Effect of external tooth bleaching on dental plaque accumulation and tooth discoloration

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Abstract

Objectives: Treatment of dental discolorations with external bleaching is becoming very common in dentistry, however, possible irreversible alterations on enamel surface due to bleaching procedures is a topic of discussion.
The aim of this study was to evaluate the clinical effects of bleaching by measuring the dental plaque accumulation on human enamel and tooth discoloration in vivo. Study Design: Forty-four teeth in eleven patients not revealing any restorations or periodontal problems were enrolled in this study. Bleaching agent applied only to labial surfaces of incisors using commercial 35 % hydrogen peroxide gel. Dental plaque and tooth color measured in the same group of participants, at the end of non-brushing periods lasting 3 and 5 days, respectively, before and after bleaching. Results: The results of the comparison of pre- and post-bleaching measurements showed that, after a non-brushing period lasting 3 day, discoloration scores and plaque accumulation scores for bleached surfaces were lower than the non-bleached surface scores. However, at the end of a non-brushing period lasting 5 day, even the color measurement score in post-bleaching period was lower than the pre-bleaching counterpart, plaque index measurements showed higher plaque accumulation scores in the bleached group. Conclusions: According to these results, bleaching with 35 % hydrogen peroxide seem to favor plaque accumulation after non-brushing period lasting 5 day and tooth discoloration after bleaching is not in correlation with the amount of plaque accumulation.

Key words: *Dental bleaching, 35 % hydrogen peroxide, plaque accumulation.*

Introduction

Tooth discoloration can be classified as intrinsic, extrinsic or a combination of both (1). Scaling and polishing of teeth are conventional treatment choices for extrinsic tooth discolorations, however, for stubborn discolorations and intrinsic stains, bleaching techniques may be needed (2). Bleaching of discolored tooth was first described in 1864 (3), and later several bleaching agents such as chloride, sodium hypochlorite, sodium perborate, and hydrogen peroxide were used (4-11). Present tooth bleaching techniques commonly use hydrogen peroxide as the active agent. Hydrogen peroxide may be applied directly, or produced in a chemical reaction from sodium perborate or carbamide peroxide (2). Concentration of the hydrogen peroxide seems to affect the success of the bleaching procedure, together with the duration and the number of times the agent is applied (2).
Bleaching has effects on enamel surface roughness

(8,9,12-14). Enamel consists of thin rods and prisms that stand upright on the surface of dentin, usually with a pronounced inclination toward the crown (15). Bleaching treatments might enlarge gaps between enamel prisms, resulting in invasive pathways to surface (16). Rough enamel surfaces promote plaque formation and maturation together with color changes (17). Previous studies have usually analyzed the morphologic changes on enamel surfaces after bleaching by different techniques. But the outcome of these hypothesized enamel alterations such as the effect of bleaching on plaque accumulation was not evaluated clinically. Our hypothesis is that; bleaching can cause morphological alterations on enamel surface, and this favors an increase in plaque accumulation, together with dental discoloration. Thus, the aim of this preliminary study was to evaluate short-term clinical effects of 35% hydrogen peroxide bleaching on the dental plaque accumulation and discoloration on human enamel *in vivo*.

Material and Methods

In order to evaluate the differences in plaque accumulation and discoloration on bleached and non-bleached teeth *in vivo*, plaque accumulation and dental discoloration were analyzed in the same patient group before and after bleaching at the end of periods lasting 3 and 5 days, where participants abstained from oral hygiene. Eleven volunteered healthy dental students (age 20-22 years) were enrolled in this study. Forty-four teeth including 4 upper anterior teeth from each subject formed the study group. The inclusion criteria were: 1) a minimum of 24 teeth in each subject, 2) no clinical signs of gingival inflammation, and 3) no probing pocket depths >3mm. The exclusion criteria were: 1) dental restorations or orthodontic treatment history, 2) having contraindicated conditions for bleaching (extremely large pulps, exposed root surfaces, severe loss of enamel, pregnancy and nursing, peroxide allergy), and 3) systemic diseases or medication usage. The study design was explained and the participants' written consents were obtained. The local institutional board of ethics approved the study. Study protocol consisted of two periods, pre-bleaching and post-bleaching periods, as shown in Figure 1. Briefly, participants abstained from oral hygiene for 3 and 5 days before (pre-3, pre-5) and after bleaching (post-3, post-5). At the end of pre-3, pre-5, post-3, and post-5 plaque accumulation and tooth color were measured. Also on the day-7 (pre-0) and day-36 (post-0) plaque accumulation and tooth discoloration were measured as baseline values of before bleaching and after bleaching periods. Bleaching agent was applied once and in an only visit.

