Original Article

pISSN, eISSN 0125-5614
M Dent J 2020; 40 (3) : 299-304

Efficacy of a bleaching agent on fluorescence loss of enamel during orthodontic treatment by quantitative light-induced fluorescence

Suleyman Kutalmış Buyuk[1], Huseyin Simsek[2], Eren Gurses[3], Ahmet Yagci[4]

[1] *Department of Orthodontics, Faculty of Dentistry, Ordu University, Ordu, Turkey*
[2] *Department of Pediatric Dentistry, Faculty of Dentistry, Ordu University, Ordu, Turkey*
[3] *Specialist in Orthodontics, Private Practice, Kayseri, Turkey*
[4] *Department of Orthodontics, Faculty of Dentistry, Erciyes University, Kayseri, Turkey*

Objective: The purpose of this study was to evaluate the effect of a bleaching procedure containing 8% hydrogen peroxide on fluorescence loss of maxillary anterior teeth during orthodontic treatment.

Materials and Methods: Six maxillary anterior teeth of 19 patients were evaluated by using quantitative light-induced fluorescence (QLF). The patients were divided into 2 groups according to the type of orthodontic bracket. Group 1: Orthodontic treatment with metal brackets and using bleaching agent during the last 10 days of orthodontic treatment. Group 2: Orthodontic treatment with ceramic brackets and using bleaching agent during the last 10 days of orthodontic treatment. QLF images were taken before and after orthodontic treatment. Four QLF parameters (ΔF, ΔFmax, A, and ΔQ) were assessed for six maxillary anterior teeth on the images.

Results: In metal bracket group, the QLF parameters revealed no significant changes except at the left maxillary lateral incisor ($P < 0.05$). In ceramic bracket group, the QLF parameters also revealed no significant changes except at the right maxillary lateral incisor, ($P < 0.05$). These two groups were reasonably similar with each other in terms of fluorescence loss.

Conclusions: The 8% hydrogen peroxide bleaching agent has no changes in fluorescence loss of maxillary central incisors and canines. Therefore, it is suggested that no mineral loss when apply 8% hydrogen peroxide on maxillary central incisors and canines during fixed orthodontic treatment.

Keywords: dental bleaching, fixed orthodontic treatment, mineral loss, quantitative light-induced fluorescence

How to cite: Buyuk SK, Simsek H, Gurses E, Yagci A. Efficacy of a bleaching agent on fluorescence loss of enamel during orthodontic treatment by quantitative light-induced fluorescence . M Dent J 2020; 40: 299-304

INTRODUCTION

It is known that plaque accumulation increases in individuals that receive fixed orthodontic treatment. Increased plaque accumulation leads to increased cariogenic activity, which results in the formation of demineralized areas on the enamel. Initial enamel demineralization appears as white spot lesions [1,2]. The appearance of white spot lesions on the enamel surface of teeth coming out during orthodontic treatment creates an uncomfortable image for patients. Moreover, patients receiving orthodontic treatment expect to have whiter teeth while their teeth are aligned [3]. Some researchers believe that bleaching agents will not be effective because of the presence of brackets during orthodontic treatment [4,5]. However, recent studies have reported that hydrogen peroxide, a frequently used bleaching agent, is effective even under orthodontic brackets and restorations due to codirectional diffusion [6,7].

Teeth whitening can be performed by the dentist in clinic or by the patient at home with specialized supervision [8]. Hydrogen peroxide

Correspondence author: Suleyman Kutalmış Buyuk
Department of Orthodontics, Faculty of Dentistry, Ordu University 52200 Ordu, Turkey
Tel: +904522121286-int:7216
e-mail: skbuyuk@gmail.com
Received : 8 May 2020 Accepted : 30 November 2020

forms are often used as different concentrations to whiten teeth [9,10]. In recent years, the bleaching system named *Opalescence Treswhite Ortho* (Ultradent, Opal Orthodontics Inc, South Jordan, UT, USA) has been developed, which is announced that it can be used for orthodontically treated individuals. This system consists of an inner layer that carries 8% hydrogen peroxide whitening agent and that is easily applied even to bracket teeth, and a semi-rigid outer layer carrying this layer. The *Opalescence Treswhite Ortho*, a bleaching system that the patient can easily apply at home with specialized supervision, has been reported to give effective results in terms of bleaching during orthodontic treatment [9].

