10.
18- Price RB, Sedarous M, Hiltz GS. The pH of tooth-whitening products. J Can Dent Assoc. 2000 Sep;66(8):421-6.
19- Larsen MJ, Pearce EI. Saturation of human saliva with respect to calcium salts. Arch Oral Biol. 2003 Apr;48(4):317-22.
20- Schlesinger DH, Hay DI. Complete covalent structure of statherin, a tyrosine-rich acidic peptide which inhibits calcium phosphate precipitation from human parotid saliva. J Biol Chem. 1977 Mar 10;252(5):1689-95.
21- Hay DI. Salivary factors in caries models. Adv Dent Res. 1995 Nov;9(3):239-43.
22- Reynolds EC. Calcium phosphate-based remineralization systems: Scientific evidence? Aust Dent J. 2008 Sep;53(3):268-73.
23- Borges BC, de Souza Borges J, de Araujo LS, Machado CT, Dos Santos AJ, de Assunçao PinheiroIV. Update on nonsurgical, ultraconservative approaches to treat effectively non-cavitated caries lesions in permanent teeth. Eur J Dent. 2011 Apr;5(2):229-36.
24- Cochrane NJ, Saranathan S, Cai F, Cross KJ, Reynolds EC. Enamel subsurface lesion remineralisation with casein Phosphopeptide estabilised solutions of calcium, phosphate and fluoride. Caries Res. 2008;42(2):88-97.
25- Vashisht R, Kumar A, Indira R, Srinivasan MR, Ramachandran S. Remineralization of early enamel lesions using casein Phosphopeptidee amorphous calcium Phosphate: an ex-vivo study. Contemp Clin Dent. 2010 Oct;1(4):210-3.