Pola Office (SDI Limited, Australia), with 35 % hydrogen peroxide solution as primary active ingredient, was used as bleaching agent. At the beginning of bleaching protocol teeth were cleaned. A resin barrier was applied to the gum areas, and hydrogen peroxide gel was applied to labial surfaces of each upper incisor. Standard dental light cure applied on teeth for 30 sec. each. The gel was then taken off using suction.

Colors of the teeth were assessed subjectively using a commercial value-orientated shade guide tabs (VITA; Zahnfabrik, Germany). The shade tabs were arranged in an order according to the manufacturer suggestions and a numerical value was assigned to each shade tab ranging from 1 to 16 (B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, C4). Two different plaque index measurements were used simultaneously in this study. According to Turesky Modification of the Quigley-Hein Plaque Index (18) (TPI), microbial dental plaque scored according to following criteria: 0, no plaque; 1, separate flecks of plaque at the cervical margin of the tooth; 2, a thin continuous band of plaque up to 1mm at the cervical margin of the tooth; 3, a band wider than 1 mm but covering less than 1/3 of the tooth; 4, plaque covering at least 1/3 but less than 2/3 of the crown; 5 plaque covering 2/3 or more of the crown. The plaque scoring in Rustogi modification of Modified Navy Plaque Index (19) (MNI) is based on the presence or absence of plaque by a score 1 or 0, on the nine areas of surface (Figure 2). In order to maintain standardization, all plaque index measurements were done by U.K.G., all color shade guide measurements were done by O.O.B., all bleaching procedures were done by D.I.E., and all scaling and polishing procedures were done by V.B. Two-sample (paired) samples *t*-test was used in statistical analysis. Pre-bleaching values of tooth-color and plaque index measurements were compared with post-bleaching counterparts. The significance level was set at $p < 0.05$. All statistical procedures were performed using SPSS 13.0 statistical software program (SPSS. Inc., USA).

Results

The 11 patients (5 male, 6 female) selected for the study were 20-22 years old. VITA, MNI and TPI mean values for pre-0, -3,-5, and post-0, -3, -5 are depicted in Figure 3. When pre-0 is compared with post-0, discoloration was found to decrease significantly after bleaching. Color shade change was significantly kept low in post-3 and post-5 in comparison with pre-3 and pre-5 scores ($p < 0.05$). Plaque accumulation measurements, both MNI and TPI, gave significantly low scores in post-3 in comparison with pre-3, in correlation with VITA scores ($p < 0.05$). However, on the contrary, post-5 MNI and TPI scores were significantly higher than pre-5 scores ($p < 0.05$).

Discussion

The present study evaluated the effect of bleaching by 35% hydrogen peroxide on dental discoloration and dental plaque accumulation in short term periods. According to the results, after oral hygiene abstaining periods lasting 5 days amount of dental plaque accumulation was higher than non-bleached counterparts.

The role of dental plaque as an etiological agent of both dental caries and periodontal disease is indisputable (20-

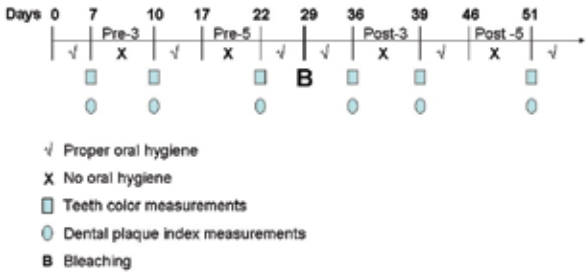

Fig. 1. Study protocol description. Study subjects received scaling and polishing and meticulous oral hygiene instructions in the day 0. After that, patients either performed proper oral hygiene or did not perform any oral hygiene procedures.

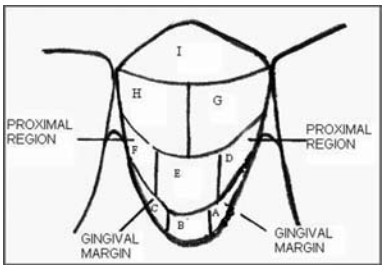

Fig. 2. Rustogi Modification of Navy Plaque Index (MNI)[19]. The presence or absence of plaque is scored by 1 or 0, on nine areas of tooth surface. Sum of the scores is the MNI score of the tooth.