Quantitative light-induced fluorescence (QLF) method, which has a very high reliability by measuring loss of fluorescence, has started to be used although many methods have been found to evaluate tooth discoloration and fluorescence loss [11,12]. The use of QLF device has become widespread in recent years and is known to be a reliable method for the diagnosis of white spot lesions, loss of enamel fluorescence, and detecting dentinal caries [2, 12-14]. In the literature, there are a few studies related to *Opalescence Treswhite Ortho* bleaching system [9,15]. However, there are no information about the demineralization on tooth enamel surface. Therefore, the purpose of this study was to evaluate the effect of bleaching procedure containing 8% hydrogen peroxide on the fluorescence loss of maxillary anterior teeth in patients with metal and ceramic brackets during orthodontic treatment.

Materials and methods

This study was approved by the Clinical Research Ethics Committee of the Erciyes University (2019-397). This research was conducted in full accordance with the World Medical Association's Declaration of Helsinki. The sample size was performed based on a power analysis using G*Power Software version 3.1.9 (Universität Düsseldorf, Germany) at alpha error probability of 0.05 and a power of 80%. The power analysis showed that 110 maxillary anterior teeth were required. All patients were divided into two groups and fixed orthodontic treatment was performed. Fixed orthodontic treatment was applied to 114 maxillary anterior teeth from 19 patients who registered at clinic for orthodontic treatment. The first group of patients (n=12) was applied with metal brackets (Mini Master, American Orthodontics, Wisconsin, USA) and with ceramic brackets (Radiance, American Orthodontics, Wisconsin, USA) in the second group (n=7). All patients received oral hygiene training during the orthodontic treatment and were asked to brush their teeth after each meal. Any supporting remineralization agent was given to the patients during treatment.

Mineralization changes in patients were measured by using QLF Digital Biluminator. This system consists of a personal computer connected to a special camera and QLF-D program. QLF images are automatically saved to the computer via the program. The photographs were taken at the same camera angle and in the same position to provide a standard. The camera settings are optimized for the dark environment where photos are taken. The same observer analyzed images by using QLF analysis software (Figure 1).

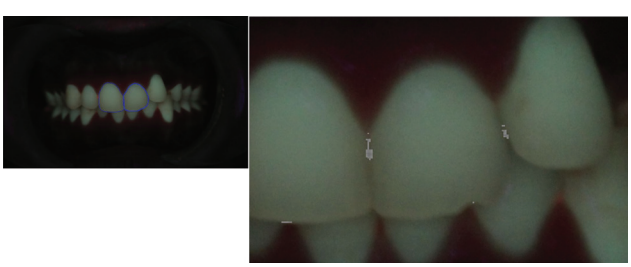

Figure 1 QLF analyzing software performed for the fluorescence measurements.

Four parameters were measured for each tooth: percentage of fluorescence loss with respect to the fluorescence of sound tooth tissue (ΔF [%]), maximum loss of fluorescence intensity in the whole lesion (ΔFmax [%]), lesion area with ΔF equal to or smaller than a–5% threshold (A [px^2]), and percentage of fluorescence loss with respect to the fluorescence of sound tissue times the area that indicated lesion volume ΔQ [$\%px^2$]).

The initial QLF values (T0) of the anterior teeth on whole buccal surfaces were recorded before the bracket placement. The bleaching agent was applied at home on the last 10 days for 45 minutes per day every day before the finishing orthodontic treatment according to the manufacturer's instructions. After the brackets were debonded in both groups, the enamel surface was cleaned in enough quantities and the QLF values were measured on whole buccal surfaces of the anterior teeth (T1).

Statistical Analysis

All statistical analyses were performed by using SPSS (SPSS for Windows version 20.0; SPSS Inc, Chicago, Illinois) program. All data normality was analyzed by using of Shapiro-Wilk test. Comparison of the ΔF, ΔF max, ΔQ and A between T0 and T1 in the metal and ceramic bracket groups were performed with the Wilcoxon signed rank test. Comparison of the changes in the ΔF, ΔF max, ΔQ and A values between the groups were performed with the Mann-Whitney U test. A level of significance of $P < 0.05$ was performed.