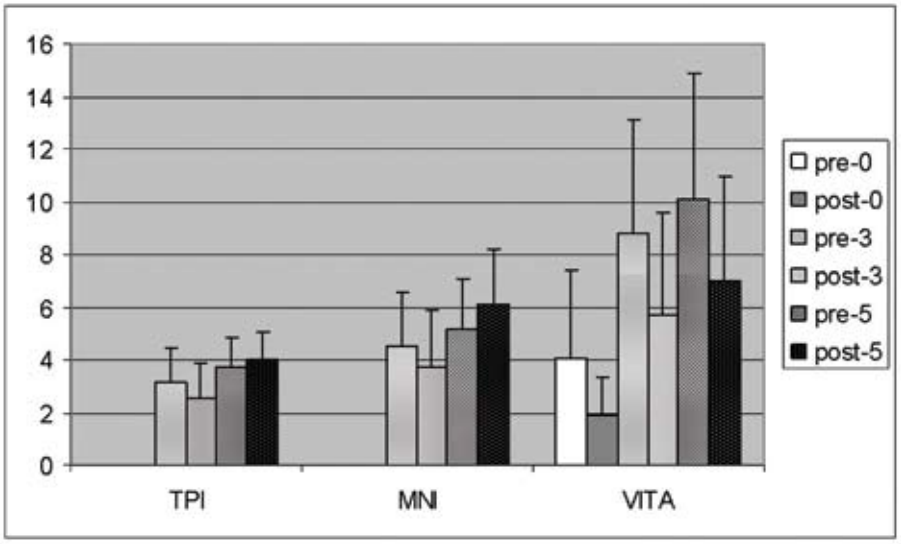

Fig. 3. Mean values of TPI, MNI, and VITA index measurements for 44 teeth. Bars give the mean numbers and standard deviations for triplicate measurements.

23). In healthy oral cavity, a dynamic equilibrium exists on teeth surfaces between the forces of retention and removal of dental plaque. However, rough surfaces promote dental plaque formation and maturation (17). In the absence of oral hygiene, a detectable dental plaque organizes in around 36 hours on human teeth. Most common areas are the gingival margin and the irregularities on the tooth (20). Morphological alterations of the enamel caused by tooth bleaching have been addressed earlier (8,9,12,13). Hosoya et al. (16) showed that vital bleaching treatment increases the enamel surface roughness and also suggested that with the repeat of bleaching, the adhesion of *Streptococcus mutans* to enamel surface increases. However, opposite results that have confirmed the safety of bleaching products have been published (5-7). Yurdukoru et al.(7) analyzed enamel surface morphology using scanning electron microscopy after bleaching with 35% hydrogen peroxide and suggested that there were no significant morphologic differences between bleached and non-bleached enamel. Controversies in enamel surface morphology issue can be explained with the differences in study designs, sample sizes, application times and enamel morphology evaluation techniques (5). Current study aimed to evaluate the discoloration and accumulation of dental plaque after bleaching; its target was not to evaluate any morphological alterations. Plaque index measurement results after non-brushing periods lasting five days showed that plaque accumulation is significantly higher on bleached tooth surfaces than non-bleached surfaces. And as the dental plaque accumulation on bleached teeth is significantly less than non-bleached surfaces after oral hygiene abstaining period lasting 3 day, it may mean that after the day 3, accumulation of plaque on bleached surfaces accelerates after its initial organization (20).

Tooth color usually changes slightly after polishing, but much promptly after bleaching. Studies by Nakamura et al. (24) and Shethri et al. (25) definitely showed that tooth color change is statistically significant after bleaching. Also Shethri et al. (25) suggested that color relapse begins after bleaching and continues up to fifth week post-operatively. In this study, color change evaluations using Vita Shade Guide showed that color scores significantly reduced after bleaching. However on bleached surfaces, plaque accumulation was higher than non-bleaching counterparts. So we may suggest that, plaque accumulation does not always have to correlate with tooth color.

In order to minimize the subjectivity in evaluations, we used two different plaque indexes while determining the plaque accumulation. Both indexes were in correlation with the others results. We used a commercial color shade guide to evaluate tooth discolorations. Using shade guides for prostheses in measuring vital teeth color has several limitations in comparison with spectrometers or colorimeters; however still it is a quick and cost effective method and human eye is very efficient in detecting even small differences of color between two subjects (26).

With recognition of this short term *in vivo* study's limits, it can be said that, bleaching accelerates dental plaque accumulation on non-brushed teeth. However color change after bleaching still get protected after short term non-brushing periods, which may mean that early plaque accumulation does not have to favor with discoloration of teeth.