Results

The data from 19 patients and totally initial 114 teeth labial surfaces were evaluated QLF fluorescence levels. The QLF parameters in metal bracket group were shown in Table 1. Only left maxillary lateral incisor showed significant changes of the QLF parameters between TO and T1 ($P < 0.05$). For the ceramic bracket group, only right maxillary lateral incisor showed significant changes of the QLF parameters between TO and T1 ($P < 0.05$), as shown in Table 2. The QLF parameters for intergroup comparisons were displayed in Table 3. The metal bracket and ceramic bracket groups were reasonably similar with each other in terms of mineral loss except maxillary right canine and lateral incisors.

Discussion

A bleaching agent containing 8% hydrogen peroxide, *Opalescence Treswhite Ortho,* was used in metal and ceramic brackets groups during fixed orthodontic treatment in the present study. The results of this study showed that bleaching application in metal and ceramic brackets groups confirmed generally similar mineralization changes during orthodontic treatment.

Hydrogen peroxide can be easily diffused in dental enamel since it has a low molecular weight, and it is frequently used as a dental bleaching agent. Hydrogen peroxide diffuses through the dental enamel and interacts pigmented organic structures in dentin, thus produces a bleaching effect. In contrast, when hydrogen peroxide is in contact with the dental enamel and dentin, loss of substance in enamel and dentin and porosity increases. This may cause hydrogen peroxide to reach the pulp chamber [5,15]. This is the most common side effect of bleaching at home, patients should be warned about its complications.

Table 1 Comparison of the ΔF, ΔFmax, ΔQ and A between T0 and T1 in the metal bracket group with the Wilcoxon Signed Rank Test.

Tooth	ΔF(%) T0	ΔF(%) T1	P-value	ΔFmax(%) T0	ΔFmax(%) T1	p value	ΔQ(%px^2) T0	ΔQ(%px^2) T1	p-value	A(px^2) T0	A(px^2) T1	p-value
11	-1.13(2.65)	-1.67(3.14)	0.465	-1.50(3.73)	-3.17(5.17)	0.279	-67.60(221.50)	-141.08(251.17)	0.345	9.91 (32.21)	32.08(68.78)	0.144
12	-1.18(3.43)	-3.04(3.89)	0.345	-2.75(5.31)	-3.58(5.60)	0.465	-207.40(628.81)	-298.75 (677.42)	1.000	23.00 (65.51)	24.33 (65.13)	1.000
13	-0.65(3.13)	-0.83(2.38)	1.000	-2.83(5.17)	-2.50(3.26)	0.892	-72.67(144.84)	-27.83 (72.60)	0.144	13.00 (23.56)	7.00 (14.71)	0.144
21	-2.35(3.63)	0.00(0.00)	0.660	-4.58(10.70)	0.00(0.00)	0.144	-88.58(22.53)	0.00 (0.00)	0.068	14.50 (31.78)	8.58 (29.73)	0.345
22	-3.4(3.59)	-0.52(1.79)	0.039*	-5.25(5.71)	-0.83(2.89)	0.039*	-148.33(180.80)	-10.91 (37.82)	0.039*	21.17 (25.85)	1.75 (6.06)	0.039*
23	-1.28(2.99)	-1.16(3.70)	0.715	0.33(6.02)	-2.33(4.46)	0.066	-19.50(45.67)	-80.91 (258.70)	0.593	4.33 (10.13)	11.33 (32.26)	0.465

*P-value <0.05

Table 2 Comparison of the ΔF, ΔFmax, ΔQ and A between T0 and T1 in the ceramic bracket group with the Wilcoxon Signed Rank Test.

Tooth	ΔF(%) T0	ΔF(%) T1	p-value	ΔFmax(%) T0	ΔFmax(%) T1	p-value	ΔQ(%px^2) T0	ΔQ(%px^2) T1	p-value	A(px^2) T0	A(px^2) T1	p-value
11	-0.87(2.31)	-1.25(3.33)	0.655	-1.00(2.65)	-2.71(7.18)	0.655	-5.14(13.61)	-61.57(162.90)	0.655	0.86(2.27)	7.00(18.52)	0.655
12	-5.10(3.56)	-2.37(4.06)	0.138	-8.86(6.62)	-3.86(6.64)	0.042	-218.00(313.67)	-35.86(61.24)	0.042*	77.71(128.52)	24.00(53.29)	0.043*
13	-4.41(4.50)	-0.60(3.71)	0.068	-8.14(9.14)	-2.14(2.91)	0.068	-197.57(291.65)	-15.00(36.65)	0.068	25.14(32.13)	4.00(6.45)	0.068
21	-3.51(6.93)	-0.90(2.38	0.317	-5.57(11.60)	-1.28(3.40)	0.655	-36.29(63.04)	-19.00(50.27)	0.655	3.57(6.63)	3.00(7.93)	0.655
22	-0.79(2.09)	0.00(0.00)	0.317	-0.71(1.89)	0.00(0.00)	0.317	-3.14(8.32)	0.00(0.00)	0.317	0,57(1.51)	0.00(0.00)	0.317
23	-0.67(3.98)	0.83 (2.19)	0.285	-2.86(3.67)	-0.42(1.13)	0.109	-3.86(6.26)	-0.28(0.76)	0.109	1.29(1.98)	0.43(1.13)	0.109

Table 3 Comparison of the changes in the ΔF, ΔFmax, ΔQ and A values between the metal and ceramic groups with the Mann-Whitney U tests.

Tooth	ΔF(%) Metal	ΔF(%) Ceramic	p-value	ΔFmax(%) Metal	ΔFmax(%) Ceramic	p-value	ΔQ(%px^2) Metal	ΔQ(%px^2) Ceramic	p-value	A(px^2) Metal	A(px^2) Ceramic	p-value
11	-0.55(3.84)	-3.39(4.35)	1.000	-1.67(6.33)	-1.71(8.06)	0.845	-73.50(295.50)	-56.43(165.71)	0.807	22.17(43.37)	6.14(19.03)	0.473
12	-1.20(4.13)	2.73(3.89)	0.090	-0.83(6.34)	5.00(6.53)	0.131	-91.33(733.41)	182.14(268.17)	0.055	1.33(98.36)	-53.71(76.16)	0.032*
13	-0.17(2.13)	3.81(5.44)	0.034*	0.33(3.52)	6.00(7.09)	0.049*	44.83(108.88)	182.57(259.72)	0.120	-6.00(13.99)	-21.14(26.19)	0.120
21	2.36(3.64)	2.61(6.91)	0.513	4.58(10.70)	4.29(11.79)	0.682	88.58(22.53)	17.29(58.01)	0.260	-5.92(46.54)	-0.57(3.60)	0.354
22	2.89(4.47)	0.79(2.08)	0.170	4.42(7.10)	0.71(1.89)	0.156	137.41(194.04)	3.14(8.32)	0.156	-19.42(28.03)	-0.57(1.51)	0.156
23	0.13(2.37)	1.50(2.71)	0.625	-2.67(6.02)	2.43(3.10)	0.110	-61.41(225.02)	3.57(6.24)	0.082	7.00(26.03)	-0.86(1.21)	0.064

**P*-value <0.05

Different methods can be performed to detect the color and mineral in teeth. Visual evaluation, digital radiography, alternative spectroscopy, spectrophotometer and recently developed QLF methods can be used to evaluate mineral loss and color changes in teeth. In addition, the white spot lesions formations can also be successfully detected by using QLF-D device [2]. The use of QLF for evaluating enamel demineralization after bleaching in different type of orthodontic bracket patients appears to be more advantageous since it provides accurate and rapid assessment. QLF device that is known to provide sensitive and reliable results was used to detect mineralization changes in the teeth [11,12].

Gomes et al. [3] applied 35% hydrogen peroxide gel for 40 minutes in two or three sessions in individuals during fixed orthodontic treatment and had satisfactory results. However, no study evaluating the effect of bleaching during orthodontic treatment on tooth mineral loss was found by using QLF. In our study, the *Opalescence Treswhite Ortho* bleaching agent was used in metal and ceramic brackets groups during fixed orthodontic treatment and successful results were obtained.

The bleaching application during fixed orthodontic treatment had been investigated in different studies. Jadad et al. [9] investigated *Opalescence Treswhite Ortho* bleaching agent during orthodontic treatment and evaluated color changes in 6 maxillary teeth by using a spectrophotometer. As a result of their study, they reported that the *Opalescence Treswhite Ortho* bleaching agent could be used effectively during fixed orthodontic treatment. Montenegro-Arana et al. [15] also stated that bleaching agents based on 8% and 10% hydrogen peroxide levels were effective during orthodontic treatment.