References

1. Hattab FN, Qudeimat MA, al-Rimawi HS. Dental discoloration: an overview. J Esthet Dent. 1999;11(6):291-310.
2. Dahl JE, Pallesen U. Tooth bleaching--a critical review of the biological aspects. Crit Rev Oral Biol Med. 2003;14(4):292-304.
3. Truman J. Bleaching of non-vital discoloured anterior teeth. Dentistry Times. 1864; 1: 69-72.
4. Ernst CP, Marroquín BB, Willershausen-Zönnchen B. Effects of hydrogen peroxide-containing bleaching agents on the morphology of human enamel. Quintessence Int. 1996 Jan;27(1):53-6.
5. No authors listed] Laser-assisted bleaching: an update. ADA Council on Scientific Affairs. J Am Dent Assoc. 1998 Oct;129(10):1484-7.
6. Spalding M, Taveira LA, De Assis GF. Scanning electron microscopy study of dental enamel surface exposed to 35% hydrogen peroxide: alone, with saliva, and with 10% carbamide peroxide. J Esthet Restor Dent. 2003;15(3):154-64.
7. Yurdukoru B, Akören AC, Unsal MK. Alterations in human enamel surface morphology following the use of an office bleaching agent and consecutive application of 37% phosphoric acid in vivo. J Clin Dent. 2003;14(4):103-7.
8. Bitter NC. A scanning electron microscopy study of the effect of bleaching agents on enamel: a preliminary report. J Prosthet Dent. 1992 Jun;67(6):852-5.
9. Bitter NC. A scanning electron microscope study of the long-term effect of bleaching agents on the enamel surface in vivo. Gen Dent. 1998 Jan-Feb;46(1):84-8.
10. Berga Caballero A, Forner Navarro L, Amengual Lorenzo J. In vivo evaluation of the effects of 10% carbamide peroxide and 3.5% hydrogen peroxide on the enamel surface. Med Oral Patol Oral Cir Bucal. 2007 Sep 1;12(5):E404-7.
11. Berga-Caballero A, Forner-Navarro L, Amengual-Lorenzo J. At-home vital bleaching: a comparison of hydrogen peroxide and carbamide peroxide treatments. Med Oral Patol Oral Cir Bucal. 2006 Jan 1;11(1):E94-9.
12. Bitter NC. Bleaching agents. J Am Dent Assoc. 1999 Jan;130(1):26-28.
13. Hairul Nizam BR, Lim CT, Chng HK, Yap AU. Nanoindentation study of human premolars subjected to bleaching agent. J Biomech. 2005 Nov;38(11):2204-11.
14. Lopes GC, Bonissoni L, Baratieri LN, Vieira LC, Monteiro S Jr. Effect of bleaching agents on the hardness and morphology of enamel. J Esthet Restor Dent. 2002;14(1):24-30.
15. Bloom W, Fawcett DW. A Textbook of Histology. 9th ed. Philadelphia: W.B.Saunders Company; 1996.
16. Hosoya N, Honda K, Iino F, Arai T. Changes in enamel surface roughness and adhesion of Streptococcus mutans to enamel after vital bleaching. J Dent. 2003 Nov;31(8):543-8.
17. Quirynen M, Bollen CM. The influence of surface roughness and surface-free energy on supra- and subgingival plaque formation in man. A review of the literature. J Clin Periodontol. 1995 Jan;22(1):1-14.
18. Turesky S, Gilmore ND, Glickman I. Reduced plaque formation by the chloromethyl analogue of victamine C. J Periodontol. 1970 Jan;41(1):41-3.
19. Rustogi KN, Curtis JP, Volpe AR, Kemp JH, McCool JJ, Korn LR. Refinement of the Modified Navy Plaque Index to increase plaque scoring efficiency in gumline and interproximal tooth areas. J Clin Dent. 1992;3(Suppl C):C9-12.
20. Newman MG, Takei HH, Carranza FA. Clinical Periodontology. 9th ed. Philadelphia: W.B.Saunders Company; 2002.
21. Beighton D. The complex oral microflora of high-risk individuals and groups and its role in the caries process. Community Dent Oral Epidemiol. 2005 Aug;33(4):248-55.
22. Marsh PD. Dental plaque: biological significance of a biofilm and community life-style. J Clin Periodontol. 2005;32 Suppl 6:7-15.
23. Rosan B, Lamont RJ. Dental plaque formation. Microbes Infect. 2000 Nov;2(13):1599-607.
24. Nakamura T, Saito O, Ko T, Maruyama T. The effects of polishing and bleaching on the colour of discoloured teeth in vivo. J Oral Rehabil. 2001 Nov;28(11):1080-4.
25. Al Shethri S, Matis BA, Cochran MA, Zekonis R, Stropes M. A clinical evaluation of two in-office bleaching products. Oper Dent. 2003 Sep-Oct;28(5):488-95.
26. Joiner A. Tooth colour: a review of the literature. J Dent. 2004;32 Suppl 1:3-12.