The results of this study showed that the left maxillary lateral incisor demineralization changes in metal bracket group, also right maxillary lateral incisor demineralization changes in ceramic bracket group. It is thought that mineral changes

in these teeth may be caused by orthodontic treatment and bracket type used. Moreover, the reason for the difference may be associated with the initial localization of the crowding, the tooth brushing hand, the eating habits of the patient or the difference in the initial mineralization level of both teeth.

Conclusion

The results of this clinical study showed that there is no change in fluorescence loss or no mineral loss of maxillary central incisors and canines when applying the *Opalescence Treswhite Ortho* bleaching agent during fixed orthodontic treatment. The use of 8% hydrogen peroxide bleaching agent could be recommended for patients who want their teeth whitening in specific teeth during orthodontic treatment.

Acknowledgements: The authors thank Eksen Medikal (Mr. I. Canbolet) for contributing the bleaching agents for the study.

Disclosure of Interest: The authors declare that they have no conflict of interest.

Informed Consent: Informed consent was obtained.

References

1. Chatterjee R, Kleinberg I. Effect of orthodontic band placement on the chemical composition of human incisor tooth plaque. *Arch Oral Biol* 1979; 24: 97-100.
2. Korkmaz YN, Yagci A. Comparing the effects of three different fluoride-releasing agents on white spot lesion prevention in patients treated with full coverage rapid maxillary expanders. *Clin Oral Investig* 2019; 23: 3275-85.
3. Gomes MN, Dutra H, Morais A, et al. In-Office Bleaching During Orthodontic Treatment. *J Esthet Restor Dent* 2017; 29: 83-92.
4. Lunardi N, Correr AB, Rastelli AN, et al. Spectrophotometric evaluation of dental bleaching under orthodontic bracket in enamel and dentin. *J Clin Exp Dent* 2014; 6: e321-e326.
5. Consolaro A, Consolaro RB, Francischone L. Clarifications, guidelines and questions about the dental bleaching "associated" with orthodontic treatment. *Dental Press J Orthod* 2013; 18: 4-10.
6. Kwon SR, Wertz PW. Review of the Mechanism of Tooth Whitening. *J Esthet Restor* Dent 2015; 27: 240-257.
7. Haywood VB, Leech T, Heymann HO et al. Nightguard vital bleaching: effects on enamel surface texture and diffusion. *Quintessence Int* 1990; 21: 801-804.
8. Barghi N. Making a clinical decision for vital tooth bleaching: at-home or in-office?. *Compend Contin Educ Dent* 1998; 19: 831-840.
9. Jadad E, Montoya J, Arana G, et al. Spectrophotometric evaluation of color alterations with a new dental bleaching product in patients wearing orthodontic appliances. *Am J Orthod Dentofacial Orthop* 2011; 140: e43-e47.
10. Dietschi D, Rossier S, Krejci I. In vitro colorimetric evaluation of the efficacy of various bleaching methods and products. *Quintessence Int* 2006; 37: 515-526.
11. van der Veen MH, de Josselin de Jong E. Application of quantitative light-induced fluorescence for assessing early caries lesions. *Monogr Oral Sci* 2000; 17: 144-162.
12. Al-Khateeb S, Forsberg CM, de Josselin de Jong E, et al. A longitudinal laser fluorescence study of white spot lesions in orthodontic patients. *Am J Orthod Dentofacial Orthop* 1998; 113: 595-602.
13. van der Veen MH, Mattousch T, Boersma JG. Longitudinal development of caries lesions after orthodontic treatment evaluated by quantitative light-induced fluorescence. *Am J Orthod Dentofacial Orthop* 2007; 131: 223-228.
14. Lee JW, Lee ES, Kim BI. Can red fluorescence be useful in diagnostic decision making of residual dentin caries?. *Photodiagnosis Photodyn Ther* 2019; 26: 43-44.
15. Montenegro-Arana A, Arana-Gordillo LA, Farana D, et al. Randomized Double-blind Clinical Trial of Bleaching Products in Patients Wearing Orthodontic Devices. *Oper Dent* 2016; 41: 379-387.